University of Roma Tre

Doctorate School on Industrial Complex Systems

1ST CYCLE

DOCTORATE CANDIDATE:
Filieri Raffaele

PH.D. ADVISOR:
Dr. Angelo Corallo

Ph.D. SCHOOL COORDINATOR:
Prof. Fabio Carassiti

Università degli Studi Roma 3
and
Istituto Superiore Universitario di Formazione Interdisciplinare (ISUFI), e-Business Management School

Overcoming Knowledge Sharing barriers through Communities of Practices

Empirical Evidence from a Big Automotive Supplier

By

FILIERI RAFFAELE

Doctoral dissertation submitted to the Università Roma 3, via della Vasca Navale 79, 00149, Roma (RM), Italy

Dedicated to my family

Index

3rd part: Methodology and Research

List of Figures

List of Tables

Acknowledgments

I sincerely would like to thank prof. Fabio Carassiti for his brilliant advises and for making the SICS a reality.
Thus, I want to thank people who, in some ways, helped me during the PhD, that is dr. Angelo Corallo, and dr. Francesca Grippa and my ex-colleagues of ISUFI with whom I have collaborated.
Finally, I want to thank my friends and my family who supported me a lot during these years.

Preface

This research started by analyzing the increased interest and popularity of some theories that are not new, but that are rediscovering a new interest by researchers and academicians.
This new interest is due to the changed requirements and needs for a competition that is global and where the main resource enabling survival and competitive advantage is now represented by knowledge.
The current environment is more turbulent, disturbed and instable than in the past, changes are dramatic and unpredictable.
Forecasting models and mathematical models of prediction are showing their limitations, the future is no more perfectly predictable, that involves a situation of instability, named in the social domain, liquid modernity (Bauman, 2000).
Today firms have to deal with: the intensification and globalisation of competition, the acceleration of technology advancements, the enlargement of required investments, the emergence of connected, informed, empowered, and active consumers; the convergence of industries, technologies and so on.
Firms are not ready to compete in such environment, there is not the right answer to all these transformation, several options are at their disposal, but managers cannot preview exactly which one will guarantee the future sustainability of their business. Briefly they lack of a flexible and clairvoyant strategy, anticipating rather than adapting to environmental conditions.
The delocalization of industrial settlements requiring basics competencies for gaining cost-advantages and the increased number of enterprises producing in the same countries the same goods, have moved the attention of entrepreneurs in searching a new way to compete in the global environment.
Moreover, enterprises benefiting of cost-production advantages as located in emerging countries, where the costs of workers is definitely lower than industrialized countries, is not more sufficient in the global market. As matter of fact, it is emerging the necessity of continuously adapting to customer needs and this means continuous innovation and improvements of products.
The complexity of society have fostered the emergence of market niches at all levels, customers are less willing than in the past to adopt the same products, dressing in the same way and doing the same things of their group of friends they belong to. A new individualism is emerging in the consumer behavior, every single customer want to distinguish from all the others and manifest his specific personality through every kind of consumer goods.
The emergence of new needs have created the necessity of adapting production process and products to new standards. For example customers today require product that respect the environment and are willing to pay more for having ecologically friendly products. Moreover, the advances in I&CT have created other needs, like being always connected to the internet even when driving a car, or having the possibility to check the mail or listen music through the mobile phone and so on. In all industrialized countries knowledge workers are replacing industrial workers, and businesses should not be seen from an industrial, but from a knowledge perspective (Sveiby, 1997, 26).

The transformation of work and workers into knowledge work and knowledge workers is at the core of a larger shift at the organizational and at the societal level. This phenomenon was first noticed in the American society, where multinationals such as Nike, Coca Cola, Levi's started to outsource the mere production, maintaining in-house only the management of the brand and the other marketing activities (sponsoring, life cycle management, identity building…).

This is reflected by a share of 60 % of US organizations which think that between 60% and 100% of their employees are knowledge workers (Delphi, 1997, 10). Businesses like automakers, software houses, pharmaceuticals or biotechnology are typical examples of knowledge intensive organizations (Jordan and Jones, 1997:392), however many other businesses, not conceived as knowledge–intensive sectors/industries before, are introducing more qualified staff as well, and configuring their business with a major focus on knowledge management.

These new needs require an increased quality and quantity of competencies, knowledge and technologies that firms have to search within and across their boundaries. Inside, by optimizing the capabilities and knowledge of their employees and facilitate their interactions; outside, by making partnerships and alliances and exploiting the knowledge within the network of collaborating firms.

Parallel to the surge in interest among practitioners, academic interest in organizational learning and knowledge management also grew considerably, as evidenced by the proliferation of books and articles recently published on the subject (Argote, McEvily and Reagans, 2003).

In order to be effective and efficient, firms today have to possess a KM strategy, develop KM goals, an appropriate organizational design describing KM instruments to be used, roles responsible for knowledge-related tasks, processes that use knowledge management systems, a supportive organizational culture and a corresponding KMS controlling that evaluates whether the goals of using these systems have been achieved (Maier, 2007:8).

Organizations 'move from Max Weber's bureaucratic organization towards the ideal of a knowledge organization that can be viewed as an intelligent, complex adaptive system consisting of networked individual, intelligent agents, knowledge workers, that together learn and quickly combining knowledge from everywhere within or beyond the organization to solve problems and thus create superior business value as well as to flexibly adapt to environmental changes' (Bennet and Bennet, 2003:625).

Recently, we have witnessed a strong growth in the literature concerning the involvement of suppliers and customers in the new product development process. However, the lack of attention devoted by scientific research to the management of international and extended innovation processes contrasts sharply with the importance attributed to it as a cornerstone of international firms success. Although several theoretical papers and empirical researches have highlighted the importance of external partners for successful new product development, few researches have highlighted the problems related to knowledge sharing within the firm and with them.

Abstract

Managing complexity and achieve effective and continuous innovations are widely recognized as a major source of sustained competitive advantage. The changes of the rules of competition require increasing investments in knowledge management due to the increasing complexity of customer requirements (and consequently shorter product life cycles) and to the growing costs of technologies that succeed that needs.

A new model of business is emerging in order to successful compete in this new competitive environment, that is the Extended Enterprise (EE). The EE can be conceptualized as a set of interdependent firms working together in intimate and trust based relationships to co-develop, co-produce or co-deliver complex products, with a determinant role played by Information and Communication Technologies (ICTs).

The capacity of the organization to share knowledge among its network of collaborators and apply it to performing important activities is increasingly seen as a vital source of competitive advantage in many industries (Dierickx & Cool, 1989; Grant, 1996; Kogut & Zander, 1992; Nonaka & Takeuchi, 1995; Teece, Pisano & Shuen, 1997; Carlile 2004).

A wide body of research has recognized several factors accelerating or lowering the process of knowledge sharing, such as geographical location, motivation, absorptive capacity and so on.

This research is aimed at investigating the strenght of the impact of social, organizational and technological factors on knowledge sharing in two Business Units (ICT and Vehicle) of Elasis S.c.p.a., a first tier supplier of R&D of the Fiat Group.

The analysis of the multidisciplinary literature related to knowledge sharing studies enabled the identification of several factors, grouped under the label of organizational, social and technological factors.

A pre-selection of these factors was done through informal interviews with managers and analysts working in Elasis. Thus, the differential impact of these variables on knowledge sharing was measured through multiple regression analysis.

Increasingly, the growing interest in facilitating knowledge sharing activities has led to increased attention being paid to social network analysis as a tool for mapping knowledge and capabilities and the nature of relationships within informal networks (Allen et al., 2007). However, despite the knowledge-intensive nature of R&D activities, social network analyses within R&D function remain relatively rare. Furthermore, this research discusses the role of informal networks in the access and sharing of knowledge within the two business lines selected for the study. Social network analysis resulted useful to map inter and intra-organizational knowledge transfer in two Business Units within Elasis: Vehicle and ICT.

Implications for the firm are clear, first of all we provide through social network analysis a better understanding of the informal organization, showing how effectively R&D work, that is how is structured their knowledge sharing network. The recognition of the hidden network of collaboration

have several implications, one of these is the creation of informal communities of practices for knowledge management.

This thesis is composed of four parts, each one has produced a paper that has been refereed and discussed in international conferences.

The first part is focused on the analysis of the metamorphosis of the firm structure due to the adaptation to environmental changes. Specifically, in this part we will introduce the model of the Extended Enterprise, a new model of the firm that tries to assimilate complexity management and try to optimize the activities of resources' exploitation and exploration within and across the network of collaborators through ICTs.

The second part focuses on the analysis of the literature on knowledge management, and in particular the barriers/enablers of knowledge sharing process from 1969 to 2007.

The third part contains the empirical analysis, in which through multivariate data analysis the main barriers affecting knowledge sharing in Elasis will be identified.

In this part, the process of anomalies audit/solution is selected as case study to show how the problems identified previously affect the process of product development.

Finally, since the creation of a Community of Practice within Elasis appeared as the best tool to solve the problems identified, we decided to use social network analysis to map the knowledge sharing network present within and across the firms' boundaries and to identify the potential members of the CoP.

1st part

Theoretical basis

1. Theoretical Basis

The theoretical basis of this work is related to the conceptualization of the emerging model of the firm of the Extended Enterprise (EE). In this chapter we are going to identify the theoretical origins of the EE and to define the main characteristics of this new way to manage businesses.

1.1 Resource Based Theory

The antecedents of the Extended Enterprise date back to Penrose' (1959) work on the growth of the firms, especially for the view of the firm as a clear-cut entity made up of different "bundles" or portfolios of resources, an entity difficult to define, except to what it does or what is done with it. Penrose (1959) and the precursors of the Resource Based View of the firm (RBV) (Wernerfelt, 1984; Rumelt, 1984; Barney, 1986; 1991) anticipated the interest for start-up pursuing entrepreneurial strategies on the accumulation of intangible resources for survival or growth.
What's new was that for the first time a distinction between tangible (such as physical, human capital etc.) and intangible assets (such as organizational routines, brand positioning etc.) emerged.
Penrose was the first who said that labor, capital and land, constitute the intangible nature of many valuable resources tied to the firms. Moreover the author recognizes that these resources can be owned by the firm or external to it and the firm has to exploit these 'productive' opportunities present in the environment.
Then, he also highlighted the role and the capabilities of the entrepreneur, saying that opportunities are numerous, but the entrepreneur can see or take advantage of some of them, so the entrepreneurship is what limits the profitability and the size of the firm. Entrepreneurship or enterprise is a kind of intangible asset and it is associated with temperament or personal qualities of individuals; so it results to be difficult to measure the performance of the firm just considering measurable indicators and ignoring the non-measurable one such as the entrepreneurship.
Then, he concludes that the creation of value is due to the capacity of the entrepreneur in the effective and innovative management of productive opportunities, giving rise to a cause-relation effect between resources management and the creation of growth and innovation, with a renewed centrality of the human resource (entrepreneurship). As in Penrose also in Wernerfelt and in Barney management has a central role. Antecedents in economics see management roles merely as a function for processes optimization within a firm. Barney see managers as 'strategizers' and accord them a central role in identifying, exploiting and developing profitable opportunities. This is consistent with Penrose', who assumes that management capabilities permit to exploit unused productive resources.
Penrose open a new orientation in considering the efficiency of a firm, in which tangible and measurable assets were as valuable as intangible and not measurable assets. He was the first who highlighted the importance of social and psychological factors to determine the success of a firm

(conceptualized as the size of the firm). Consequently, it emerges the necessity to start to consider non-measurable aspects.

According to Penrose (1959), idiosyncratic resources provide services and that services depend on the capacities of the employees to use them. But these capacities are partly shaped by the resources with which employees deal with, so resources and capabilities are interdependent and their combination enable the exploitation of the productive opportunities of the firm, providing a competitive advantage.

Anyway, getting a competitive advantage is not enough, as firms have to try to sustain their competitive advantage (SCA) in the long-period. According to RBV authors SCA is acquired when:

a) It takes into consideration also of potential competitors (Barney, McWilliams and Turk, 1989);

b) it considers competitive advantage that lasts a long period of calendar time (Jacobson, 1988; Porter, 1985);

c) It exists after the efforts to duplicate it have ceased (Lippman and Rumelt 1982; Rumelt, 1984).

In order to become sources of sustained competitive advantage these resources have to possess 5 attributes (the Vris model, see in the picture below) (Barney, 1991; Teece, 2000):

- Valuable;

'Resources are valuable when they enable a firm to conceive or implement strategies that improve its efficiency and effectiveness' (Barney, 1991). In particular those attributes that neutralize threats and/or exploit opportunities can be considered resources.

- Rareness;

Resources are possessed by a single or a few firms in an industry.

- Imperfect Imitability;

Firm resources can be imperfectly imitable for one or a combination of three reasons:

(a) The ability of a firm to obtain a resource depends on unique historical condition. This involves that firms are conceived as historical and social entities such that the resource accumulation is considered a path-dependent process. Thus, the particular set of resources of a firm are, in part, specific to that firm given its particular trajectory in space and time (Barney, 1991). These authors don't use the term path dependence but in Penrose as in Wernerfelt and Barney we see this concept, a firm's history shapes its future opportunities and diversity of firm resources will lead to diversity of strategies and hence increasing diversity of resources;

(b) The link between the resources possessed by a firm and a firm's sustained competitive advantage is causally ambiguous; when the link between the resources controlled by a firm and a firm's sustained competitive advantage is not understood or understood only very imperfectly.

(c) The resource generating a firm's advantage is socially complex (Dierickx & Cool, 1989), such as the interpersonal relations among managers in a firm (Hambrick, 1987), a firm's culture (Barney

1986b), a firm's reputation among suppliers (Porter, 1980) and customers (Klein, Crawford & Alchian, 1978; Klein & Leffler, 1981).

- Substitutability;

It mustn't have strategically equivalent substitutes that are valuable but neither rare nor imperfectly imitable. Resources are strategically equivalent when they each can be exploited separately to implement the same strategies.

- Non-appropriability (Wernerfelt, 1984; Teece, 2000).

Wernerfelt in his analysis provide an analytical tool for the evaluation of the resources that can lead to higher returns over long periods of time. He also sees the imitation as a potential threat for all firms' resources; in fact he focuses more on resource analysis and resources' acquisition and protection dynamics. The author states that resource position barriers are the barriers that firms are able to build in order to protect their resource from other incumbent's acquisition influencing their revenues or costs. And he adopts the growth-share matrix, for evaluating the importance of a resource in a product and vice versa. Wernerfelt doesn't give a prescription of how to get a competitive advantage and hoe resources have to be for getting a similar goal, he just put resources and products on the same level and try to adopt the product-tools and threats also for resource as he believes that resource are very important in order to assure an advantage on other competitors. He says that the resource point of view can provide richer and new strategic options to the firms.

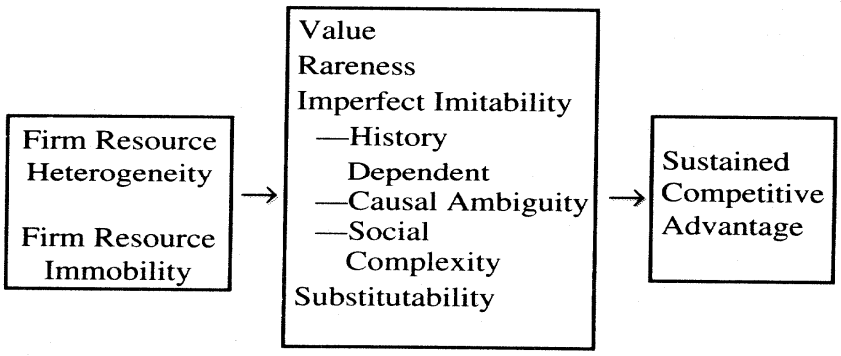


Figure 1.The relationship between resources heterogeneity and immobility, value, rareness, imperfect imitability, and substitutability, and sustained competitive advantage

Finally, for Barney: immobility, heterogeneity (valuable, rare, imperfectly imitable and non substitutable) and right expectations (through information) are a potential source of sustained competitive advantage.

Resource heterogeneity is the most basic condition of resource-based theory (Penrose, Barney, and Wernerfelt). It assumes that some resource bundles and capabilities are heterogeneous across firms. Barney focuses more on the characteristics of the resources susceptible to generate a sustained competitive advantage and he suggests that heterogeneity is necessary but not sufficient for a sustainable advantage. In fact if we consider top management, it may not be copied exactly, although strategies implemented often might be equivalent. If a large number of competing firms have a similar

vision even if one firm has rare and imperfectly imitable resources as top management, however it will not acquire a sustained competitive advantage.

In Barney (1986), firms are heterogeneous different and they have different information different expectations about the future value strategies. Barney extends the product-market view and includes factor markets, suggesting that firms wishing to obtain expected above normal returns from implementing factor market strategies must be consistently better informed about the future value of those strategies than other firms in the same market (Barney, 1986). The imperfection creates in the market are considered as a source for differentiate firms operating in it.

Also Wernerfelt consider resources heterogeneity as important element that gives a competitive advantage to firms through differentiation, expansion and growth.

Indeed, firms with such resources will be strategic innovators, for they will be able to conceive and engage in strategies that other firms could either not conceive, or not implement, or both, because these other firms lacked the relevant firm resources (Barney, 1991).

Barney focused his attention on which type of resources can create a sustained competitive advantage and what kind of imperfections can create above normal returns. He always wanted to provide strategic insights to firms for sustaining advantage on competitors through the knowledge of the typology of resources firms need and on how to predict their value for long run competition.

Barney look at the firm the same way, firm is a bundle of resources, which includes all assets that may enable firm to conceive and implement strategies that improve its efficiency and effectiveness (Wernerfelt, 1984). But in addiction Barney specify the typology of all assets: physical capital resources (Williamson, 1975); human capital resources (Becker, 1964); organizational capital (Tomer, 1987).

With Wernerfelt and Barney there is a theoretical break from the neo-classical tradition: from the firm as a mere profit function to the firm as an organization with the control of potentially valuable resources. This is consistent with Penrose' work, in which: 'a firm is both an administrative organization and a pool of productive resources' (Penrose, 1959, p.2).

Moreover, both authors try to find the sources of competitive advantage on internal resources and firm capabilities rather than in the products sold or in the market.

Wernerfelt (1984) start adopting the firm's resource side rather than the product side and define an economic tool for providing a framework for firms' resources analysis. He wants to show how this change of perspective can give a different and perhaps richer perspective on products growth prospects in a long period of time. In Wernerfelt the firm is a collection of productive resources that are defined as anything that is a strength or weakness of the firm. He considers both tangible (such as physical, human capital etc.) and intangible assets (such as organizational routines, brand positioning etc.) which are tied semi-permanently to the firm (Caves, 1980).

He wants to quantify the strategic weight of resources' importance for firm's activities in different products-markets. Here resources are the prerequisite for higher returns and expansion but through a sequential entry strategy. He thinks that 'looking at diversified firms as portfolios of resources rather

than portfolios of products gives a different and perhaps richer perspective on their growth prospects' (Wernefelt, 1984, p.178).
The RBV since the late 1959s have focused his attention on internal sources of competitive advantage and inter-firm variations in performance. The focus for searching the sources of advantage is internal, but it's aimed at creating an advantage on external competitors. So these authors implicitly introduce the notion of benchmarking.
Barney criticizes the theoretical basis of the environmental models and suggests that internal resources can give sustained competitive advantage to the firms. Moreover environmental analysis is important but as it's a systematic, not rare and perfectly imitable analysis, it can be used by many other firms. He says also that only when information is gotten through non systematic means may give to firm exceptional advantage.

1.2 Dynamic Capabilities

Not only knowledge, rather the capacity to create and manage such knowledge, can provide a sustained competitive advantage. It was highlighted that knowledge is not static; rather it's dynamic and changes continuously. The dynamic capability paradigm (Lado and Wilson, 1994; Teece et al., 1997) is an integrative approach to the RBV offering a closer understanding of sources of competitive advantage. Firms must respond to changes quickly and efficiently, that's why dynamic capabilities are fundamental as they represent "the capacity to sense opportunities, to reconfigure knowledge assets, competences, and complementary assets" (Teece, Pisano and Shuen, 1997).
Among dynamic capabilities the organizational learning (Argyris, 1977; Senge, 1990; Huber, 1991; Weick, 1991; Mintzberg et al. 1998; Crossan and Berdrow 2003) is the collective ability of a group to expand continuously its capacity to create the future. Most observers view organizational learning and the learning organization as virtually synonymous terms, with the former focusing more on process and the latter on structure. A learning capacity indicates a firm's ability to comprehend and assimilate new knowledge, which would allow the recipient unit to innovate or to imitate other firm's innovations.
Huber (1991) extended the definition of organizational learning by identifying four necessary constructs: knowledge acquisition, information distribution, information interpretation and organizational memory. Organizational learning capability is especially critical since idiosyncratic advantages naturally erode over time, and an intensive exchange of knowledge, deliberately delivered, may help to reinforce strategic positioning (Lorenzoni and Lipparini, 1999). Firms are developing routines in order to enable organizational learning within the firm, enacting the passage from a manufacturing to a service-oriented economy: firms that are thriving in the new strategic environment see themselves as learning organizations pursuing the objective of continuous improvement in their knowledge assets (Senge, 1990); the Extended Enterprise is a kind of learning organization.

The capacity to acquire knowledge is also called absorptive capacity (Cohen and Levinthal 1990), that's "the ability to recognize the value of new information, assimilate it and apply it to commercial ends …which depends on the level of existing related knowledge in the company"(ibid., p.128). They consider all the obstacles and problems linked with this activity and highlight the role of prior knowledge as a factor conditioning the retention of new knowledge. In general, many authors agree that that the ability to acquire, integrate, store, share, and apply knowledge is the most important capability for building and sustaining competitive advantage" (Zack, 1999).

2. Complexity Theory

A system is complex when it has many components that interact continuously in an interesting way. A system can be qualified as complex whether it has the following characteristics:

- *Agent-based*: The basic building blocks are the characteristics and activities of the individual agents in the environment under study.
- *Heterogeneity*: These agents differ in important characteristics.
- *Feedback*: Individual learns through feedbacks, which are released by their environment as a result of their activities.
- *self-organization*: in order to adapt to the environment agents that make the systems collectively and autonomously self-organize in order to get the same result.
- *Emergence*: actors are structured in sub-groups and their interactions cause the emergence of macro-level phenomena.
- *Dynamic and nonlinear*: These agents are intelligent as they change over time by learning and adapting to their environment, or experience natural selection in the regeneration process. The dynamics that describe how the system changes over time are usually nonlinear, sometimes even chaotic. The system is continuously between chaos and perfect equilibrium, in a state called the edge of chaos. This approach contrasts sharply with the neo-classical approach to modelling economic systems based on Newtonian physics of cause-effect phenomena explanation. Usually, in order to work with expressions and equations that are tractable by mathematical analysis, microeconomic theorists assume that all consumers are identical and never change their preferences or characteristics. In order to use mathematical models they adopt models that dramatically simplify the reality under observation, failing in representing the reality of phenomena.
- *Interdisciplinary Approach:* in order to get to a full comprehension of a pohenomenon it is fundamental to adopt an interdisciplinary approach. It is adssumed that every phenomenon has a basic underlying structure even if disciplines have different approaches and have been used to see different things. The identification of a deep overlying structure can help to transfer methods of analysis and understanding from one field to another enriching the set of analytical tools at disposition of researchers.

- *Computer Simulations:* In many cases computer simulations are outgrowths or natural extensions of the insights of simpler mathematical models. In other cases computer simulations are constructed by modeling directly the features and interactions of the agents in the system being modeled. Then, analysis of the dynamics and emergent behavior of these simulation models can lead to new mathematical models, new hypotheses and new real- world experiments or field studies to test these new models and hypotheses. In addiction to computer simulation, mathematical techniques of the complex system approach include: nonlinear dynamics, especially differential equations, difference equations and cellular automata, game theory, Markov processes, genetic algorithms, social network analysis and time series analysis.

2.1 Managing in Complexity

Macro-environmental transformations becomes more and more unpredictable compared to the past, rigid models of performance prediction seem to be useless, and it is fundamental for firms to quickly adapt to the changed conditions in order to survive. Firms have to follow the transformation occurring in the environmental just like living creatures adapt to ecosystems in order to survive.
The legacy of complexity theory is evident in the new model of the firm. Firms have to start to learn to be proactive by managing the ubiquitous, unpredictable and striking changes of complex environments, a strategy that put the firm at the edge of order and chaos, at the edge of chaos (Brown, Eisenhardt, 1998).
The edge of chaos is 'a natural state between order and disorder, a grand compromise between structure and surprise' (Kauffman 1995).In more concrete terms, being at the edge of chaos means that change occurs when strategies and their related organizations are sufficiently rigid so that change can be organized to happen but not so rigid that it cannot occur (Brown, Eisenhardt, 1998). This state is created by managers instilling a sense of tension, a capacity to read the signs of crisis, and a capability of flexible adaptation to the new conditions, meaning tightening strategic alliances, acquiring the needed knowledge and capabilities, transforming the image of the firm and so on.
The extended enterprise should be conceptualized as a complex system. It is important to start to consider its value not simply as the sum of its tangible assets (asset 1 + asset 2 + asset 3 = value of the firm), rather as the final result of the interaction of its tangible and intangible assets at inter-functional, inter-departmental and inter-firm level.
This should be done with the awareness of co-evolution and competition and not just competition in the economic environment in order to maximize the exploitation of the resources.
Through ICT firms are extending their possibilities of communication, collaboration and cooperation within the organization; within the network of actual and potential partners; and with competitors.

Moreover, the increasing competition has also accelerated the process of aggregation among enterprises, through acquisition and alliances, giving rise to a new way to compete and cooperate (Moore, 1996; Davis and Spekman 2003).

Suppliers, buyers and customers once considered quite as competitors and external to the firm, are internalized and considered important collaborators with whom the firm can co-evolve in order to survive when it goes through the edge of chaos. As Martin, Mitchell, and Swaminathan (1995) pointed out, strategy theorists once tended to view suppliers and buyers primarily as antagonists seeking to appropriate the profits of existing business activities in an industry chain. Yet, as evidence accumulated on the advantages of a cooperative mode, both practitioners and strategy researchers have paid increasing attention to networking, alliances, and cooperative inter-firm relations. Some researchers have argued that firms with collaborative inter-firm relations could be more competitive than those without (Miles and Snow, 1984; Jarillo, 1988; Johnston and Lawrence, 1988). Gomes-Casseres (1996) further argued that growing collaboration among firms generated new forms of rivalry. Business rivalry could often occur between sets of allied firms, which he called 'constellations,' rather than between individual firms.

Finally, the new model of firm has to face complexity, the new rules o take into account are:

- Interactions develop within a system and across other systems;
- Continuously being at the edge of chaos;
- Co-evolve with some players and competitors;
- Self-organization;
- Non linearity;
- 'Adaptivity' to the changing conditions;
- Interdisciplinary, since make a bridge between different disciplines.

3. The Extended Enterprise

According to the evolutionary literature studies, the EE can be defined as a bundle of dynamic resources, capabilities and relationships (Penrose, 1959; Teece, Pisano and Shuen, 1997; Venkatraman, 1998) interacting with new and different players (such as customers and suppliers), organizations and industries (Scott, 1996) through advanced computer communication technologies and formal or informal linkages (Brown, and Duguid, 1991; Wenger, 2000; McDermott, Wenger, and Snyder, 2002), with the aim of creating, sharing, recovering, deploying new knowledge and capabilities from the business ecosystem in order to create value and producing innovation (Filieri and Al Guezaui, 2007). In addition, the EE is a learning organization that uses ICTs to enhance its learning processes, and can be mainly characterized with the following features:

- The EE seeks to leverage the skills of its suppliers (Spekman, 2003) and to enhance their efficiency by helping them in reducing costs. All partners must believe that competitive

advantage is greatest through partnering (where each partner concentrates on its particular strength). The collection of partners becomes a winning combination (C. Banks).

- There must be a win-win strategy (Hall, 2004), for conflict resolution. All other conflict resolution strategies guarantee that one party's gain will come at the expense of another, a result that will break trust and begin a process of disintegration (C. Banks).
- It works in real-time across heterogeneous environments, and across public and private networks. It focuses on the speed at which information becomes available. When all constituents are armed with data in real time, latency among automated IT systems and human decision-makers is virtually eliminated, which allows near-real-time information systems to super-speedy, "just-in-time" processes (Bort, 2003).
- Customer participation in the development and design of goods, services and user innovation (Thomke and von Hippel, 2002; Berger et al., 2005).
- Creating and increasing the social capital by increasing the size of the network and the efficiency and effectiveness with which members transact business, share information and make decisions that create value for individuals and the community. And, as social capital increases, so too does economic value for all. (Applegate, 2004)

3.1 A strategy for the Extended Enterprise

The EE aims at reducing NPD cost and time to market. It is fundamental to clearly indicate the direction to take in order to get these goals. A strategy for the EE should take into consideration some aspects of the market-driving strategy. It is evident that we cannot assume any more traditional strategies, as they are no more suited for industries with intense, high-velocity change (Brown and Eisenhardt, 1998). In complex and turbulent environments the right answer to sustain a business is not more just the adaptation to the changes of the market, as postulated in the 'sense and respond' firm (Evans and Wurster, 1997) or in the market-driven strategy. Firms need to be proactive, learning from their environment, anticipating the changes and leading the markets (Brown, Eisenhardt, 1998; Jaworsky, Kohli and Sahay, 2000). This is a risky strategy that fosters the continuous search of breakthrough innovation for leading global markets.
This could be done through a proactive attitude (Lumpkin and Dess, 1996) adopting a flexible strategy and striving continuous innovation flows.
A strategy for anticipating knowledge changes focus on analyzing the current situation related to what the firms knows and what the firm have to know for adapting to the changing conditions. We have assumed that adaptation is an aspect of the EE; however it is important to consider and balance both adaptation and search for changes' anticipation in the current environment.
The firm has to balance two different but not mutually exclusive strategies:

1) Explore: knowledge in the industry is changing rapidly; the organization may need to be creating new knowledge just to keep the pace of change.
2) Exploit: resources and capabilities exceed the requirements of a competitive position offer the opportunity to further exploit that knowledge.
Adaptation the environment was a characteristic of the market-driven orientation, where the company's main ability is to learn, understand and respond to the market (Jaworski, Kohli, and Sahay 2000). On the other hand, the company's ability to change the market is related to the capacity of driving markets (Jaworski, Kohli, and Sahay 2000; Kumar, Scheer, and Kotler 2000; Harris and Cai 2002).
Being proactive, it means that firms continually scan the environment and detect the signals coming from it for making foresights on the future trends in knowledge, technology, and social dynamics (Hamel and Prahalad, 1994). Proactiveness refers to a firm's approach to market opportunities through active market research and first mover actions such as the introduction of new products/services ahead of competitors (Lumpkin and Dess, 1996). Proactiveness is a crucial organizational process, since it entails a forward-looking perspective. Being a pioneer by anticipating and pursuing new opportunities and participating in emerging markets is the hallmark of entrepreneurship. Proactive start-ups tend to become first movers by forging a new market segment or by replacing established companies with new products/services (Christensen, 1997).
Successively, the firm has to decide how to acquire technology, knowledge and capabilities needed and how to accelerate the emergent trends.
In order to monitor the dynamics of the knowledge market, practitioners have adapted two marketing tools such the swot analysis and the benchmarking[1].
Being fast at developing new products or locking–in customers, adapting on the specific needs of customers or shaping their needs became a necessity for sustaining competition. And on the contrary being late to market, on the other hand, can carry significant penalties in terms of reduced market share and profitability, especially where product life is short.
As Hamel says 'industry revolution is the product of strategy innovation. In an increasingly non-linear world, only non-linear strategies will create new wealth. As companies move beyond the incremental, strategy innovation—the capacity to reengineer product and service concepts, redraw market boundaries, and radically alter deep-down industry economics—will become the next critical competitive advantage. Strategy innovation is the only way for a company to renew its lease on success' (Hamel, 2000).

[1] S.W.O.T. analysis of proprietary knowledge and capabilities and on the knowledge and capabilities present in the market could enable the firm to map their opportunities and threats, in order to understand if it is going in the right direction. This map enables firms to understand the Knowledge gaps of the firm, it is this gap that knowledge management must address to add significant and lasting value" (Zack, 2000: 85). Benchmarking activities for knowledge and capabilities acquisition is seen as another fundamental process of the EE (Zack, 1999).

But the orientation of the firm has not to be too related to just customers, multiplying product improvements with the risk of causing a second myopia (Gummesson, 2004). New knowledge and breakthrough innovations can come from other external sources, such as research center, suppliers, lead-users.

Market-driving firms go beyond customers' expressed needs and involve firms to be proactive in discovering and satisfying the latent, unarticulated needs of customers. The related strategies are (Jaworski, Kohli, and Sahay, 2000; Narver, Slater, and MacLachlan, 2000; Slater and Narver, 1998):

- Working closely with lead users,
- Uncover new market opportunities,
- Undertaking market experiments to discover future needs,
- Cannibalizing sales of existing products,

Prior research (Jaworski, Kohli, and Sahay 2000) on market-driving organizations has focused on the different way to drive a market: first, deconstruction implies the elimination of competitor in a value chain (Suppliers, distributors, wholesalers…). Second, construction, it involves the creation of new players in the value chain. Third, functional modification consists in changing the functions performed in a market by the players.

These ways of driving a market are well suited for the EE, which in fact is already adopting the market-driving strategy; firms are eliminating competitors in the value chain integrating them in their network of relationships. These players are also thought and considered with a new role, suppliers have not just to provide semi-finished products or raw materials, rather they have to know what firm's customers want, what kind of products, what kind of design is more requested, customers are not more just served and studied, some of them are asked to create new products. Suppliers and customers, but also other players should share their ideas, insights and knowledge in the fuzzy front end, becoming co-creator of new products. Differently from the past, suppliers and customers are not more considered as opponents; rather they are integrated in the NPD development.

This strategy should take into consideration the centrality of knowledge, and the related activities of sharing, deploying, and integrating it into and across the firms. In this context, the alliances are strategic, since they allow the integration of different partners in terms of their knowledge capital, technology or other specific capabilities.

Inter-firm alliances' goals can vary deeply: firms form new alliances to enter different markets nationally and internationally, to jump market barriers, and to share proprietary knowledge, specific capabilities, or technological infrastructure.

Since the innovation often occurs across networks, an element of the EE strategy is to set up processes enabling the scanning of the external environment in order to identify the most innovative players, new ideas and knowledge freely available. Learning routines could be an enabler of such a process. Following Grant (1996) a learning routine is a regular pattern of interactions among individuals that permits the transfer, recombination, or creation of specialized knowledge. Collectively, these routines may be viewed as the reinforcement of the capability of managing knowledge flows in intra-firm,

inter-groups and inter-firm networks (Lorenzoni and Lipparini, 1999). Potential innovators present in environment of the firm can be lead-users, customers, manufacturers, suppliers, research communities, and competitors (Von Hippel, 1986; Thomke and Von Hippel, 2002) and they can be tightened to the firm through formal or informal linkages. Then, NPD is a process of co-creation (Prahalad and Ramaswamy, 2004) being not just a mere function of R&D.

In the traditional conception of value creation process, consumers, suppliers, competitors were "outside the firm" and considered as opponents; thus, value creation occurred inside the firm (through its activities) and outside markets (Sawhney, Verona and Prandelli, 2005). Nowadays, it is exactly the opposite. Competitive advantage is a function of the firm's ability of borrowing knowledge and capabilities and of its capability to identify and retain the most creative, connected and acknowledged players presented in the business environment. Considering this strategic framework, communication is a key-process and a link among nodes; even more, it shapes the firm's structure. For instance, the balance of top-down and bottom-up communication flows means that top managers interact with the lower level of the firm, where specialized knowledge is resident (Grant, 1996). Such organizational environment may enhance the creativity of its employees and then, the innovativeness of the firm. Consequently, rather than a market-driven strategy, it is preferable to adopt a market-driving strategy focused on strategic knowledge and relationships management to compete in turbulent environment and by analyzing the literature, two main strategic capabilities are perceived to be the core components of the EE to achieve successful NPD: knowledge management and relationship management capabilities (Figure 2).

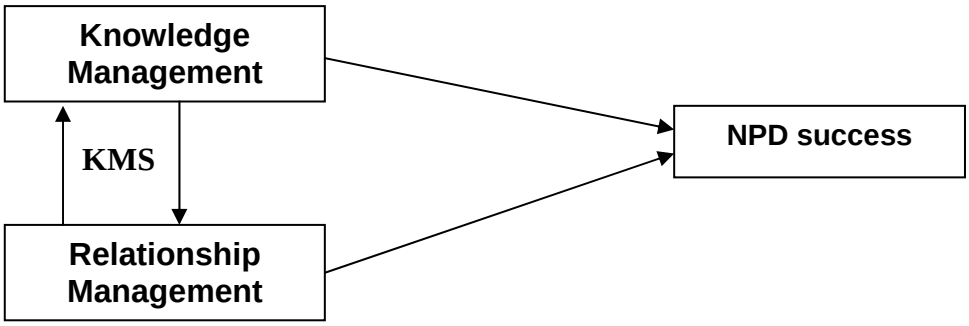


Figure 2. Constituent of NPD success (my elaboration)

3.2 Knowledge Management Capability

A strategy that is aimed at innovating rapidly and effectively, even in ever-changing environment, has to be focused on the activities of acquiring, integrating, storing and exploiting knowledge (Grant, 1996), and has then to set-up a knowledge strategy (Zack, 1999). This phenomenon is more evident in complex NPD process, where the increasing need of different and cross-functional/industrial knowledge and capabilities and of expensive technologies have further decreased the benefits of

innovations. Thus, firm's competitive advantage is related to its capacity to favour organizational learning and developing knowledge tools.

Due to the complexity of the current NPD processes, more knowledge is required from outside the firm. Contrary to the past, knowledge transfer becomes easier through ICTs within and across firms and potential customers located everywhere in the world. The change provided by ICTs is radical, especially for the fuzzy front-end, since firms can harness the huge amount of knowledge and ideas of potential worldwide users.

Knowledge refers to a fluid mix of framed experience, values, contextual information, and expert insights providing a framework for evaluating and incorporating new experiences and information (Davenport and Prusak, 1998).

Knowledge can also be searched within firms' boundaries where the main part is tacit since it is difficult to codify in the natural language and is embedded in performing complex tasks. The explicit knowledge or information includes "facts, axiomatic propositions, and symbols such as information on size and growth of a market, production schedules, and so forth" (Dyer, 2000) and is easily to codify and to communicate. "While explicit knowledge is more easily managed and shared, tacit knowledge potentially has more strategic value, being derived from particular circumstances and events and thus unique and hard to imitate" (Zack, 2000). Both tacit and explicit knowledge reside at four levels of an organization: individual, group, organization, and inter-organization (Hedlund, 1994). Therefore, knowledge sharing, conversion, and learning are not only occurring at the individual level, but also at the inter-organizational level (Nonaka and Takeuchi, 1995; Lank, 2005).

(for a more detailed treatise on knowledge management see the chapter 4.3. 'Managing knowledge into Organizations')

3.3 Knowledge Management Systems

The network capability and its exploitation in terms of deriving the knowledge needed for enhancing the firm's competitiveness and innovativeness is considered a central theme in the conceptual framework of the Extended Enterprise. Accordingly, two essential constituents represent the basis for the EE mainly: knowledge and relationship management. With this regard, knowledge is considered the major pillar of EE and its management is a core process for implementing successful NPD and gaining sustainable competitive advantage. Nonaka and Takeuchi (1995) focused on the dynamics of knowledge creation and suggested that the four major activities of KM are socialization, externalization, internalization and combination. Nonaka and Konno (1998) argued that an essential element to knowledge creation is establishing an organization's "ba," which is defined as a common place or space for creating knowledge. Four types of ba corresponding to the four modes of knowledge creation were identified: (1) originating ba, (2) interacting ba, (3) cyber ba, and (4) exercising ba (Nonaka and Konno 1998).

Practitioners and researchers found that IT plays an important role in supporting the different modes of knowledge creation since it provides the adequate tool that provides the appropriate "ba" for creating value. Information and Communication Technologies (ICTs) enable the processes of knowledge management at the group, organization, and inter-firm level and facilitate the capability of a firm to effectively manage its network. As a matter of fact, Knowledge Management Systems (KMS) provide the specialized and practical technologies or tools that enhance the knowledge creation modes, which is the core of the EE. Consequently, various conceptual designs of the KM functions and different practical implementation of the KM tools can serve for the same KM activity.

For instance, KMS providing 'interacting ba' can be designed to support collaboration, coordination and communication processes among different players in the social context of the EE. Indeed, these information systems, such as electronic mail or group support systems, can facilitate the teamwork across the network and can expand the firm's network to more extended, or even weaker, ties that may provide new knowledge (Robertson et al, 1996). Another example of KMS that may support knowledge creation activities through interaction is the intranet. This tool, supplemented by enhanced capabilities such as computer simulation and smart software tutors, can provide the context through which different members of the network interact with each other for constructing and sharing beliefs, for confirming consensual interpretation, for making observations concerning specific issues, and for allowing expression of new ideas (Henderson and Sussman 1997).

Throughout analyzing the literature on IT applications to knowledge management activities, Alavi and Leidner (2001) recognized three major applications: (1) the coding and sharing of best practices, (2) the creation of corporate knowledge directories, and (3) the creation of knowledge networks. This latter can be formed through providing online forums for interaction among the different members of a network in order to create value. For instance, Zack (1998) observed that Buckman Laboratories has responded effectively to the environmental changes through using an online interactive forum where users' comments are considered as themes for conversation and are classified by topic, author and date. Recently, Maier (2007) emphasizes the importance of ICT support to foster networking, which is considered the essence of the EE. In fact, he highlights the tools and systems that increase the visibility of networks and communities, such as knowledge maps, directory services and catalogues (Maier, 2007). Further, he presents the following framework for designing KMS aiming at supporting KM initiatives in a network (Maier, 2007) (Figure 3).

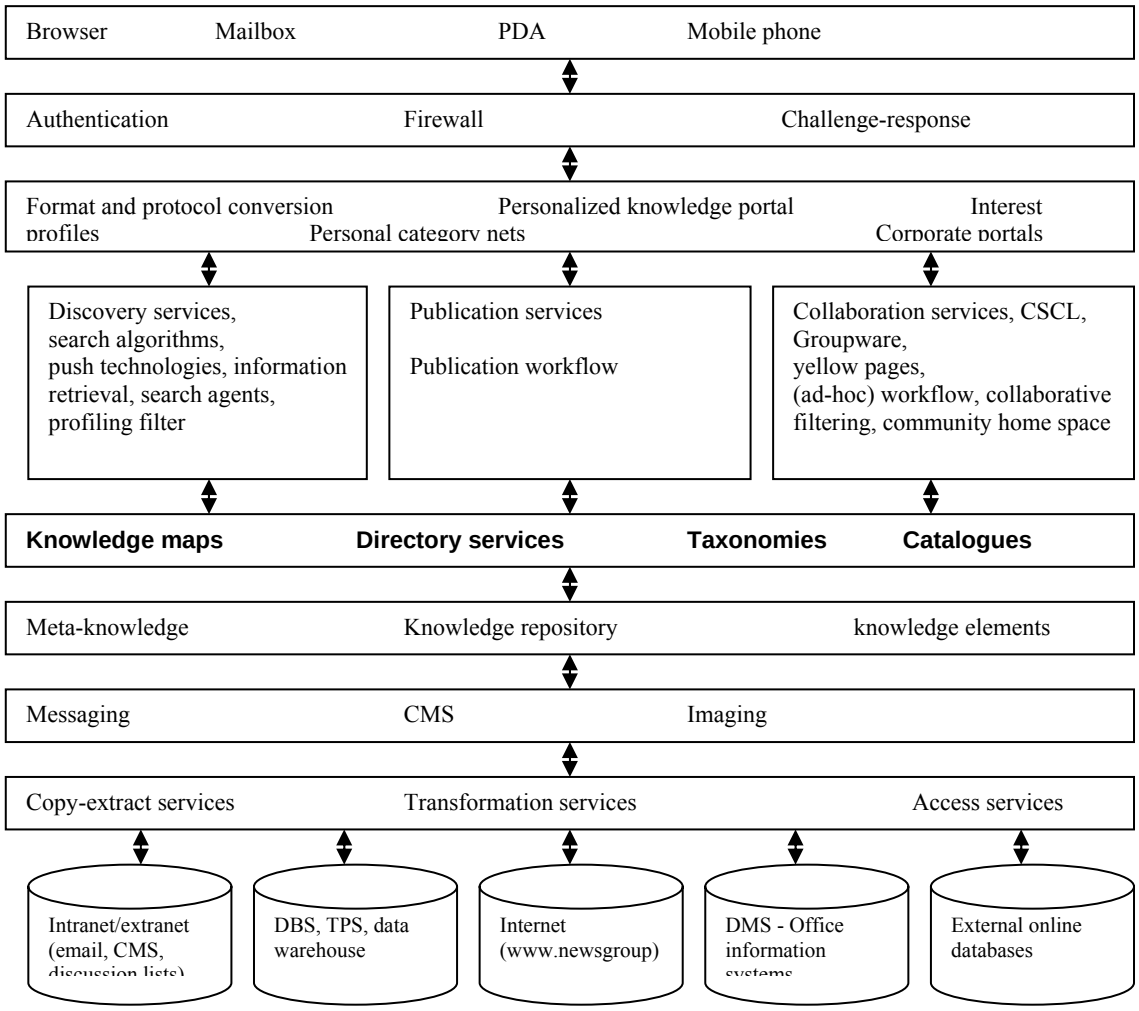


Figure 3: ICT infrastructure, KM tools and systems for "network and community" (Maier, 2007)

3.4 Relationship Management Capability

Due to their open-innovation processes aiming at extending their collaborations with partners, suppliers, and customers, the EE boundaries are blurred at three levels: intra-organizational (Grant, 1996), inter-organizational, and inter-industrial. Nowadays, the value of the relationship is conceived as a viable solution for acquiring unique and inimitable resources.

Accordingly, trust-based relationships and collaborative practices are the bases for knowledge creation and transfer (Nonaka, 1994; Dyer and Nobeoka, 2000) in order to improve firm's innovative performance. Relationships within the EE need to be managed for enabling the acquisition, recovering, sharing and exploitation of knowledge resources.

Accordingly, the communication process is a key-asset of relationship management.

Effective communication calls for a change in the management of relationship with the network of each multinational.

Effective communication means some change in the attitude towards external and internal actors' communications. In fact, instead of activating persuasive communication for convincing the client to remain loyal to the firm (Rothwell, 1994), the firm has to communicate purposively with an increased quantity and quality of learning from its creative players. For instance, in marketing communication, there is the need for other communication roles, rather than persuasion, such as informing, answering, and listening (Duncan and Moriarty, 1998). Concerning the EE, communication is considered dialogue and discussion for knowledge and ideas' generation; and high value is assigned to every feedback, especially that one coming from the lower level of the firms, where there is the great amount of specialized knowledge (Grant, 1996). Moreover, advances in ICTs have given rise to modern agora, where people don't simply discuss or meet themselves virtually, rather they collaborate for exchanging knowledge and for creating new products. The emerging B2B, C2C and B2C discussion forums are increasing the possibilities to grasp the knowledge produced by customers, clients and other actors. Moreover, it is impossible to achieve knowledge acquisition and sharing without having previously established good contacts, trusted relationships with clear and effective communication.

Moreover, the acquisition of knowledge depends on absorptive capacity (Cohen and Levinthal, 1990) of the employees, especially R&D, to deal with external sources of knowledge. Additionally, it is important that R&D function knows exactly what kind of knowledge is looking for and understands the utility of such knowledge. However, the management of such kind of relationships is always allocated to formal knowledge gatekeepers. The gatekeeper refers to the concept of 'internal communication stars' (Allen and Cohen 1969), strongly connected to external sources of information than non-stars. The term technological gatekeepers, first introduced by Allen (1977), linked "their organizations to the technological world at large" and it refers to the function of reducing the communication problems in technology or in a context of R&D organizations. Allen (1977) claimed that "there will always be some people who, for various reasons, tend to become more acquainted with information sources outside their immediate community. They either read more extensively than most or develop personal contacts with outsiders. A large proportion of these people in turn attract colleagues from within the community who turn to them for information and advice" (Ibid.: 150). Gatekeepers provide to each of the actors a connectivity function that allows them to avoid the cost of maintaining side by side relationships. As a matter of fact, they have a double role of co-ordination and knowledge search.

Thus, a new strategic activity needs to play the new role of enabling the knowledge updating and sharing within and across the network of the firm.

The integration of marketing and R&D is required also for this reason, they can learn and understand each other's needs regarding information and knowledge requirements only if they are in proximity (Allen, 1977) and cooperate and collaborate on the same projects.

In-depth studies of product development in automobiles (Clark and Fujimoto, 1991), mainframe computers (Iansiti, 1995), semiconductor photolithography (Henderson and Clark, 1990; Henderson, 1992), and pharmaceuticals (Henderson, 1994) have concluded that differences in firms' performance can be attributed largely to the degree of marketing and R&D integration in their development processes. These studies stress the importance of (a) frequent, early, and 'thick' communication among the various specialties needed to launch a new product, (b) the critical need for 'boundary-spanning' individuals who possess both interdisciplinary knowledge and organizational clout, and (c) the value of searching system-wide, rather than just locally, for solutions to design and technology problems.

In analyzing the literature on product development, it is striking that interdepartmental and inter-functional communication have been identified as distinguishing successful from unsuccessful projects for over 20 years (Allen and Cohen 1967, Allen 1977, Cooper 1979, Souder and Chakrabarti 1979, Cooper 1983, Maidique and Zirger 1984; Cooper and De Brentani, 1991; Cooper and Kleinshmidt, 1987; Dougherty, 1990; Moenaert and Souder, 1990; Moenaert et al. 1994).

If we assume that firms have to innovate faster and better than competitors to survive in turbulent environments, firms have to set an organization-wide capability to identify and keep in contact with potential sources of innovation such as individuals, group or organizations. As matter of fact, Relationship Management should be viewed as an organizational strategic attitude that has to be learned also by R&D. They have to learn the attitude of managing long-term relationships with multiple and different players, but mainly with specialist in their scientific domain. In the case that Marketing department manages consistently its relationships with customers, suppliers and other stakeholder, it is also important that internal R&D learns to manage relationships with researchers, research centres, and universities. However, this activity should be promoted and supported by the management, in order to avoid the fear of being replaced by other researchers and ignoring external knowledge producers as competitors (Teece, 2000).

Finally, RM has to embrace 'all relationships providing value-creating processes' (Morgan and Hunt, 1994: 22). Potential innovators are present in different relationships with different players. In RM literature there is Christopher et al. (1991), which includes the development and management of relationships with six markets: internal, customers, suppliers, referral, influencer, and employee recruitment markets. Gummesson (1998) highlights also the importance of other relationships, such as the mega relationships, with other players such as political parties, institutions, mass media, and others not belonging specifically to the market but exert pivotal influence on market behaviour; and the nano relationships, concerning the internal relationships in a company, (internal customers, other profit centres, and to owners and investors). Sawhney and Zabin (2002: 314) reinforce the conviction that an extension of the marketing relationship paradigm is needed, saying that: 'competitive advantage…stems from its (the firm's) ability to build and leverage relationships with customers, partners, suppliers and employees'. It is also suggested that the relationship marketing have to focus also on supplier's relationships to his or her own suppliers, competitors, and middlemen, naming them

market relationships (Gummesson, 2000; Workman, Homburg, and Jensen 2003). Nevertheless, all these players have different creative potentials; RM should build a long-term, trusted and mutually profitable relationship with the most creative among them.

Thus, an actor that merit particular attention is the lead-user. Von Hippel (1988) demonstrated that users were about the developers of the most important scientific instrument innovations, and that most of them had the characteristics of the lead-users. The lead-users generally recognize latent needs before the market encounters them, they improve the products for obtaining superior solution to their needs: 'they can provide valuable new product concept and design data to inquiring manufacturers in addition to need data' (Von Hippel, 1987: 570). Thus, not all customers are innovators, just a few among them, the same percentage it can be found among other actors. Innovation here is not about product improvement, rather it can lead to breakthrough innovation and it is distributed.

Thus, RM has to find the strategies and technologies to involve both the external actors and their networks in the NPD process. The focus is not more simply customer needs and complains, the problems of a similar approach are the difficulties in realizing breakthrough innovations (Berthon, Hulbert, and Pitt 1999; Hamel and Prahalad, 1994; Christensen and Bower, 1996; Gummesson, 2000). The focus of the RM is the broad array of players and the linked networks identified by the firm for having a high creativity potential. The RM has to value much more the relationship with players that are more willing to interact and collaborate with the firm for co-inventing new products.

In the future, the value of relationships will result from the amount and quality of the information, knowledge and ideas created and shared across every firm's network of innovators. Adopting RM, managers have to consider one other important actor, the Opinion Leaders. The role of opinion leader is valued in every context, especially for their power in favouring the spreading of an innovation or a new product (Rogers, Shoemaker, 1971). Opinion leaders perform similarly to hubs, "nodes with an enormously large number of links" (Barabasi, 2000). Since they are considered the experts in an area and they can affect behaviours and attitude of the people present in their network. They can be seen as the connectors between economic actors, but they are important because they possess strategic information about difficulties rising from the environment or latent opportunities. Moreover, researcher have found that the productive information and resources gathered through social networks can help to compensate for constraints and that the use of social networks can counteract many difficulties and, in some instances, the robustness, accuracy and relevance of appropriate local information is crucial for business survival and development (Jack, 2005). Finally, a renewed RM capability should focus more on creative players but also on actors that play the role of opinion leaders.

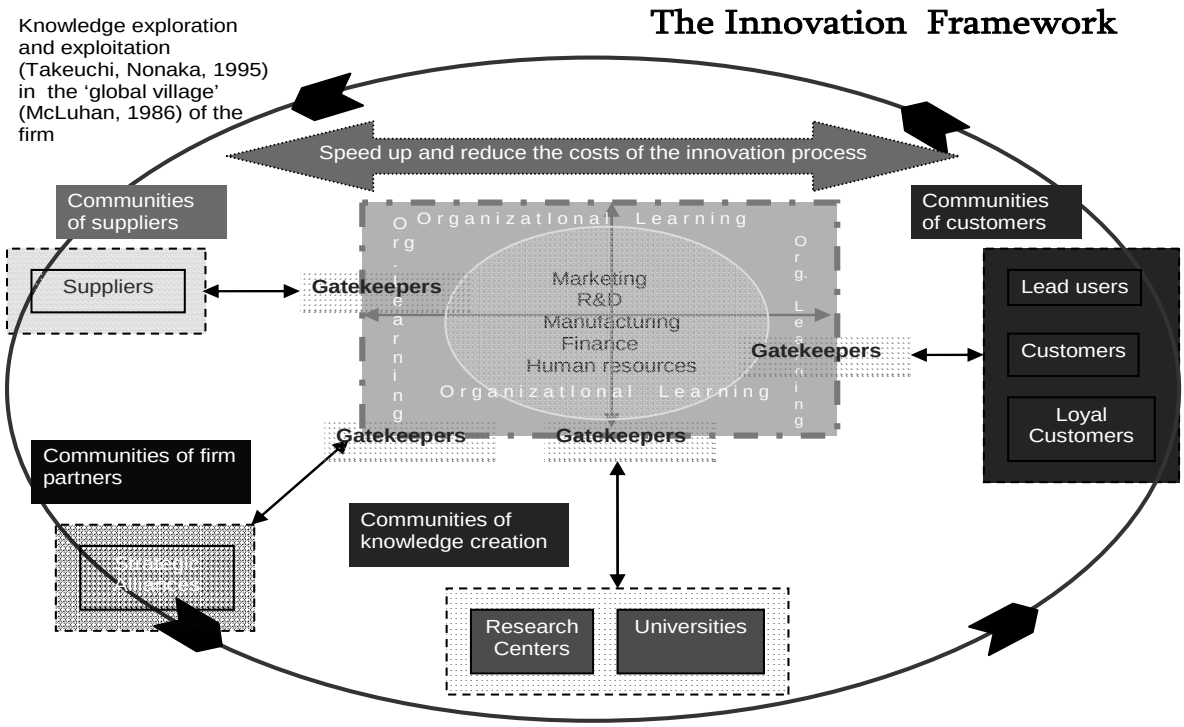


Figure 4. The innovation framework (my elaboration)

3.5 Strategic Alliances and Informal Networks

Inter-firm relationship is increasingly considered as the ideal locus of value creation and a way to stimulate firm performances and innovativeness (Dyer & Singh, 1998; Lorenzoni & Lipparini, 1999). Several scholars have studied the relationship between a firm's strategic alliances and its innovative performance or new product development (Shan, Walker, and Kogut, 1994; Kotabe and Swan, 1995; Deeds and Hill, 1996; Baum, Calabrese, and Silverman, 2000; Lerner, Shane, and Tsai, 2003).
In literature there are three main approaches and theories (Osland and Yparak, 1993): the Organization Theory (Kogut, 1988); the Competitive Position (Porter, 1986); the Transaction Cost Economics (Williamson, 1975) are not adequate to include all the motivation for current alliances formation, especially considering the shape of the EE and the increasing value of the knowledge and relational resources.
Since knowledge, ideas and capabilities are the most important resource and the capabilities of managing multiple alliances is the most important capability, the related organizational capabilities of learning and communicating is the key-enabler of those processes. Alliances have been frequently used as strategic instruments because they provide quick and flexible access to external resources

(Anand and Khanna, 2000; K. M. Eisenhardt and C. B. Schoonhoven, 1996) that can be obtained efficiently without mergers or acquisitions. One of the most evident consequences is the emergence of a of new way to compete and cooperate (Moore, 1996; Davis and Spekman 2003), shedding light to a new typology of firm, limitless and focused on knowledge acquisition and sharing throughout the network of partners and competitors. Then, firms are dissolving their boundaries for inter- and intra-firms relations (Takeishi, 2001) and inter-industry relations (Scott, 1996), trying to facilitate learning activities (Anand and Khanna, 2000; Dyer and Nobeoka, 2000; Dyer and Singh, 1998) in order to gather knowledge, ideas, information and capabilities. And the greater the size of the gap and the existing desire in what the firms want to achieve and what the firm can achieve, the more likely the firm will form alliances with other firms (Osland and Yaprak, 1993).

But, before tightening alliances firms need to make foresight and benchmarking about future partnerships, technology and knowledge and capabilities required. Multiple alliances are a source of networks resources (Gulati, 1999). Harrigan and Gulati define strategic alliances as any voluntarily initiated cooperative agreement between firms that involves exchange, sharing, or co-development and it can include contributions by partners of capital, technology, or firm-specific assets (Harrigan, 1985; Gulati 1995a; 1995b).

The strategic alliances become strategic networks, since the EE start to think the way to exploit resources present in the linkages present among firm's partner and other players or firms. Since innovation process for being effective has to reduce product development costs (Chesbrough, 2007), it is evident the strategic value of a network of alliances. In fact, these networks provide quick response to firm's requests and if they are ready with the technology, the knowledge the capabilities required for producing the innovation, they get commitments from the main firm of the network.

The increasing importance of alliances has increasingly created the need within firms to create business units completely dedicated to the management of alliances, becoming more and more strategic for the business of the firms. Moreover company wide standards and customized tools for multi-alliance management are asked by the firms (Hoffmann, 2005).

Thus, a critical element for businesses' success is the awareness of the social capital of the firm and of the capacity to manage good and productive relationships with an increased and extended quality of players. That's why the strategy has to consider the critical elements for successful relationship management: Trust and Commitment, Communications, Integrative mechanisms, Decision making style, Company culture (Davis and Spekman (2003).

In this process the EE has to take into consideration also the informal linkages (Brown and Duguid, 1991; Wenger et al. 2000) with different players. These weak ties may refer to persons in the firm's or employee's relationship with whom it/they has less frequent mutual confiding contact. Several studies confirmed that weak ties are important in bringing new information in organizations (Weenig, 1993, 1999; Weenig & Midden, 1991). Informal relationships are much more important than formal ones in the innovation process; in fact since they are not rigidly structured they facilitate the

communication of ideas and the creativity of people. Formal Informal linkages of networks refer to the social capital of the firm.

Nevertheless, both in formal or informal linkages the connector is represented by face-to-face or computer mediated communication acts. Moreover if we consider that every player linked to the firm has an own network of relationships with other suppliers, stakeholders, institutions; it is necessary to create the condition to acquire also the network resources, that often are present but hidden in the environment of the firm. Real-time communication provided by computer mediated communication tools, reconfigure the concept of *hic et nunc* of the communication act and gives new, extended in time and space, possibilities of communication. Through two-way communication each player can become at his turn an active participant of the communication process, having the possibility and the interest to share freely his knowledge.

Each one has the same importance since this type of communication is not authoritative; it doesn't follow a bottom-up direction. Among firms in a network communication strategies are built in order to not shape the authority of the most important one, since collaboration calls for dialogue and discussion rather than unidirectional information. Face-to-face meetings are important since tacit knowledge "is created and shared via direct person-to-person interaction, story-telling, and shared experience" (Zack, 2000:81). Knowledge results from interaction among individuals; for example "Communities of interaction" contributes to the amplification and development of new knowledge (Nonaka and Takeuchi, 1994). Evidences of the importance of face-to-face communication are also acknowledged by an EE as Toyota. This enterprise has created regional suppliers association that organize general assembly, top management meetings and executive meetings allowing high-level communication within the supply network with regard to production policies, plans, market trends and other issues (Dyer and Nobeoka, 2000). The frequency of the communications and the quality of it can influence the quality of the relationship, and then the trust and knowledge sharing activity. This is one of the future research questions that we will be going to prove.

3.6 A New Model for the New Product Development Process

The capacity of innovating has become the key process for the achievement and for maintaining the competitive advantage (Day, 1994; Dickson, 1996; Han, Kim and Srivastava, 1998; Kotler, 1991; Porter 1990). Since innovation process has become very ineffective not adequate to today's competitive game (Pina e Cunha and Gomes, 2003), considering the increasing costs of technology and the decreasing product life cycle (Chesbrough, 2007), organizations are developing new approaches to the product innovation process.

We have already highlighted the strategic value of knowledge and formal and informal networks of relationships. In fact, these networks provide quick response to firms' requests concerning technology, knowledge, capabilities required for producing innovation, receiving in exchange commitments from

the main firm of the network. An open- innovation model is the most efficient solution since from the idea generation to the commercialization, the network of formal or informal resources linked or linkable by the firm, become critical for reducing costs and increasing revenues.

Product innovation is a complex, cross-functional and dynamic process, which is difficult to manage (Crawford, 1996). It consists of changed or entirely new services or products which are developed to the stage of commercialization, and whose novelty should be evident to either producers, consumers, suppliers or competitors. The process tend to integrate different activities performed by different units around the innovation process, unlikely the EE is a successful model for speeding –up innovation because it reconceptualises the NPD process involving new and different participant, such as customers, suppliers, partners, universities and competitors. In fact, 'NPD can be especially costly and complex; when a high degree of component integration is needed; when a nascent technology is being developed and included in a new product; when a company develops a product with a partner; when a company develops a radical innovation' (Kim and Wilemon, 2003 : 15). Then, it is a good strategy to develop knowledge management systems, which is the process of creating, capturing and using knowledge to enhance organizational performance (Bassi, 1998). Knowledge can be searched within the firm, or in the inter-firm networks of the firm. Internal activities and units of the firms even if they are geographically dispersed, can work together through knowledge sharing tools (Lipnack and Stamps 1997; Cohen and Gibson, 2003; Zakaria, Amelinckx, Wilemon, 2004). The organization's mission is to catch and provide the right knowledge to the right person at the right time in the right format anywhere within the EE. The first step is to separate consumer interactions into two distinct stages – "Divergent" and "Convergent thinking". These two stages have different purposes and outcomes, and call for different techniques. The "divergent thinking" stage is exploratory and open-ended, and is used for gaining fresh consumer insights and generating ideas at the ambiguous "fuzzy front end". In the later "convergent thinking" stage these concepts and ideas are validated and refined – this is standard procedure for many companies.

This network of formal and informal participants is managed through ICT systems that enable these actors to actively learn and to suggest new solution to the firm. Then, firms can access to a more and extended array of new ideas and knowledge, reducing uncertainty, costs, time and the market risk. In the past it has been proved that innovations can come from different players such as lead-users and customers, manufacturers (Von Hippel, 1986; 1988; Anderson & Crocca, 1993; Ramirez, 1999; Prahalad & Ramaswamy, 2000; Thomke & Von Hippel, 2002; Kristensson et. al, 2004), suppliers (Gold, 1987; Von Hippel, 1988; Asanuma, 1988, 1989; Clark, 1989; Clark and Fujimoto, 1991; Mabert, Muth and Schmenner, 1992; Takeishi, 2001), research communities (Allen, 1977; Henderson and Cockburn, 1994; Takeishi, 2001), competitors (Gomes-Casseres, 1996; Takeishi, 2001).

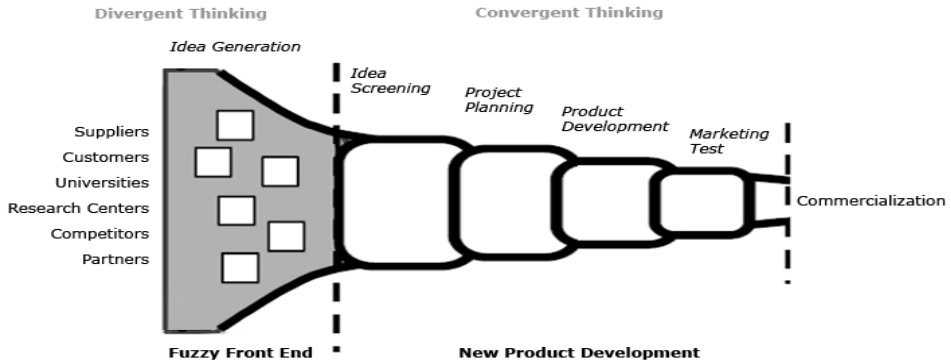


Figure 5: New Product Development Phases within the Extended Enterprise

Toyota (Dyer and Nobeoka, 2000; Clark and Fujimoto, 1991) highlighted the superior performance achieved by firms which rely on tiers of external suppliers, and mobilize them in order to reduce development risks, time-to-market, quality defect rates, and stocks, while at the same time enhancing their capacity for innovation and flexibility (Helper, 1991). Then NPD is a process of co-creation (Prahalad and Ramaswamy, 2004) being not just a mere function of R&D. Accordingly, an open-model of innovation for the EE describes the activity of exploration of the firm throughout his network of relationships.

Competitive advantage could be linked to the capability of identify, manage and retain the most creative, the most connected and the most acknowledged players present in the business environment. Communication is essential in the conceptual innovation which refers along all the phases and through these processes different players originate, evaluate, and develop ideas relevant to scientific practice. want. The creation of direct communication tools with all the players considered as potential innovators and collaborators is critical. For gathering their ideas firms have created communities through the Internet, like Newsgroup, Forum, Open Source Communities, Communities of Practice (Brown and Duguid, 1991; Wenger et al. 2000). In this model of the firm the ICTs play the role of enabler of communication activities among members, building an arena where firms may have an not-mediated, costless, real time, two-way communication with a huge array of players, with the concrete possibility to grasp their resources (the extelligence).

The project planning and product development can be outsourced to linked firms that continuously learn from the firm, and that are ready to do what firms want. Knowledge sharing can be improves through the creation of new players, the intermediaries of knowledge, defined also gatekeeper. For example, Toyota has two major divisions the Operation Management and Consulting Division supporting suppliers learning activities, and if it's necessary other divisions are involved to solve problems with suppliers (Dyer, 2000). For facilitating the learning of their members Toyota developed different association with different tasks like: on site consulting, supplier learning teams, problem solving teams, employee transfer, performance feedback, and process monitoring. So a new strategic activity should be the setting up of routines enabling the knowledge updating and sharing within and across the network of the firm.

Surely, the NPD process is not more a sequential process, to be successful, it has to follow the stochastic and unpredictable nature of ideas generation, and thus firms have to be ready and flexible to sense the ideas and to apply it more quickly and efficiently than competitors. Non- programmed innovation (Zaltman et al., 1973) is the change that is not planned in advance and it can occur as a result of serendipity, the 'eureka' factor within organizations. Then more innovation firms in the future will be that one with a more innovative innovation network, firms that have developed the ability to search for ideas externally, firms that learn and acquire them quicker then others. It is clear that to maintain these networks firm have to create new capabilities and units, like for example a relationship management capability, not just focused with customers. Moreover the ability to maintain this network loyal to the firm is also one other aspect to take into consideration.

The new product development is a multidisciplinary process and all functions are important. Gupta (1986) showed that when the environment is uncertain the integration of marketing and R&D is particularly critical for New Product Development success.

The process is not more sequential (Cooper, 1993) but in parallel, group works are adopted and the functional separation is rejected. All the units of the firm, from marketing to finance and manufacturing participate in the exploration activity enabled by organizational learning activities within, outside and across the firm, cooperate and share knowledge and ideas through horizontal and vertical communication processes.

The boundaries between units are blurred and in fact in the case of new product development these groups work jointly through a two-way process of communication enabled by modern ICTs.

Especially Marketers and Researcher have to work jointly for new product development, since it could be the result of market needs, knowledge and ideas. In this case knowledge sharing activities are aimed at integrating valuable information and knowledge within the firm.

Through the correct integration additional value will be provided, both constituted in new product and service, in new processes or in new organizational forms.

Finally we can say the more and the faster firms have to learn and collaborate with their formal and informal, internal and external networks, the more they will be intelligent this network and the capacity to absorb and manage these resources, the more the firm will be innovative.

3.7 The metaphor of the symbiogenesis

A metaphor from biology can describe very well the new rules of competition; this is the mechanism of symbiogenesis.

Margulis and Sagan (1966) saw that symbiosis is the main mechanism for creating new species in evolution. They introduce compelling evidence that symbiogenesis is a major source of evolutionary innovation leading to the origins of new species. Margulis considered symbiosis an essential principle in the creation of eukaryotic cells from the prokaryotic cell.

According to Margulis the Darwin's notion of evolution as the "survival of the fittest", a continual competition among individuals and species is incomplete. According to her et al. (1986), "Life did not take over the globe by combat, but by networking". According to Margulis and Sagan (2002), evolution did not take over the globe by combat, but by networking, cooperation among different species. Rather than focus solely on the elimination of competitors, Margulis' view of evolution downplays competition itself on the basis of symbiotic relationships.

This concept is consistent with the co-opetition among firms. In complex environments often firms' competitors prefer to collaborate rather than to compete, Brandenburger and Nalebuff (1996: 39) describe co-opetition as 'a duality in every relationship, the simultaneous elements of cooperation and competition. War and peace. Co-Opetition'.

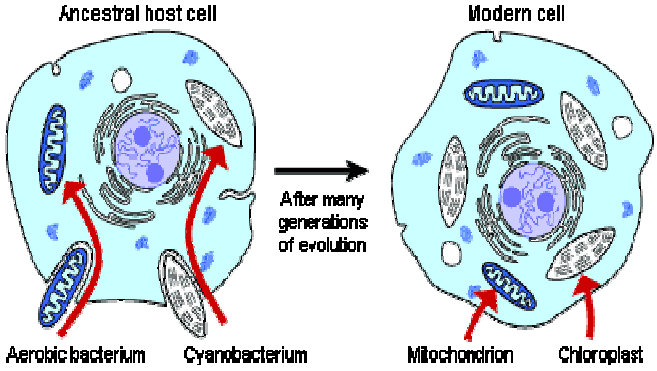


Figure 6. The Symbiogenesis

As pointed by Moore (1996) traditional winner taker all competition '…ignores the need for co-evolution with others in that environment, a process that involve cooperation as conflict'.

This is what emerges from the analysis of the Extended Enterprise, where mergers and alliances giving rise to new morphologies and physiologies evolutionarily more advanced than their constituents and originating new players or new products.

Bibliography

Anand, B. N., Khanna, T., "Do firms learn to create value? The case of alliances", Volume 21, Issue 3, Pages 295 - 315

Asanuma B. (1989) "Manufacturer-supplier relationships in Japan and the concept of relation-specific skill". *Journal of the Japanese and International Economies* 3 (1): 1–30.

Barney, J. B. (1986a), "Strategic Factor Markets: Expectations, Luck and Business Strategy", *Management Science*, 32, 1231-1241.

Barney, J. B. (1986b), *Organizational Culture: Can It Be a Source of Sustained Competitive Advantage*, *Academy of Management Review*, 11, 656-665.

Barney, J. B. (1991)."Firm resources and sustained competitive advantage". *Journal of Management* 17 (March): 99-120.

Barney, J. B., Abigail McWilliams, and Thomas Turk (1989), "On the Relevance of the Concept of Entry Barriers in the Theory of Competitive Strategy," paper presented at the *Annual Meeting of the Strategic Management Society*, San Francisco.

Baum J. A. C., Calabrese, T., Silverman, B., S., "Don't go it alone: alliance network composition and startups' performance in Canadian biotechnology", *Strategic Management Journal*, Volume 21, Issue 3, Pages 267 - 294

Barabasi, A. L., Linked: The New Science of Networks, Perseus, 2002

Baumann Z., Liquid Modernity, Cambridge: Polity Press 2000

Berthon, P., Hulbert J., Pitt, L., (1999), "To Serve or to Create? Strategic Orientations towards Customers and Innovation." *California Management Review* 42(1):37–58

Bijker, W. E., Law J., (Eds.), Shaping technology/building society: Studies in socio-technical change. Cambridge, MA: MIT Press.

Bower, J. L., and C. M. Christensen. "Customer Power, Strategic Investment, and the Failure of Leading Firms." *Strategic Management Journal* 17, no. 3 (March 1996): 197-218.

Brandenburger, A.M., Nalebuff B.J., Co-Opetition, Doubleday, 1996

Brown, J. S., Duguid, P."Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation"; *Organization Science* 2, 1 (1991), 40-57.

Brown, S.L., Eisenhardt, K.M., (1998), Competing on the Edge, *Harvard Business School Press*, Boston, Massachusetts

Burt, R. S. 1992. Structural Holes: The Social Structure of Competition.

Caves, R.E., "Industrial organization, corporate strategy and structure", *Journal of economic Literature,* 58, 1980, pp.64-92

Chesbrough H., (2007), "Why firms should have open business frameworks", *MIT Sloan Management Review*, Vol. 42, n.2

Christensen, C. M. (1997). “Making strategy: Learning by doing.” *Harvard Business Review* 75, no. 6 (November-December 1997)

Christensen, C. M. (1997). The Innovator’s Dilemma: When New Technologies Cause Great Firms to Fail. Boston, Mass.: Harvard Business School Press

Clark KB, Fujimoto T. (1991). *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Harvard Business School Press: Boston, MA.

Clark K.B. (1989). Project scope and project performance: the effect of parts strategy and supplier involvement on product development. *Management Science* 35(10): 1247–1263.

Cockburn, I. M., Henderson R. M. (1998). Absorptive capacity, coauthoring behavior, and the organization of research in drug discovery. *Journal of Industrial Economy* 46(2) 157–182.

Cohen W.M., Daniel A. Levinthal, Absorptive capacity: a new perspective on learning and innovation, *Administrative Science Quarterly*, Vol. 35, 1990

Cooper, M.C., Ellram, L.M. (1993), “Characteristics of supply chain management and the implications for purchasing and logistics”, *International Journal of Logistics Management*, Vol. 4 No.2, pp.13-24.

Davis E., R. Spekman, Hall P., (2004). The Extended Enterprise. Gaining competitive advantage through collaborative supply-chain. Prentice Hall.

Day, G. S. 1994. “The capabilities of market-driven organisations.” *Journal of Marketing*. 58 (October): 37-52.

Day, George S. 1992. “Marketing’s contribution to the strategy dialogue.” *Journal of the Academy of Marketing Science*. 10 (May): 323-329.

Day, G.- S. and Robin Wensley. 1988. "Assessing advantage: A framework for diagnosing competitive superiority." *Journal of Marketing*. 52 (April): 1-20.

Demsetz, H., “The theory of the firm revised”, *Journal of Law, Economics and Organization*, vol. 4, No. 1, Spring 1988,

Drucker, P., 1993, *Post-Capitalist society*, Harper Business, New York City

Dyer J., Singh, H., “The Relational View: Cooperative strategy and sources of interorganizational competitive advantage”, *Academy of Management Review*, 1998, vol. 23, No.4, 680-679

Dyer, J., Nobeoka, I., “Creating and Managing a High-Performance knowledge sharing network: the Toyota case”, *Strategic Management Journal*, 21, 345:367 (2000)

Evans P. B., Wurstel, T.S., “Strategy and the new economics of information”, Harvard Business Review, 1997, Sep.-Oct; 75(5):70-82

Gabbay, S. M., Zuckerman, E. W.: “Social Capital and Opportunity in Corporate R&D: The Contingent Effect of Contact Density on Mobility Expectations”, Social Science Research, 27, 2 (1998), 189-217.

Gold B. (1987). “Approaches to accelerating product and process development”. *Journal of Product Innovation Management* 4: 81–88.

Gomes-Casseres B. (1996) The Alliance Revolution: The New Shape of Business Rivalry. Harvard University Press: Cambridge, MA.

Granovetter, M. S. 1973. The strength of weak ties. *American Journal of Sociology* 78 1360–1380.

Grant, R. M. (1991), The resource-based theory of competitive advantage: Implications for strategy formation, *California Management Review*, 33 (Spring), pp. 114-135

Grant, R. M., "Toward a knowledge-based theory of the firm", *Strategic Management Journal*, Vol. 17 Issue 10, 1996

Gulati, R., Nohria, N., and Zaheer A., (2000), "Strategic networks", *Strategic Management Journal*, 21: 203-215.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, 19, 293-317.

Håkanson, L. and U. Zander (1986). "Managing International Research and Development". Sveriges Mekanforbund, Stockholm

Hall, Richard. 1992. "The strategic analysis of intangible resources." *Strategic Management Journal*. 13 (February): 135-144.

Hamel G. and C.K. Prahalad, (1990), The Core Competence of the Corporation, *Harvard Business Review*, vol. 68, no. 3, May-June 1990, pp 79-93

Helper, S., (1991) "Strategy and Irreversibility in Supplier Relations: The Case of the US Automobile Industry," *Business History Review,* 65, no. 4, Winter 1991, pp. 781-824.

Henderson RM, Cockburn I. (1994). "Measuring competence? Evidence from the pharmaceutical drug discovery." *Strategic Management Journal*, Winter Special Issue 15: 63–84.

Huber, G., "Organizational learning: the contributing process and the literatures", *Organization Science*, Vol. 2, no.1, February 1991

Hunt, S. D. and Morgan R.M. (1996). "The resource-advantage theory of competition: dynamics, path dependencies, and evolutionary dimensions." *Journal of Marketing*. 60 (October): 107-114.

Iansiti, M. and McCormack, A. (1997) "Developing products on Internet time". *Harvard Business Review*, 75, September±October.

Inkpen, A.C. (1996). "Creating Knowledge through Collaboration". *California Management Review 39*, 1, 123-140

Jaworski, B., Kohli A.K. and Sahay A., (2000), Market-Driven vs. Driving markets, *Journal of the Academy of Marketing Science*, vol. 28, no.1, pp. 45-54

Kauffman, S., (1995) At Home In The Universe, New York, Oxford University Press, 1995

Kim, D.H. (1993). "The Link Between Individual and Organizational Learning". *Sloan Management Review* 35, 1, 37-50

Kogut B.and Zander U., Knowledge of the Firm, Combinative Capabilities, and the Replication of Technology, *Organization Science*, Vol. 3, No. 3, Focused Issue: Management of Technology. (Aug., 1992), 383-397.

Kogut, B. (1988). Joint-Ventures: Theoretical and Empirical Perspectives. *Strategic Management Journal 9*, 4, 319-322.

Kohli, A. K., Jaworski, B. J. (1993), Market Orientation: Antecedents and Consequences, *Journal of Marketing*, Vol. 57 (July), pp. 53– 70

Kohli, A. K., Jaworski, B. J., (1990), Market Orientation: The Construct, Research Propositions, and Managerial Implications, *Journal of Marketing*, Vol. 54 (April), pp. 1 – 18

Krackhardt, D. and J. R. Hanson, "Informal Networks: The Company Behind the Chart", *Harvard Business Review*, July-August, 1993, pp. 104-111

Kristensson et al., "Harnessing the Creative Potential among Users", *Journal of Product Innovation Management***,** Volume 21 Page 4 - January 2004

Kuppers, G., Pyka, A., *Innovation Networks, Theory and Practice*, Edwar Elgar Publishing, USA, 2002

Lado A.A., Wilson M.C., "Human resource System and sustained competitive advantage: a competency-based perspective", *Academy of Management Review*, 1994, vol. 19, no.4, 699-727

LaLonde BJ, Pohlen TL. 1996. "Issues in Supply Chain Costing". *The International Journal of Logistics Management,* Vol. 7 No.1, pp.1-12

Lancaster, K. (1991). Modern Consumer Theory. Brookfield Vermont, USA: Edward Elgar Publishing Limited.

Leonard-Barton, D. (1995), Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation, Harvard Business School Press, Boston, MA

Leonard, D., Sensiper, S. (1998). "The role of tacit knowledge in group innovation", *California Management Review*, Vol. 40 No.3, pp.112-32.

Lesser, E. L., Slusher, J., Fontaine, M. (2000). Knowledge and Communities, Butterworth-Heinemann, Boston.

Levitt, V., March J. G. (1988) "Organizational learning". *Annual Review of Sociology* 14: 319–340.

Liebeskind, J. P., "Knowledge, Strategy, and the Theory of the Firm", *Strategic Management Journal*, Vol. 17, Winter Special Issue, 1996

Lippman, S.A. and Richard P. Rumelt (1982), "Uncertain Imitability: An Analysis of Interfirm Differences in Efficiency Under Competition," *The Bell Journal of Economics*, 13 (Autumn), 418–38.

Liyanage, S., Greenfied, P. F., Don, R.: "Towards a fourth generation R&D management model - research networks in knowledge management"; *International Journal of Technology Managemen*t, 18, 3/4 (1999), 372-394.

Lorenzoni, G., Lipparini A., The leveraging of interfirm relationships as a distinctive organizational capability: a longitudinal study, *Strategic Management Journal*, Volume 20, Issue 4**,** Pages 317 - 338

Lumpkin, G.T., Dess, G.G., "Clarifying the entrepreneurial orientation construct and linking it to performance", *Academy of Management Review*, 1996, vol. 21, no. 1, 135-172

Mabert VA, Muth JF, Schmenner RW. 1992. Collapsing new product development times: six case studies. *Journal of Product Innovation Management* 9: 200–212.

Maier R., (2007). Knowledge Management Systems. Information and Communication Technologies for Knowledge Management 3rd ed., 2007, Springer Verlag

March, J.G., “Exploration and Exploitation in Organizational Learning”, Organization Science, Vol. 2, No. 1, 1991, pp. 71-87

Margulis L. and Sagan D. (2002) Acquiring genomes a theory of the origins of species, Basic Books

McDermott R., (1999). “Learning Across Teams: The Role of Communities of Practice in Team Organizations”. KMR

Mintzberg H, Ahlstrand B, Lampel J. 1998. *Strategy Safari: A guided tour through the wilds of strategic management*. The Free Press: New York.

Moore J.F., “The death of competition: leadership and strategy in the age of business ecosystems”, 1996, Harper Business

Narver, J. C., Slater, S. F., Mac Lachlan (2000), Total Market Orientation, Business Performance and Innovation, *Marketing Science Institute*, *Working Paper Series*, Report # 00.16

Nelson, R., S. Winter. 1982. An Evolutionary Theory of Economic Change. Harvard University Press, Cambridge, MA.

Nonaka I. and Takeuchi, H. (1995), “The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation”, (Oxford University Press).

Nonaka, I., (1994). “A Dynamic Theory of Organizational Knowledge Creation”, *Organization Science*, vol. 5, no. 1, 1994, pp.14-37

Nonaka, I., (1997). “The Knowledge-Creating Company,” *Harvard Business Review on Knowledge Management,* pp. 21-45, 1997, Harvard Press, Massachusetts

Normann R., and R. Ramirez (1998), *Designing Interactive Strategy from Value Chain to Value Constellation*, 2nd ed. Chichester, UK: John Wiley.

Passiante, G. and Andriani, P. (2000) Modelling the learning environment of virtual knowledge Networks: some empirical evidence. *International Journal of Innovation Management*, Vol. 4, No. 1.1-31.

Penrose, E.T., (1959), “The Theory of the Growth of the Firm”, Basil Blackwell, London.

Pine, B., J., Davis, S., Mass Customization. the new frontier in business competition, Harvard School business Press 1993

Polanyi, M. 1966. *The Tacit Dimension*. Routledge & Kegan Paul, London, UK.

Porter, Michael E. (1980), Competitive Strategy. New York: Free Press.

Porter, Michael E. (1991), “Towards a Dynamic Theory of Strategy,” *Strategic Management Journal*, 12 (Winter), 95–118.

Powell, W. W.: “Learning From Collaboration: Knowledge and Networks in the Biotechnology and Pharmaceutical Industries”, *California Management Review*, 40, 3 (1998), 228-240.

Prahalad C.K., Ramaswany V., (2004), “Co-creation experiences: the next practice in value creation”, *Journal of Interactive Marketing*, Vol. 18, N. 3

Prahalad, C. K. and Hamel G. (1990). “The core competence of the corporation.” *Harvard Business Review,* n. 68 (May-June): 79-91.

Prahalad, C.K. and Ramaswamy, V. (2000). "Co-Opting Customer Competence". *Harvard Business Review* 78(1):79 – 87.

Quinn, J. B. (1992) Intelligent Enterprise: A Knowledge and Service Based Paradigm for Industry, Free Press, New York.

Ramirez, R., "Value co-production: intellectual origins and implications for practice and research", *Strategic Management Journal,* Volume 20, Issue 2, Pages 49 - 65

Rogers, E. M. (1995), Diffusion of Innovations, Free Press, New York

Rogers, E., M., Shoemaker F.F. (1971), Communication of Innovation: A Cross-Cultural Approach, New York, The Free Press

Rothwell, R., (1992), Successful industrial innovation: Critical factors for the 1990s, *Research and Development Management*, 22(3), 221–239

Rumelt, Richard P. (1984), "Towards a Strategic Theory of the Firm," in *Competitive Strategic Management*, R. Lamb, ed. Englewood Cliffs, NJ: Prentice Hall, 556–70.

Sawhney, M., Verona, G., Prandelli, E., (2005) "Collaborating to create: the internet as a platform for customer engagement in product innovation", Journal of Interactive Marketing, Vol. 19, N. 4

Senge, P., *The Fifth Discipline: The Art and Practice of the Learning Organization*, Doubleday, 1990.

Seufert, A., Back, A., Krogh, G. von: "Towards a Reference Model for Knowledge Networking", Working Paper, Research Center Knowledge Source, BE HSG/ IWI 3 Nr. 5/ IfB Nr. 34, University of St. Gallen (1999)

Shan, W., Walker, G., Kogut, B., (1994) "Interfirm cooperation and startup innovation in the biotechnology industry", *Strategic Management Journal* 15:55, 387-394.

Slater, S. F., and Narver J.C., (1998). "Customer Led and Market Oriented: Let's Not Confuse the Two." *Strategic Management Journal* 19 (10): 1001-1006

Song X.M.; Montoya-Weiss M.M., "Critical Development Activities for Really New versus Incremental Products", *The Journal of Product Innovation Management*, Volume 15, Number 2, February 1998, pp. 124-135(12)

Spender, J. C., "Making Knowledge the Basis of a Dynamic Theory of the Firm", *Strategic Management Journal*, Vol. 17 (Winter Special Issue), 1996, pp. 45-62

Spender, J. C. Industry recipes: The nature and sources of managerial judgement, Oxford: Basil Blackwell, 1989.

Takeishi A. (2001). "Bridging inter- and intra- firm boundaries: Management of supplier involvement in automobile product development", *Strategic Management Journal,* 22: 403–433

Teece D. J., "Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How", *The Economic Journal*, Vol. 87, No. 346. (Jun., 1977), pp. 242-261.

Teece, D., (2000). Managing Intellectual Capital, Oxford University Press, London

Teece, D.J., Pisano, G., Shuen, A., (1997) "Dynamic capabilities and Strategic management". *Strategic Management Journal*, 18, 509-33

Thomke, S. and von Hippel, E. (2002) “Customers as Innovators: A New Way to Create Value”, *Harvard Business Review*, Vol. 80, No. 2.

Toffler, 1990, Powershift, New York: Bantam Books

Von Hippel E. (1986). “Lead users: a source of novel product concepts”. Management Science, Volume 32, Issue 7, 791 – 805.

Von Hippel E. “Cooperation Between Rivals: Informal Know-How Trading,” Research Pol-icy, 1987, 16: 291-302.

von Hippel E., (1994). “Sticky Information and the Locus of Problem Solving: Implications for Innovation”, *Management Science*, Vol. 40, No. 4. (Apr., 1994), pp. 429-439

Von Hippel E. “The sources of innovation”, New York, Oxford University Press

Waldrop, M.M., (1992), Complexity at the Edge of Order and Chaos, Touchstone Books, New York

Watts, D. J., (2003). Six Degrees: The Science of a Connected Age (Hardcover) W. W. Norton & Company, New York

Watts, D. J., S. Strogatz (1998) “Collective dynamics of small world networks”. *Nature* Jun 4;393(6684):440-2

Weick, K. E., (1993). “The Collapse of Sensemanking in Organizations: The Mann Gulch Disaster”, *Administrative Science Quarterly*, Vol. 38, pp. 628-652

Weick, K. E., Sensemaking in Organizations, Sage Publications, 1995.

Wenger, E. and Snyder W. M., (2000). *Communities of Practice: The Organizational Frontier*, Harvard Business Review, January-February.

Wenger, E., McDermott, R., Snyder, W. M. (2002). “Cultivating Communities of Practice. A Guide to Managing Knowledge”, Harvard Business School Press, Boston/MA

Wernerfelt, B. (1984) “A resource-based view of the firm”, *Strategic Management Journal* no.5 (2), pp.171-180

Winter, S. G., “Knowledge and competence as strategic assets”, in Teece, D.J. (ed.), The Competitive Challenge: Strategies for Industrial Innovation and Renewal, (Cambridge: Ballinger, 1987), pp. 159-184

Zack, M. H., (1999). “Developing a Knowledge Strategy”, *California Management Review*, Vol. 41, No. 3, Spring 1999, pp. 125-145

Zack, M. (1999). “Competing on Knowledge”. *Handbook of Business Strategy.* New York: Faulkner & Gray, 1999, pp. 81-88

Zaltman, G., Duncan, R. and Holbek, J. (1973). Innovations and Organizations. New York: Wiley and Sons

Zander, U., & Kogut, B. (1995). “Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test.” *Organization Science*, 6(1), 76-92.

2nd Part

Knowledge, knowledge management and knowledge Sharing Research

4. The knowledge-based view of the firm

According to the Resource Based Theory, some resources can create a sustained competitive advantage whether they possess certain attributes such as value, rareness, imperfect imitability, and non-substitutability (Barney, 1991).

Several authors for long time have questioned which resources contribute to firm's sustained competitive advantage. Nowadays, the competitive environment evolves rapidly and the capacity to manage knowledge-based intellect is the critical skill of this era (Quinn, 1992). The wealth-creating capacity of the enterprise is based on the knowledge and capabilities of its people (Savage, 1990). In order to adapt to the changing environment firms see themselves as learning organizations pursuing the objective of continuously improve their knowledge assets (Senge, 1990).

Some author questioned the reason why knowledge is so important (Zack, 1999), concluding that it has all requirements for being a kind of resource that promote sustained competitive advantage since:

1. it's not easily purchased in the marketplace in a ready-to-use form,
2. it's acquired through experience and takes time (path-dependence),
3. the more firms know the more they can learn (cumulative nature of learning),
4. the synergistic combination may add value to knowledge,
5. knowing more about something than competitors,
6. knowledge provides increasing returns as it is used,
7. there are areas where some knowledge leads the competition, acquiring and using that unique knowledge can be applied profitably in the marketplace
8. firms have to identify knowledge upon which is based their current or future position and continually improve or update it.

Nonaka and Takeuchi (1997) affirmed that knowledge, in his dual nature of tacit and explicit (Polanyi, 1958; 1967), may be viewed as the basis for creativity and innovation. Clark and Fujimoto state that new product development embodies knowledge creation as new products embody new knowledge (Clark and Fujimoto, 1990). Therefore the NPD process is greatly influenced by learning processes and knowledge management (KM) applied within the company. Knowledge adds value to products and services, such as technical know-how, product design, understanding of customer needs, creativity and so on.

Consistently, knowledge and the capacity to create such knowledge is widely considered the most important source of sustainable competitive advantage (Dierickx & Cool, 1989; Kogut & Zander, 1992; Pettigrew and Whipp 1993; Nonaka & Takeuchi, 1995; Nonaka,1994; Prahalad and Hamel, 1990; Nelson, 1995; Leonard-Barton, 1995; Liebeskind 1996; Grant, 1996; Nahapiet and Ghoshal 1998; Spender 1996; Teece, Pisano & Shuen, 1997; Zack, 1999; Teece, 1990; 2000; Carlile 2004).

4.1 A clear definition of knowledge

But what is exactly knowledge? And how can we distinguish for example between knowledge and information?

It is important to give a clear definition of what knowledge is and what it is not, how it is recognizable and so on. A wide body of literature has not always clearly faced the problem.

At the time when businesses were based on mass production, knowledge was not considered an important asset. Machines, time and production capacity were the most important asset for competing. Nowadays, the increasing complexity and rapidity of the pace of change within the society have created the necessity of knowing better customers, continuously update knowledge and competencies, and search for the most effective and efficient way of doing this. Everyone of this aspect is linked with knowledge creation and acquisition, related to work processes, products' components, customer's expectations, emerging technologies and so on.

We said that some years ago firms manage information rather than knowledge. The Latin origin of the word information means 'give shape to something', in mass media studies information was a message prepared by a source that uses a communication channel for sending that message to the receivers. The message was generally associated, like in marketing studies, with the aim of producing some effect on the receiver, so to shape how to look or how to approach to things.

Also news has the role of shaping the receiver's outlook or insight about war, crimes, public security and so on. According to what is showed and what it is hidden by the video-camera we receive a certain shape of the world, of other cultures, of goods and other things.

Advertising is simply a set of messages that have the role of shaping customer's needs or attitude towards a specific brand/product. Similarly information provided by some source may have the goal of giving an outlook or insight about something. This negative definition of the term was not present in organizational studies, where information constituted an important resource flowing within businesses. Differently from data, information is a data that makes a difference (Davenport and Prusak, 1998: 3), such as it has an impact on receiver's behavior and judgment.

Knowledge and especially the way we know things, is the most ancient subject of inquiry in different fields, especially philosophy. The discussions started with Parmenides, for him knowledge directly comes from reason, for Plato senses were as well important; Aristotle said that men knew through senses but they got the essence of things through the active participation of the human intellect, which helped in abstracting from the particular and specific facts, events…the universal nature of things and phenomena.

Knowledge is then an old subject of inquiry, actually many authors, mainly belonging to business studies, are trying to measure and quantify its importance and contribution to firm's performance. Moreover, authors have then proposed different definition for distinguishing information from knowledge. According to Davenport and Prusak (1998:5) knowledge 'is a fluid mix of framed experiences, values, contextual information, and expert insight that proves a framework for evaluating

and incorporating new experiences and information. It originates and is applied in the mind of knowers. In organizations, it often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms.' Increasingly, knowledge is the capacity of distinguishing one approach from another, to face different situations or problems, the capacity to speak different languages and it contributes to build the reputation and credibility of people and the acceptance of their statements as true.

The credibility degree of a statement, message is due to the status of expert in a (knowledge) domain as recognized by the community or by a group of people of the people that have produced that message, statement and so on.

However, dynamically knowledge has some attributes, such as (1998: 7-12):

- develops through experiences. Knowledge develops over time, through learning experiences such as seminars, workshops, but also referring to what we have already done in the past. An expert is a people that overcome successfully a test thanks to his experience in a certain domain. The experience in doing something help people in doing things quickly and better than other that have not experience with it.
- Ground truth, means what really works and what doesn't. An example is lessons learned.
- Complexity, the importance of experience and ground trust in knowledge is one indication of knowledge's ability to deal with complexity. As such, knowing more leads to better decision than knowing less, even if the less seem more definite and clearer. Knowledge is aware of what it doesn't know. It looks like Socrates' statement: 'The more I know the more I'm aware of my ignorance', a humble attitude that makes people ready to deal with the unexpected, unpredicted events that break up certitudes and forecasting. The more one person knows the more is aware of not knowing everything and the lesser is rigid and prone to accept and expect changes or radical transformation.
- Judgment, knowledge contains judgments of past situations and it is flexible to refine itself for adapting to changing environments.
- Rules of Thumb and Intuition, that is flexible guides to action developed through trial and error and over the long experience and observation. These are heuristics that contain solution to new problems that resemble problems previously solved by experienced workers. So they don't have to build an answer from scratch every time. Sometimes we arrive to solve problems very quickly by intuition, but intuition is not mystical; it means that we have thoroughly learned the steps that they happen automatically without conscious thought, and therefore at great speed. Karl Weick named it 'compressed experience'.
- Values and Beliefs, people values and beliefs have an impact on organizational knowledge, such as the history of the company that should influence people's actions and values working within it. People with different values and beliefs see things differently in the same situation. According to Nonaka and Takeuchi (1995) the power of knowledge to organize, select, learn and judge comes from values and beliefs rather than information and logic.

Coming back to the distinction between knowledge and information, Wiig (1993) say that information are facts, organized to describe a situation or condition, while knowledge is truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know how. According to Quigley and Debons (1999) information are text that answer to the questions who, when, what or where, while knowledge is text that answer the question why or how.

Leonard Barton and Sensiper (1998) point out to the subtle difference between knowledge and information, suggesting that knowledge in the business context comprises of relevant, actionable, information that is partially based on experience. For Moenaert and Caeldries (1994) 'each member of an organization can be seen as a pocket of knowledge and such knowledge includes facts, principles, experience-based insights, working procedures, research findings and ideas' (:26).

According to Nonaka and Takeuchi: 'information is a flow of messages, while knowledge is created by that very flow of information, anchored in the beliefs and commitment of its holder. . .Knowledge is essentially related to human action' (Nonaka and Takeuchi 1995:58–59).

Definitions of knowledge	Authors
Knowledge 'is a fluid mix of framed experiences, values, contextual information, and expert insight that proves a framework for evaluating and incorporating new experiences and information. It originates and is applied in the mind of the knowers… It often becomes embedded not only in documents or repositories but also in organizational routines, processes, practices and norms.'	Davenport and Prusak 1998
Knowledge is truths and beliefs, perspectives and concepts, judgments and expectations, methodologies and know how.	Wiig 1993
Knowledge comprises of relevant, actionable, information that is partially based on experience.	Leonard Barton and Sensiper 1998
Knowledge is created by the flow of information, anchored in the beliefs and commitment of its holder. . . .Knowledge is essentially related to human action.'	Nonaka and Takeuchi 1995: 58–59
'Each member of an organization can be seen as a pocket of knowledge and such knowledge includes knowledge includes facts, principles, experience-based insights, working procedures, research findings and ideas'	Moenaert and Caeldries 1994
Knowledge comprises all cognitive expectancies-observations that have been meaningfully organized, accumulated and embedded in a context through experience, communication or inference- that an individual or organization actor uses to interpret situations and to generate activities, behaviour, and solutions no matter whether these experiences are rational or used intentionally.	Maier 2007: 76
Kknowledge is to some extent the process of communicating, directly or indirectly, an articulated meaning, ideas, or practices by two subjects that produce and send messages, verbally or not, which are	Proposed definition

processed mentally by the receiver that, to his turn, replicate the same process, idea, meaning or its own vision according to his experience, beliefs, practical experiences, values.	

Table 1. Definitions of Knowledge

Then, knowledge is to some extent the process of communicating, directly or indirectly, a meaning, an idea, a practice by two subjects that mutually produce and send messages, verbally or not, which are processed mentally by the receiver that, to his turn, replicate (logically) to the message with his own vision and opinions based on his experience, beliefs, practical experiences, and values.

The process of creating and sharing knowledge could also be conceptualized as a *communic-action process*, while for example two people for sharing knowledge necessarily have to use a certain communication channel, such as verbal or written communication, gestures, or other typology of body communication to describe, share, show how to do things.

Communication is very related to knowledge also as its meaning reflect the sharing of something; the Latin origin of the word *communico* expresses the activity of sharing something with somebody, to make somebody to be aware of something. If it is true that every communication is not intended to share knowledge, knowledge between individuals can be only shared through communication (verbal or paraverbal, oral or written). Communication such as knowledge sharing is a social act, and then involves different people with different point of views and needs with the goal of making understand something.

This kind of knowledge, called also tacit, is generally more difficult to communicate verbally or by paper and pencil, however sharing it, still remains basically a communication process. We cannot not communicate, even when we don't say anything we are communicating something (Watzlawick, et al. 1967). Therefore everything is a message: 'Activity or inactivity, words or silence all have message value: they influence others and these others, in turn, cannot not respond to these communications and are thus themselves communicating' (Id.: 1).

Sending information have always been associated to persuasive goals, like shaping the opinion of somebody on something or for making him doing something; this is generally the style of communication we find in advertising or in TV journals.

Sending or better sharing knowledge in organizations is more, or better should be, associated with the goal of improving counterpart's knowledge capital sharing what I know or what I know how to do with him. This communication act has no persuasive goal, it is neutral and it is aimed at communicating terms, concepts, theories, methodologies, practices…

Knowledge is the result of the interaction between two or more actors that communicate and that produce a negotiated vision on something based on experiences, previous knowledge, and other socio-psychological aspects (values, beliefs, opinions, motivation, trust…).

The recent conceptualization of a knowledge-based view also represents the ability of the firm to integrate knowledge (Grant, 1996a) and to transform dispersed, tacit, and explicit competencies into a wide body of organizational knowledge (Nonaka, 1994).

Companies having superior knowledge are able to coordinate and combine their resources and capabilities in distinctive ways, providing more value for their customers than can their competitors. This competitive advantage is sustainable because the more a firm already knows, the more it can learn and take time advantage in launching new products on the market before competitors.

4.2 Taxonomy of Knowledge

Authors have identified different taxonomies of knowledge. These classifications are often dichotomised in order to describe two different opposite typologies of knowledge. These classification and their authors are presented in the table below (adapted from Maier, 2007:68):

Author	Taxonomy
Scheler, 1926	1. Instrumental knowledge 2. Intellectual knowledge 3. Spiritual knowledge
Machlup, 1962 (builds on Scheler, 1926)	1. Practical knowledge 2. Intellectual knowledge (embracing scientific, humanistic and cultural knowledge) 3. Small talk / pastime knowledge (news, gossip, stories) 4. Spiritual knowledge 5. Unwanted knowledge
Hayek, 1945	1. Scientific knowledge 2. Knowledge of the particular circumstances of time and place
Ryle, 1949	1. Knowing that 2. Knowing how
Sackmann, 1992 (builds on Ryle, 1949)	1. Dictionary knowledge (what?) 2. Directory knowledge (how?) 3. Axiomatic knowledge (why?) 4. Recipe knowledge (what should?)
Quinn et al. (1992) (similar to Sackmann)	1. Cognitive knowledge (know-what) 2. Advanced skills (know-how) 3. Systems understanding (know why) 4. Self-motivated creativity (care why)
Anderson, 1976; Squire 1987; Fayol 1994	1. Declarative knowledge 2. Procedural knowledge 3. Meta-knowledge
Heideloff and Baitsch 1998;	1. Fact knowledge 2. Episodic knowledge 3. Procedural knowledge
Russell 1948	1. Individual knowledge 2. Social knowledge
Polanyi, 1966	1. Tacit knowledge 2. Explicit knowledge
Henderson & Clark, 1990	1. architectural knowledge 2. component knowledge

Spender, 1994 (builds on Russell and Polanyi)	1. Conscious knowledge (explicit individual knowledge) 2. Automatic knowledge (implicit individual knowledge) 3. Objectified knowledge (explicit social knowledge) 4. Collective knowledge (implicit social knowledge)
Wilke, 1998 (builds on Polanyi)	1. Implicit knowledge 2. Explicit knowledge 3. Public knowledge 4. Proprietary knowledge
Wiig, 1998	1. Public knowledge 2. Expert knowledge 3. Private knowledge
Matusik and Hill, 1998	1. collective 2. individual
Collins, 1993	1. Embrained knowledge (brain) 2. Embodied knowledge (body) 3. Encultured knowledge (social system) 4. Symbol-type knowledge (symbols)
Bohn, 1994	1. Complete ignorance 2. Awareness 3. Measure 4. Control of the mean 5. Process capability 6. Process characterization 7. Know why 8. Complete knowledge
Blackler, 1995 (adapt to Collins' classification)	1. Embrained knowledge (depends on conceptual skills) 2. Embodied knowledge (depends on physical presence) 3. Encultured knowledge (shared understanding, socialization) 4. embedded knowledge (in systemic routines) 5. encoded knowledge (signs, symbols)
Sveiby 1997	1. Explicit knowledge 2. Skill 3. Experience 4. Value judgement 5. Social network
Baecker, 1998 (knowledge in organizations)	1. Product knowledge 2. Societal knowledge 3. Leadership knowledge 4. Expert knowledge 5. Milieu knowledge
Hansen, 1999, Zack 1999a	1. Knowledge as object (codified, independent person) 2. Knowledge as process (personalized)
Zack 1999b (categorize industry knowledge)	1. Core knowledge 2. Advanced knowledge 3. Innovative knowledge
Table 2 A Taxonomy of knowledge	

4.2.1 Tacit and Explicit Knowledge

Probably the most popular distinction is the one between tacit and explicit knowledge. Knowledge can be tacit or explicit (Polanyi 1966) But only a small part of our knowledge is explicit; "we can know more than we can tell" (Polanyi 1966, p. 4). This distinction between the two types of knowledge is important because of the transferability and appropriability of explicit knowledge, as opposed to tacit knowledge (Grant 1996 a, b).

The main part of knowledge present in organizations is tacit or *know-how*, and it is hard to articulate and difficult to communicate, since it's difficult to codify in the natural language, it is normally embedded in performing complex tasks and held in peoples' heads. The explicit knowledge or information is easily to codify and to communicate and is normally accessible to everyone. It includes 'facts, axiomatic propositions, and symbols such as information on size and growth of a market, production schedules, and so forth'. (Dyer, 2000: 63). In fact, 'while explicit knowledge is more easily managed and shared, tacit knowledge potentially has more strategic value, being derived from particular circumstances and events and thus unique and hard to imitate' (Zack, 2000 :81). It is clear why the tacit knowledge more than the explicit can be considered a source of sustainable competitive advantage.

Finally all the activities directly related to the acquisition, management and sharing of knowledge across the firm acquire huge importance in the organization of the firm. Knowledge can be present in the head of people, in the document or knowledge management systems of the firm, and in the processes of the organizations.

During the years individuals in an organization make experience of different situation, face different problems, find solutions, develops a common language and so on. All this knowledge is present in the head of individuals and helps them in their daily work; moreover it represents the historic knowledge of a firm.

However, sometimes this knowledge is codified and archived in databases, or knowledge management systems and it is at disposition also for the newcomers and for other workers in order to reapply the knowledge to new problems and projects whether it is possible.

Knowledge is also present in the processes of the organization, and it represents rules, routines, behavior that is not written and is acquired during years of work experience.

4.3 Managing knowledge into Organizations

Knowledge management roots can be identified in the Anglo-American literature of the late 60s and the early 70s. Zand (1969) anticipated the changes that were leading to the emergence of the knowledge society and the appraisal of the knowledge workers, but he did not use the term knowledge management, rather management of the knowledge organization (Maier, 2007). On the contrary

Rickson (1976), a sociologist, used the term knowledge management but referring to analysis application of knowledge in the society and not within organizations (Maier, 2007).

Knowledge is an intangible asset, and its management is more complex than any other physical asset such as workers, machineries, raw materials, industrial establishments, and so on. Managing knowledge is a very complex task since often the benefits of acquiring knowledge are difficult to recognize and even to measure after the knowledge acquisition. Moreover, it often happens that firms don't preview routines for sharing or archiving knowledge impeding the accumulation of historical knowledge.

Knowledge management (KM) is a set of processes aimed at maximizing the outcomes of the knowledge produced within a business unit, a firm, a network of firms. Knowledge management isn't only related with the activity of storing document and paper in a database; however it entails a much complex set of activities and roles.

KM has been conceptualized differently by different authors and different disciplines; however the goal is always the same that is to make knowledge available to the right person (of the firm) at the right moment in the right form. This condition means to identify and codify such knowledge and make it available through documents, informal conversations, on the job learning routines, best practices collections, plenary sessions and so on.

KM is a multidisciplinary discipline; it has been approached by sociologists, informatics, psychologists, and economists and so on. Economists focus more on productivity pitfalls of knowledge management, psychologists investigate the motivations and behaviour of people during the knowledge creation/sharing process, sociologists investigate the condition that facilitate or hinder interpersonal knowledge sharing, while informatics more focus on technological systems that enable the knowledge management. The heterogeneity of knowledge management research raises important questions about the degree of integration across disciplines and the extent to which a truly cumulative body of knowledge is emerging (Argote, McEvily, Reagans, 2003).

Generally, there is agreement about the distinction between two different approaches: human and technology-oriented KM, which basically reflects the origin of the approaches either in a human/process oriented organizational learning, organization science background, or on the other hand in a technological/structural organization science, a MIS or computer science/artificial intelligence background (Maier, 2007). There is also agreement that there are more holistic approaches, but they don't really integrate the two directions (ibid.).

Knowledge management projects are more likely to be led by the IT Department (22%) than by marketing (16%), human resources (5%), or operations (4%), and are often built around some kind of intranet, shared database, or groupware software that allows people to communicate with one another, share ideas, and engage in discussions (KPMG 2000).

KM has been defined differently by different disciplines. There are strategy or management oriented definitions such as: applying knowledge management throughout the organization requires taking a systematic and holistic view of the knowledge agenda-understanding the strategic role of knowledge,

linking it to key management decisions and business processes and improving processes for knowledge creation, sharing and use (Skyrme and Amidon, 1997:30).

There is definitions focusing on a life cycle and more oriented to knowledge tasks, functions and processes, as such: Knowledge management comprises methods, procedures and tools which support the core activities: generate, transfer, store and apply knowledge (Heisig and Vorbeck, 1998).

There are definitions more technology oriented such as: 'extend the object of information management which include knowledge management, both in the form of 'somewhat of more valuable valuable information and context enriched information to be stored with the help of communication and information systems, and in the form of knowledge in people's head' (Maier, 2007:54).

Then, there is a wide range of other definitions, such as Wig (1993), who defines knowledge management as a systemic, explicit and deliberate building, renewal and application of knowledge to maximize an enterprise's knowledge related effectiveness and returns from its knowledge assets. The processes identified in this definition are knowledge creation, knowledge update, knowledge application.

For the Gartner Group (1999) knowledge management promotes an integrated approach to identifying, capturing, retrieving, sharing and evaluating an enterprise's information asset. Information assets include databases, documents, policies and procedures, as well as the uncaptured tacit expertise and experience stored in individual workers' heads. Then, we can identify the following processes: knowledge identification, storage, retrieval, sharing and evaluating.

Alavi and Leidner (1999) view knowledge management as a systemic and organizationally specified process for acquiring, organizing and communicating knowledge of employees so that other employees may make use of it to be more effective and productive in their work. The resulting processes are knowledge acquisition, organization (storage and retrieval), sharing, and application.

According to Macintosh et al. (1999), knowledge management involves the identification and analysis of available and required knowledge, and the subsequent planning and control of actions to develop knowledge assets so as to fulfil organization objectives.

The above definition of knowledge management implies that it is necessary for organizations:

- to be able to *capture and represent* their knowledge assets;
- to *share and reuse* their knowledge for differing applications and differing users; this implies making knowledge available where it is needed within the organization;
- to *create a culture* that encourages knowledge sharing and reuse.

Maier (2002, 2007) defines KM as the management function responsible for the regular selection, implementation and evaluation of goal-oriented knowledge strategies that aim at improving an organization's way of handling knowledge internal and external to the organization in order to improve organizational performance. The implementation of knowledge strategies comprises all person-oriented, organizational and technological instruments suitable to dynamically optimize the

organization-wide level if competencies, education and ability to learn of the members of the organization as well as to develop collective intelligence (Maier 2007:57).

The processes identified by Maier are:

- Knowledge identification,
- Knowledge acquisition,
- Knowledge creation,
- Knowledge organization,
- Knowledge publication,
- Knowledge distribution,
- Knowledge search and retrieval,
- Knowledge application,
- Knowledge evolution,
- Knowledge deletion and archiving.

Finally we can say that knowledge management should be viewed as a systemic and not linear, organization-wide and not only individual, strategic and not chaotic process aimed at identifying potential knowledge gaps within the firm and its network of collaborators (suppliers, partners…), and then search or create the knowledge needed, codify and organize such knowledge, store and at the same time share, retrieve and exploit it.

These processes of knowledge management should be anticipated by an analysis, such as a swot analysis/benchmarking of the knowledge asset, aimed at monitoring the status of the firm's knowledge in the market compared also with the main competitors. If competitors do something better than us, it is important to understand and fill this gap, and this is true especially in high technology industries.

Figure 7. Strategic Knowledge Management Process. Source: my elaboration)

Moreover, the process is not sequential; rather it is systemic and dynamic as it involves the continual interactions among firm's workers and partners, which determine the state and the behaviour of the system.

The workers have to learn from other actors, exploiting their personal networks of individuals or organization external or across the firm's boundaries. This activity, imply an optimization of firm's efforts and create a win-to-win approach in the relationships with suppliers, customers and other partners.

Different typologies of knowledge are acquired and gathered from the external environment, such as market knowledge such as market trends, perceived brand image, evolving customer needs, emergent latent needs, and customers' feedback and so on. This knowledge may enable products innovation like the creation of new products, new category entries, additions to product lines, market extension, product improvements, repositioning, strategic alliances, increasing sales.

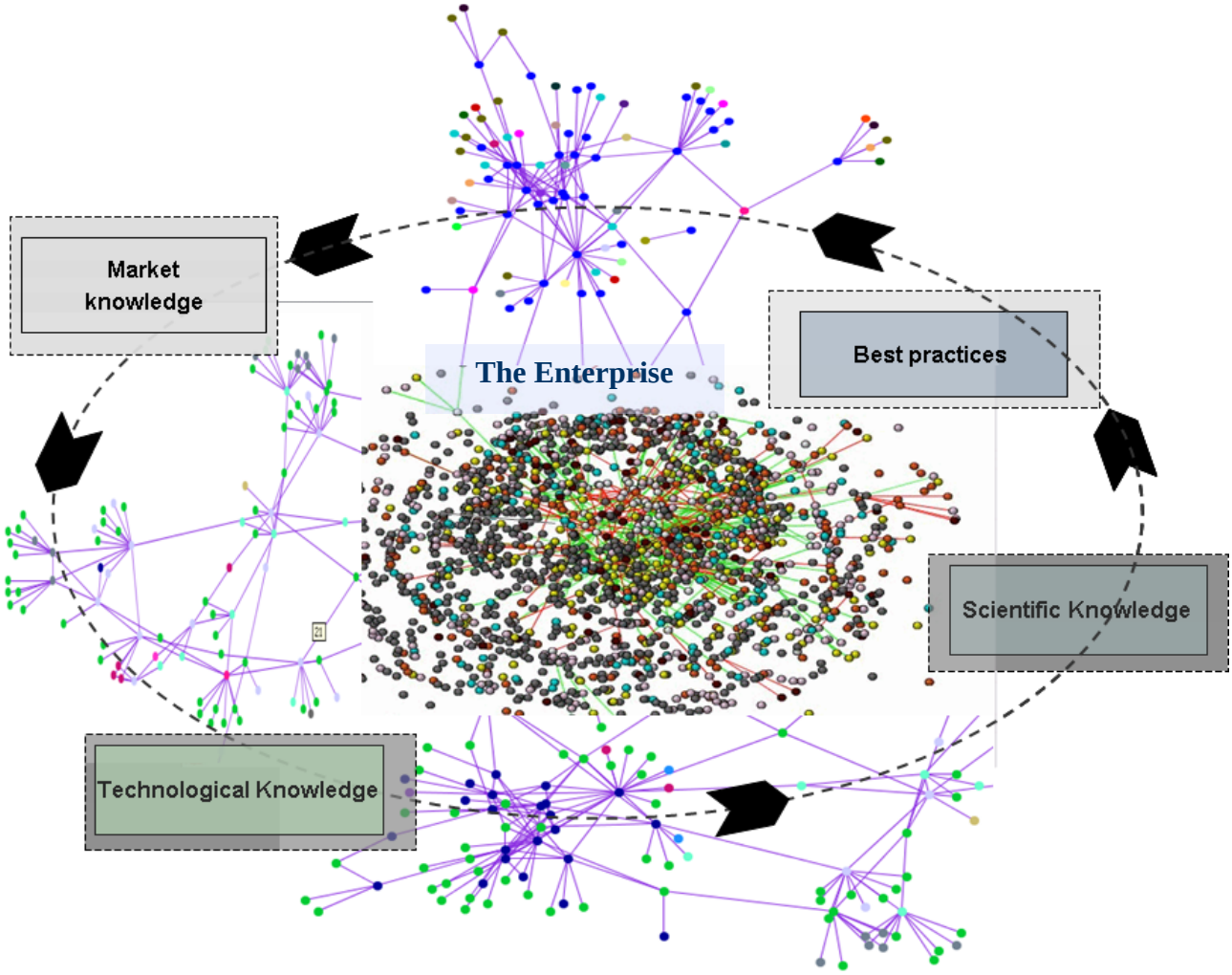


Figure 8.The knowledge management network of the firm. Source: my elaboration

4.4 Where does knowledge reside?

Both tacit and explicit knowledge reside at four levels of an organization: individual, group, organization, and inter-organization (Hedlund, 1994). Definitely, knowledge can be searched and transferred within the firm or outside the firm.

Internally, knowledge may reside within peoples' heads; be embedded in behaviors, procedures, software and equipment; or stored in knowledge management systems or platforms. Externally, knowledge can de found in publications, universities, government agencies, professional associations, personal relations, consultants, customers, and inter-organizational alliances.

Also Wernerfelt (1984) speaks about merger and acquisition where buyers and targets have different needs and confer different values to different resources. He says also that is very difficult to make predictions about the amount and kind of resources they need.

Barney introduce the concept of the strategic factor market where 'strategizers' and controllers sell and buy the resources they need for implementing strategy according to their expectations. Barney speaks about 'market imperfections' for describing the asymmetry in the amount and kind of information among strategizers and controllers.

This metaphor of the market where strategizers buy and sell resources is very similar to the one used by Davenport and Prusak, a market where firms buy and sell knowledge. According to Davenport and Prusak there is a real market for knowledge and he recognizes also the presence of three systems of payment in such market like:

1) Reciprocity, I help some that I expect will help me in the future,

2) Reputation, I share my knowledge if I 'm recognized as a knowledgeable person with valuable expertise that I can share with others in an organization. Good reputation is very important for career opportunities, higher salary, and for all rewards and trappings of a company guru. Reputation generally flows through informal networks.

3) Altruism, nice guy that expect only a thank-you or a passionate about a subject that he is happy to share with someone else whenever he has the opportunity. Then, knowledge may be shared thanks to a love for a subject (a shared interest) or for a natural impulse in helping others for 'the good of the organization'. e.g.: Chrysler 'tech club'.

4) Trust, without trust knowledge initiatives will fail, regardless of how they are supported by technology and rhetoric and even if the survival of the organization depends on effective knowledge transfer (Nonaka and Takeuchi, 1995). Trust must be established in the following three ways (Davenport and Prusak, 1998:34-35):

- be visible, people must see people get credit for knowledge sharing, must experience directly reciprocity
- be ubiquitous, otherwise the market becomes asymmetric and inefficient,

- must start at the top, top managers can influence the trust level of the whole organization, if they cynically exploit other's knowledge for personal gains, distrust will propagate throughout the company.

Ghoshal and Bartlett (1990), Gupta and Govindarajan (1991), and Hedlund (1994) have suggested, knowledge transfers within the MNCs take place within the context of an interorganizational "network" of differentiated units. Thus, according to Gupta and Govindarajan (2000) flows of knowledge through the network can be studied from at least three different levels of analysis:

- nodal (i.e., a focus on the behavior of individual units),
- dyadic (i.e., a focus on the joint behavior of unit pairs),
- systemic (i.e., a focus on the behavior of the entire network).

Given the highly complex nature of the phenomenon under investigation and the relative dearth of previous empirical work on it, in this study, we have chosen to limit our investigation to the dyadic level, focusing on the behavior of two business units.
Similarly, if we assume that knowledge sharing is basically a communication process, Robert Nobel and Julian Birkinshaw (1998) suggest, different lines of communication facilitate the adoption of new ideas by Multinationals and improve responsiveness to local contingencies. The four lines are:
- First, there are vertical lines of communication with entities in the head office. These are overlain on, and often part of, the MNC's control mechanisms, but they are conceptually separate in that it is possible to have vertical communication without control and, indeed, control without communication (e.g., through formalization).
- Second, there are lateral lines of communication with other international R&D units. These are particularly important when there are task interdependencies, for example in international innovation projects (Hedlund and Ridderstråle, 1995; Ronstadt, 1977), but they are also useful for promoting the flow of new ideas between units.
- Third, there are lateral lines of communication to other functions, notably manufacturing and marketing, within the same subsidiary (Pearce, 1989). Again, these are most necessary where there are interdependencies, but there is potential for synergistic interaction as well.
- Fourth, and somewhat differently, there are lines of communication to external entities such as customers, suppliers, and local universities, which comprise the environment in which the MNC is embedded.

Daveport and Prusak (1998) say that there are some signals that enable firms to understand where knowledge resides. These are:
- Position and education, is the most common formal signal indicating who has or should have valuable knowledge. Often the organizational chart is not an effective guide to company knowledge. Position and education should influence also the identification of the experts within a firm. In fact,

whether or not a message sender is perceived as an "expert" (and thus of high credibility) is determined from an evaluation of the knowledge that a person holds (Gotlieb & Sarel, 1991), as well as if -by virtue of his or her occupation, social training or experience- that person is in a unique position (Schiffman & Kanuk, 1995).

- Informal networks, people during their job continuously ask who knows what or how to do things through informal communications and calls. Informality is the benefit and the drawback of these networks. Informality engenders trust that is essential for knowledge sharing. However, these networks are not readily available to all people that in a firm need them, their awareness depend on chance conversations, coffee breaks, and other similar events.
- Communities of practice, are self-organized group of workers that frequently interact for sharing common work practices, interests and aims (Davenport, 1994). If their communications prove to be useful over time, formalized groups and interactions will be created. E.g. British Petroleum scientists and engineers with a shared interest in water produced as a by-product of drilling formed a group. Academics often form these groups and work through the internet.

Firms have developed different strategies for favoring the meeting and knowledge sharing between seeker and knowledge provider. Romans and Greeks met at the agora for taking decisions and for selling and buying goods and other services.

Many firms have established virtual or real *talk rooms* such as the Japanese Dai-Chi Pharmaceuticals where researchers are expected to have a cup of tea and spend 20-30 minutes discussing on one another's work (ibidem:46). In American companies these kind of informal talks happen more often at the water cooler, coffee machine or cafeteria.

Several organizations manage *knowledge fairs* where knowledge sellers display their expertise and buyers can search for what they need or serendipitously find knowledge that they did not know they needed but they can use it (ibidem:46).

However, all these initiatives such as internet or intranet discussion groups, groupware discussion database contains a lot of good knowledge and other resources, however Davenport and Prusak (1998) say that if workers have not the time to search for them they are useless.

4.5 Knowledge sharing as a knowledge creation process

Knowledge sharing can be assumed also as a creative process, through which new knowledge can emerge when individuals discuss and combine together pieces of old knowledge. Interaction is fundamental for product innovation; in fact symbolic interactionists (Blumer, 1969; James, 1967; Mead, 1934) have argued that ideas are essentially properties and products of relationships rather than individual possessions.

The history of innovation is full of examples of technologies that have been created by fusing together previously separate knowledge streams (Cradwell, 1995). Accordingly, Kogut and Zander (1992) proceed to empirically demonstrating that intra-organizational knowledge sharing affects business unit product innovation positively.

Research on innovation diffusion (Rogers 1983), new product development (Dougherty 1992), creativity (Amabile 1996, Unsworth 2001), and how people reuse knowledge when innovating (Swan 2001, Gray 2000) comes to the opposite conclusion: divergence and lack of shared experiences are critical for developing new ideas.

Knowledge is seen as the raw material for innovation. Kogut and Zander (1992) assert that innovations are created through new combinations of resources and that knowledge sharing is one mechanism for recombining existing ideas. Often even if ideas or suggestions are not original or new, innovation can emerge through a new combination of these ideas. And they argued that the "combinatory capability" to generate new applications from existing knowledge can be a critical asset for sustaining competition.

Indeed, Schumpeter assumed that innovation 'consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence' (Nelson and Winter, 1982: 30). Grant (1996) argued that such a capability is a strategically significant resource to a competitive organization.

Knowledge sharing can be assumed as a best practice for making innovation emerge and for exploiting ideas and other resources present within or across firms' boundaries; it is generally present in people's mind and it is explicated only through interaction, discussion, workshops….

4.5.1 The social nature of knowledge creation

According to Nonaka and Takeuchi the main mechanism for sharing knowledge is interaction among individuals, and "communities of interaction" facilitate the amplification and development of new knowledge (Nonaka and Takeuchi, 1994).

The importance of knowledge, but more specifically the value of its tacit nature has been highlighted for the first time by Japanese. Western culture and philosophy is described as having struggled to understand whether knowledge is based on what we experience (empiricism) or inherent truths

(rationalism), and to have focused more on explicit knowledge. Japanese thought has tended to treat tacit knowledge as more important.

The channels knowledge flows through can be distinguished mainly into two groups: person-to-person or document-to-person, whether we share and retrieve knowledge from other persons or from codified and archived documents in computers, books...

Studies have shown that managers get two-third of their information and knowledge from face-to-face meetings or phone conversations, and only one third comes from document (Davenport, 1994). Allen (1977) reports that technical employees are up to five times more likely than other staff to turn to a person, rather than a data source, to obtain information important to their work (Allen, 1977). This is in significant part attributed to the complex issues of trust that exist between scientists. R&D workers tend to build very strong relationships with the peers with whom they collaborate and they are likely to turn to them, and not to an alternative source, be it personal or data, for assistance when it is required.

Attempts to transfer knowledge can lead to the creation of new knowledge. For example, Song, Almeida, and Wu (2003) show how new knowledge, in the form of patents, is generated when knowledge transfers across organizations through personnel movement (Argote, McEvily, Reagans, 2003).

Indeed, Nonaka (1995) has described "knowledge conversion" as the interaction between tacit and explicit knowledge for the knowledge creation. He identified a model for knowledge conversion named SECI. The ideas comes from Anderson's ACT model developed in cognitive psychology. The ACT model is unidirectional and only involves transformation from the declarative to procedural knowledge (for developing cognitive skills), while it can be argued that the transformation is bidirectional. The bidectionality is also consistent with theories and models of communications developed by sociologists in this period.

As information was considered a piece of content that could be transferred easily from one person to another, academicians have for long time accepted the deterministic model of learning such as every content transmitted to a source have produced a cognitive change in that source.

Nevertheless, information transmission and then learning doesn't work as a linear, one-way deterministic process such as in the source different mechanisms intervene in mediating both the effect and the meaning of the content transmitted. These are: social conditions, differential match between the status, the values, the opinions, the experiences, the social condition, the knowledge capital… of the receiver and the receiver. Hence, information and knowledge are not transmitted as the term implies the one-way flow, rather they are shared and mutually co-constructed. Much of the conceptual basis for these theories were founded on the work of Vygotsky (1978) who believed that

knowledge was socially constructed through collaboration and interaction in activities and used the notion of a Zone of Proximal Development (ZPD) to describe the way in which a learner interacts with others in a particular activity.

Drawing on Nonaka and Takeuchi' model, it considers four modes of knowledge conversion: Socialization, Externalization, Combination and Internalization.

Knowledge conversion (between explicit and tacit) is a crucial part of the social job of sharing knowledge.

From \ To	Tacit Knowledge	Explicit Knowledge
Tacit Knowledge	**1. Socialization** Learning involves imitation, observation and practice. Team or a field of interaction, experiences sharing creates tacit knowledge. Example: on-the-job training.	**2. Externalization** Articulate tacit knowledge explicitly: metaphors, analogies, models, writing.
Explicit Knowledge	**4. Internalization** Learning by doing, to develop shared mental models and technical know-how.	**3. Combination** This knowledge is transmitted through communication, in meeting and telephone conversations. Example: formal education.

Figure 9. The Knowledge conversion/creation process (adapted from Nonaka and Takeuchi, 1994)

Nonaka identified how the knowledge creation process works and how from individual the knowledge can flow across all the organizational units, namely the "organizational knowledge creation should be understood as a process that "organizationally" amplifies the knowledge created by individuals, and crystallizes it as a part of the knowledge network of the organization" (:17).

The spiral is a model that shows the relationships between the epistemological and ontological dimension of knowledge creation. If tacit and explicit knowledge don't communicate problems firms can experience lack of commitment and scarce consciousness of the importance of knowledge. It means that pure combination becomes a superficial combination of existing knowledge and other problems related to new knowledge creation, knowledge sharing.

In the model of the spiral the interactions between tacit knowledge and explicit knowledge tend to become larger in scale and faster in speed as more actors in and around the organization become involved. It's an upward spiral process, starting at the individual level moving up the collective level and then the organizational level, sometimes reaching the inter-organizational level.

Consistently with this process, Nonaka and Takeuchi (1995) argued that the traditional hierarchical model and also the bottom-up management approaches have some limitations. Top-down presumes an authoritative source of communication, while bottom-up view the management as just receiving communications from workers, employees and so on. Both models ignore the ability of middle management to reconcile the problems. Nonaka and Takeuchi' *middle-up-down* approach recognizes that middle managers often create knowledge (the front-line is too busy with today; top management is out of touch). This puts them in a dynamic position, and belies the trend to eliminate middle

management. A bureaucratic structure is too locked in to repeating its past; task forces or projects are important but need overall structure.

The solution proposed by these authors is a *hypertext organization*: combining a business system layer, a project-team layer, and a knowledge base layer. Team members can shift layers, but belong to only one at a time (unlike a matrix approach). Knowledge is combined across layers. Projects tend to be controlled more directly by top management, letting the team focus on short-term needs and speeding up communication.

"These new organizations: (1) tend to be flatter than their hierarchical predecessors; (2) assume a constant dynamic rather than a static structure; (3) support the empowerment of people in building intimacy vis-a-vis customers; (4) emphasize the importance of competencies - unique technologies and skills; and (5) recognize intellect and knowledge as one of the most leverageable assets of a company". (p. 162)

The knowledge-based view suggests that to the extent that 'higher-level decisions' are dependent upon immobile 'lower level' knowledge, hierarchy impoverishes the quality of higher level decisions. The production requires many types of knowledge and this knowledge is resident in different individuals but the integration mechanisms involve only a small number of people. The organizational structure to solve this problem is the team-based organization where all specialists and specialist coordinator (manager) are directly involved and for coordinating have to access to specialist knowledge. Team organization has to be created throughout all production activities.

The model to follow is the Total Quality Management (Wruck and Jensen, 1994), a team-based organizing providing technological systems which permit organization to access the knowledge located at low level of an organization.

4.6 Theoretical origins of knowledge sharing: the Sociology of Communication and mass media studies

The origin of the knowledge sharing resides to sociology of communication and mass media studies.
Sociologists studied the communication process outside organization focusing more on political campaigns, mass media communications and the resulting effects on groups' behavior and on society. Communication such as knowledge sharing is a social act, and then involves two or more people that meet presenting their point of views, needs, values, opinions to the other.
Different approaches and models have been developed starting from 1949, year in which two engineers, Shannon and Weaver (1949), developed the mathematical theory (and model) of communication. Shannon was a research scientist at Bell Telephone Laboratories; he tried to achieve maximum telephone line capacity with minimum distortion. Though he had never intended for his mathematical theory of signal transmission to be used for anything but telephones, the Weaver adaptations were very influential in information theory.
Thus, this linear model was also applied to human communication even if it was thought for solving technical communication problems. The purpose of the model was to calculate the entropy or the interferences of the communication through the redundancy of the signals.

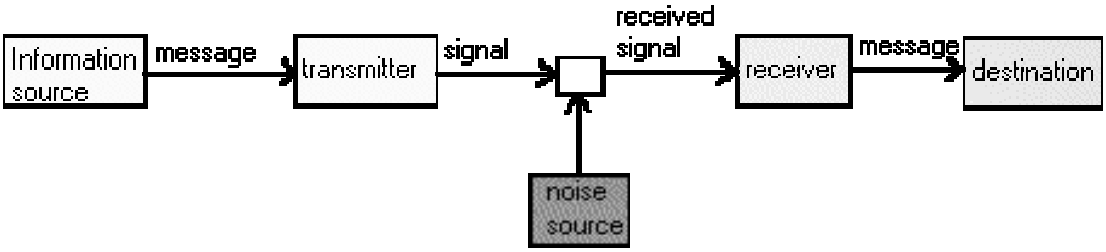


Figure 10. The Shannon and Weaver mathematical model of communication

It is possible to see that at one side of the model, there is an information source composing a message and selecting a channel for transmitting the message through an encoder (or transmitter). This latter codifies the message into signal that can be received by a decoder that codifies the message so that the destination source (or receiver) can see/read it. The signal before being received by the receiver can be disturbed or modified by a source of noise.
This model had the goal of simplifying communication process in its main constituents, just describing the technical nature of a transmission. In fact, Shannon was not particularly concerned with the interactive nature of communication and with the complexity of the meanings.
Similarly, Szulanski, an expert of organization, says (2000:23) that knowledge transfer should be regarded as a process of reconstruction rather than a mere act of transmission and reception.
However, it is true that communication and mass media studies have abandoned this model long time ago, privileging models which better incorporated the complexity of the communication act. This has

not yet happened in organizational and business studies, where many researchers still cite Shannon and Weaver and assume their model.

Harold Lasswell was the first that introduced an important element to take into consideration in any communication process: the effect. He studied the effect produced by political campaigns on individual's attitudes and noticed that political communication had a strong effect in changing vote opinion. He started a tradition of studies on communication effects and produced a linear model, better known as Lasswell Formula (1948)

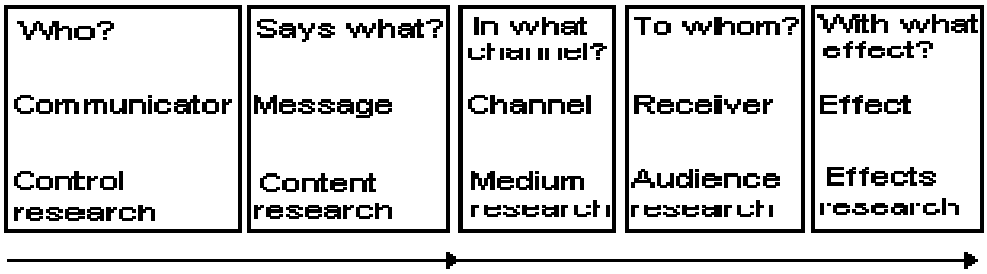


Figure 11. The Lasswell Formula

It is Wilbur Schramm' 1954 model which places greater emphasis on the processes of encoding and decoding, introducing reciprocity and interactivity in his communication model. He conceptualizes the process of communication as circular process, and distinguishes clearly the receiver from the sender. This circular model reminds that receiving a message is not simply a matter of decoding, but also of interpreting the message and actively making sense of it. And different people make sense differently, and then semantic noises could always emerge.

The Shannon and Weaver' model was efficient for solving technical problems connected with the transmission of information, rather the Schramm' model is more oriented towards semantic noises, concerning the meaning of the message, drawing attention to the possibility of a mismatch between the operation of the encoding and decoding devices.

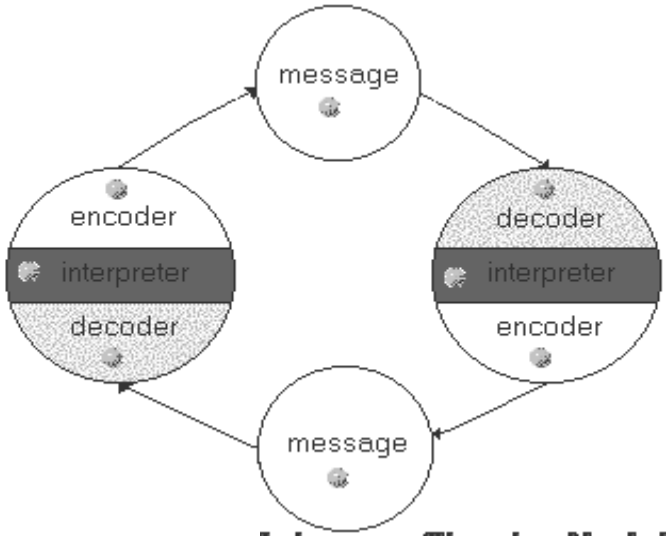


Figure 12. The model of Schramm

Schramm went on to introduce the notion of a 'field of experience', which shows a much greater awareness of the subtleties involved in human-to-human communication, drawing our attention to the numerous shared socio-cultural factors which are necessary for successful communication to take place.

The Berlo's S-M-C-R (Source - Message - Channel – Receiver, 1960) focuses on the way that attitudes, knowledge level, communication skills, culture and social position of the source and the receiver affect the encoding and decoding of messages. The more are developed these capabilities between both actors of the communication process the more effective will be encoding/decoding of the message.

With this model, Berlo highly emphasize the complexity of the communication process, since he states that all decision about the message and the channel should be made taking into consideration the characteristics of the receiver.

Consequently, he placed great emphasis on dyadic communication, therefore stressing the role of the relationship between the source and the receiver as an important variable in the communication process.

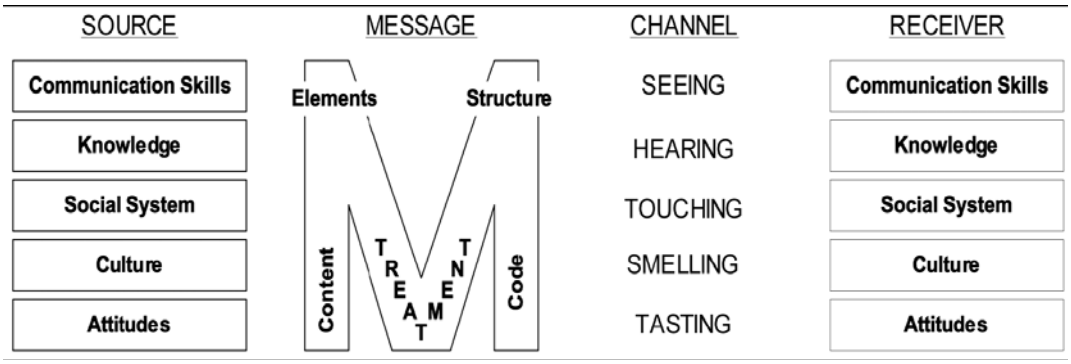


Figure 13. The Berlo' Model

Communication skills of the encoder /source involve:

- knowing and applying the code's grammar
- knowing and using a broad vocabulary
- knowing and applying the conventions
- adapting the use of your code to your audience

The encoder's communication knowledge is affected by his/her knowledge of:

- *his/her own attitudes* - we may have attitudes of which we are unaware. If a source/encoder is aware of an attitude which for example in the presence of any given receiver, might arouse hostility, he works for concealing that attitude. If a source is not aware of that attitude, then he will not attempt to conceal it and the communication may suffer of it.
- *the ways in which s/he can produce or treat messages* – it is important to know all the possibilities available for producing/treating the message. For example, if a person has a limited experience of the internet communication possibilities, and he is not aware of the

possibility to send a similar message to thousand different people, he will lose much time to send it to each singular person. And this should be also takes into consideration receiver possibilities.

- *The kinds of choices s/he can make about communication channels etc.* – there are different channel to communicate a message and it is up to the source but considering the characteristic of the receiver to select the most appropriate.
- *The subject matter* – it is important that the source is an expert or know enough about a subject for affecting communication quality.

Then, Berlo emphasize also the influence played by the socio-cultural system. No source communicates as a free agent without being influenced by socio-cultural system. People belonging to differing social classes, coming from different geographical areas and presenting different levels of education communicate differently.
Social and cultural systems partly determine:

- the word choices which people make
- the purposes they have for communicating
- the meanings they attach to certain words
- the choice of the receivers
- the channels they use for this or that kind of message etc.

Then, Berlo considers also the attitude (interest and prejudice) towards a subject matter and towards receiver as other fundamental factors that can influence the communication process.

After Berlo, the model of Gerbner is important as it emphasizes the interactive and dynamic nature of the relationship between the form (S=signal) and the content (E=event) of the communication process but he missed to consider separately the code, the message and the signal.
E1 is the event-as-perceived (E) by the man or machine M. The event (E1) can be also a person. The perception (E1) that a person has of that event (or person) is more or less close to the objective nature of that event. The degree of correspondence between M's perception of event E (E1) is a function of M's assumptions, point of view, experiences, social factors etc. To send that message, M has to use channels (or media) over which he has a greater or lesser degree of control. The question of 'control' relates to M's degree of skill in using communication channels. If using a verbal channel, how good is he at using words?
If using the Internet, how good is he at using new technology and words? SE (statement about event) is what we would more normally call the 'message'.
Similarly to Berlo' model, Gerbner introduces some factors influencing how E will be perceived, such as:

- *Selection:* M, the perceiver of the event E (or receiver of the message, if you prefer) selects from the event, paying more attention to this aspect and less to that. This process of selecting, filtering is commonly known as gatekeeping, particularly in discussion of the media's selection and discarding of events or aspects of them.
- *Context*: a factor often omitted from communication models, but a vitally important factor. The sound represented by the spelling 'hair' means an animal in one context, something that's not supposed to be in your soup in another. Shouting, ranting and raving means this man's very angry in one context, raving loony in another.
- *Availability*: how many Es are there around? What difference does availability make? If there are fewer Es around, we are likely to pay more attention to the ones there are. They are likely to be perceived by us as more ''meaningful'. What sort of Es are there - for example, in the UK's mainly Conservative press, how many non-Conservative messages are available to us?

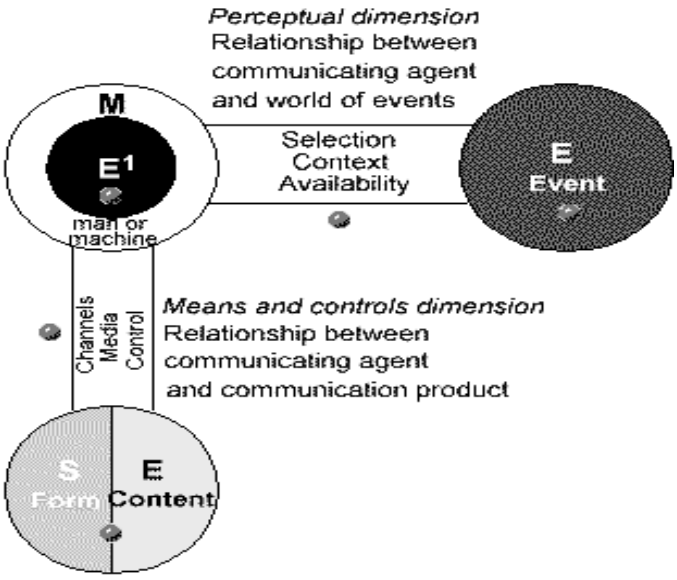


Figure 14. The model of Gerbner

Finally, these socio-cultural mechanisms influencing the communication process have been widely used by organizational and business, engineers' academicians to describe impediments to knowledge transfers, however, the origin of these studies has only rarely been mentioned.

According to the interpretative approach, the term knowledge sharing implies the giving and receiving of information framed within a context by the knowledge of the source. What is received is the information framed by the knowledge of the recipient. Although based on the knowledge of the source, the knowledge received cannot be identical as the process of interpretation is subjective and is framed by individual mental schemata and experiences.

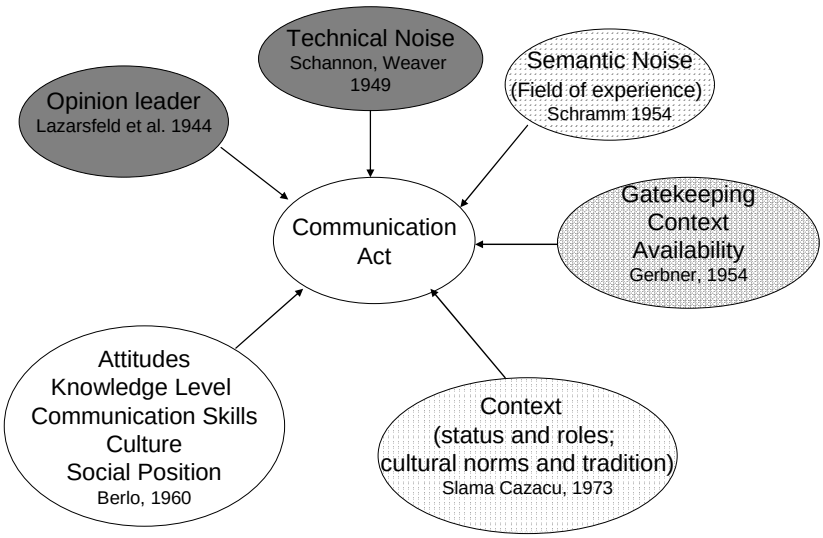


Figure15.Complexity of communication

5. Knowledge Sharing Research 1969-2007

5.1 Origin of the studies

Researchers have investigated the 'frictions' that slow or prevent knowledge transfer and are likely to erode some of the knowledge as it tries to move through the organization.
The origin of the studies on knowledge sharing date back 70's, when knowledge was not still considered a strategic assets. The first research is probably Allen and Cohen' on gatekeepers. They studied the internal communication in Research & Development contexts, discovering the role of the *technological gatekeeper*.
Then, much research has found that communication, and in particular proximity and face-to-face communication among researchers was one of the most important predictor of R&D's innovativeness and productivity.
Much research has than concentrated on identifying the different barriers to communication for knowledge sharing, such as functional separation, organizational boundaries, distance, absorptive capacity and so on.
Several studies have investigated the economic problems related to knowledge transfer. Hoopes and Postrel (1999) measured the 'glitches', that is the costs associated to lack of knowledge sharing across different functional specialties on firm performance in a scientific software company during a two year study. Glitches are defined as 'costly mistakes that could have been avoided if some of the parties involved had understood things that were known by other participants' (:838). At this company, gaps in shared knowledge did cause the company to incur significant excess costs. The absence of shared knowledge had a significant negative effect on the Company's performance for different reasons; the most important was that the same things could have been accomplished with one-seventh fewer people than actually were employed.
Some other authors have also tried to consider the costs associated to the transfer of the required knowledge to the right person or place. Von Hippel (1994: 429) defines information as sticky if it is 'costly to acquire, transfer, and use in a new locus.' There may be many causes of such stickiness, such as the tacit, situated, or procedural nature of the information, as well as the lack of a common semantics through which the parties can communicate. Of course, much information is non sticky, or one might say 'mobile,' in the sense that it can be easily shifted for use from one locus to another. According to him, sticky information refers to the incremental expenditure required to transfer the information in question to the right person in a usable form. Tacit knowledge is related to company's capability to respond to the market better than competitors in term of time and cost.
Actually, research on knowledge sharing is divided into two main streams: intra-organizational and inter-organizational. Differently from the past, firms have extended their boundaries to include also players that traditionally are outside the firm, such as suppliers, customers and competitors and a lot of strategic alliances are done for acquiring knowledge.

At the beginning of this work we have widely described a new model of the firm, the Extended Enterprise, which fosters its competitive advantage by leveraging the quality and satisfaction of its network.
The coopetition, the rising interests in strategic alliances and in one word the search for collaboration as opposed to competition have strengthen the flows of knowledge and information among different firms and not more only within firms and among different units or research centres.
The growing ambiguity of the EE boundaries have created the condition for a more easy transfer of tacit and explicit knowledge among firms favouring learning activities and improvements, like the Toyota case demonstrate (Dyer and Nobeoka, 2000).
This distinction has to be clear as in this research we focus on both intra and inter-firm knowledge sharing.

5.2 Defining Knowledge Transfer

As we have seen knowledge sharing is important for creating new knowledge and ideas for new products, however, members of an R&D organization need to share knowledge to create a common understanding of the problems at hand, and to coordinate activities (Katz and Allen, 1982; Hoopes and Postrel, 1999; Berends et. al. 2006:86).
Confusion is dominant in knowledge sharing focused researches.
It is important that future research start to follow a unified literature on knowledge sharing, in order to identify the set of constructs that merit more attention and avoid redundancies of concepts and researches. Moreover, it is important to start to clarify terms and concepts being used by researcher in order to reduce complexity and confusion.
First, before studying knowledge sharing we have to distinguish between two different approaches: person-to-person and document-to-person; the document-to-person knowledge sharing, that investigates problematic inherent to the flow of knowledge from impersonal media such as document, computer and so on, to the persons; and the person-to-person approach, that focuses more on interpersonal mechanisms influencing knowledge sharing.
The sharing of knowledge implies that a resource such as knowledge, information, data is exchanged from a source to a recipient. This activity involves a dyadic relationship, one source and one receiver, the act of sending and receiving data, contents, messages, knowledge. This act can be mediated by a computer or a technological tool.
In this research we focus on both, however we go more in depth with the person-to-person knowledge sharing approach, analyzing social and organizational mechanisms that facilitate or relent the flow of knowledge within unit, between them and between them and other firms' units.

For meaning the exchange of knowledge, researchers have used different terms sometimes inappropriately, as for the term knowledge sharing. The result has been the increasing complexity of an area of study that is not specific to a particular area of study.

Therefore, the field of knowledge management has set out to improve knowledge sharing within organizations, in general (e.g. Davenport and Prusak, 1998), and within R&D, in particular (Kerssens-van Drongelen et al., 1996; Miller and Morris, 1999; Collinson, 2001).

Moreover, it is possible to find different terms for meaning the same concept, such as knowledge dissemination, knowledge transfer, knowledge flows, knowledge sharing, and integration mechanisms. The word 'transfer' is used rather than 'diffusion' to emphasize that the movement of knowledge within the organization is a distinct experience, not a gradual process of dissemination, and depends on the characteristics of everyone involved (Szulanski, 1996: 28).

Argote and Ingram (2000, p. 152) define knowledge transfer as 'the process through which one unit (e.g., individual, group, or division) is affected by the experience of another', such as the movement of knowledge from an "expert" to a "novice" site, while other researchers have focused on knowledge transfer as a repeated process.

In addiction, we have some definition of the KS as a set of processes, such as the one of Majchrzack et al. (2005), for whom the knowledge transfer process can generally be subdivided into knowledge sharing (the process by which an entity's knowledge is captured; Appleyard 1996) and knowledge reuse (the process by which an entity is able to locate and use shared knowledge; Alavi and Leidner 2001).

Hargadon and Sutton (1997) propose a process model of knowledge transfer based on organizational learning and memory perspectives (Huber 1991, Walsh and Ungson 1991) that includes knowledge acquisition, knowledge storage, and knowledge retrieval. Here, knowledge is acquired from external sources

via organizational search routines, stored in organizational memory (e.g., in people's minds and organizational routines; Nelson and Winter 1982), and retrieved from organizational memory for use.

Drawing from Lippamn and Rumelt (1982), for Szulanski (2000) the transfer of knowledge can be seen as an effort to create a partial or exact replica of a complex and causally ambiguous practice, that is, as a replica of a web of relationships connecting specific productive resources. Szulanski conceive knowledge transfer as a process through which it is possible to seek and implement a new practice. He identifies four stages, such as: initiation, the initial implementation effort, the ramp-up to satisfactory performance, and subsequent follow-through and evaluation efforts to integrate the practice with other practices of the recipient. Between 'the initial implementation of a new practice and the subsequent ramp-up to satisfactory performance, there is two-step sequence of first "learning before doing" (Pisano, 1996) and then 'learning by doing'' (:12).

The term dissemination is used to mean how knowledge is distributed among different business units within the firm. Several managers noted that for an organization to be competitive in the knowledge

intensive economy, knowledge must be communicated and disseminated to relevant departments and individuals in the organization (Van Der Bij, Song, Waggeman, 2003).

Matusik and Hill (1998) speak about 'integration mechanisms' in transferring knowledge within firms and into firms and Collinson and Gregson (2003) use the term 'integrative capabilities' indicating the differential efficiency and effectiveness with which large corporations manage intra-firm exchange, development and application (KM) of specialist knowledge for innovation. Integration refers more specifically in the addition of new practices and new knowledge within organization's processes.

Definition	Author
Knowledge transfer is "the process through which one unit (e.g., individual, group, or division) is affected by the experience of another." such as the movement of knowledge from an "expert" site to a "novice" site.	Argote and Ingram (2000, p. 152)
Propose a process model of knowledge transfer based on organizational learning and memory perspectives (Huber 1991, Walsh and Ungson 1991) that includes: 1) knowledge acquisition, 2) knowledge storage, 3) Knowledge retrieval.	Hargadon and Sutton (1997)
The transfer of knowledge can be seen as an effort to create a partial or exact replica of a complex and causally ambiguous practice, that is, as a replica of a web of relationships connecting specific productive resources. A process through which it is possible to seek and implement a new practice. He identifies four stages, such as: 1) initiation, 2) the initial implementation effort, 3) the ramp-up to satisfactory performance, 4) subsequent follow-through and evaluation efforts to integrate the practice with other practices of the recipient. Between 'the initial implementation of a new practice and the subsequent ramp-up to satisfactory performance, there is two-step sequence of first "learning before doing" (Pisano, 1996) and then 'learning by doing'' (:12).	Szulanski (2000), drawing from Lippamn and Rumelt (1982)
The knowledge transfer process can generally be subdivided into: 1) knowledge sharing (the process by which an entity's knowledge is captured; Appleyard 1996) 2) knowledge reuses (the process by which an entity is able to locate and use shared knowledge; Alavi and Leidner 2001).	Majchrzack et al. (2005) based on Appleyard,1996 and Alavi and Leidner, 2001
Integrative capabilities indicate the differential efficiency and effectiveness with which large corporations manage the addiction of new practices and new knowledge within organization's processes. .	Collinson and Gregson (2003)

Table 3. Definitions of Knowledge Transfer

Knowledge transfer in this study is based on Hargadon and Sutton (1997) definition, as such KS is conceptualized as a three stage process, in which knowledge is acquired through computer-to-person or person-to-person an interaction by employees, then it is stored in knowledge management systems or other storage supports, and then it is retrieved by the same or other employees for its reuse. Here, knowledge is acquired from external or internal sources, stored and retrieved.

5.3 Strategies for enhancing knowledge sharing

Knowledge sharing is fundamental for determining firms' success, that's why firms are developing specific strategies to favor or encourage this activity. Strategies may be related to knowledge sharing through technologies or face-to-face communication and then co-location.

Learning by observation is an example of such indirect learning. Instead of accumulating knowledge directly, an individual accumulates knowledge by watching another person performing a task (Nadler et al. 2003).

De Meyer (1991) argues that a variety of mechanisms must therefore be used to circumvent the problem related to geographical and cultural distance among researchers, including: socialization of managers, formalization of systems, use of boundary-spanning individuals, a network organization, central office processing, and electronic systems.

Davenport and Prusak (1998) focus their attention on face-to-face occasion for knowledge sharing and highlight the importance of water cooler, talk rooms, knowledge fairs and open forum.

1) Water cooler conversation in fact often focus on work, as they ask how to solve problems, ask each other on about current projects and define new ideas. According to Davenport and Prusak should be conceived as work. As Alan Webber in his article 'What's So New About the New Economy' says: 'In the new economy, conversations are the most important form of work. Conversations are the way knowledge workers discover what they know, share it with their colleagues, and create new knowledge for the organization' (1993: 28).

2) Talk rooms. They say that many Japanese firms have set up talk rooms to encourage knowledge transfer and idea generation. In Dai Ichi Pharmaceuticals there are rooms with green tea and attractive lighting that researcher is expected to visit 30 minutes as a normal part of their workday. The expectation for these talk rooms is that the researcher will chat about their work with whomever they visit and that these more or less random conversation will create value for the firm. Japanese manager spend many after-work hours together.

Group dinners and visits to nightclub are part of Japanese corporate culture (:92). These meetings are held for sharing knowledge but also for establishing trust and give the opportunity to criticize something that is not working. Probably American corporate culture is more focused on the extensive use of technologies of communication for sharing knowledge and that's why every solution should fit with the organizational or corporate culture.

3) Knowledge fairs and open forum. These are an example of occasion that firms create to make employees interact informally and randomly. Davenport and Prusak cite two cases, CSIRO, a large Australian contract R&D organization, that held a knowledge fair in Melbourne bringing together scientists from across the country who communicated electronically but that they have never meet personally. One of the attendant to the fair felt a sense of excitement in the air as these researcher have finally the opportunity to meet.

Dyer and Singh (1998) define an inter-firm knowledge sharing routine as a pattern of interactions that permits the transfer, recombination or creation of specialized knowledge (1998: 665).

For Singh (2005) external knowledge flows can be enhanced through deliberate cultivation of interpersonal networks, for example, by encouraging mobility and interaction of people across firm and regional boundaries. His research proved that geographic constraints can be overcome by fostering interpersonal links across regions (2005).

Thus, they concluded that 'an important component of a firm's human resource management should be not

only to track the knowledge base of its employees, but also to understand their participation in key interpersonal networks that span regional and firm boundaries' (:768).

Interruptions in experience provide opportunities for knowledge transfer (Zellmer- Bruhn 2003). They found that units are more likely to transfer best practices from units that are part of the same organization than from units that belong to a different organization.

6. Methodology

In the present study we are going to identify the main barriers/facilitators that a big automotive supplier (R&D) has to solve in order to enable the sharing of knowledge between units or departments of the same firm and between different firms/organizations. Then, it is important to review the entire literature on knowledge sharing in order to identify the main enablers and inhibitors of such activity.
Moreover, strategic alliances for knowledge transfer are more and more diffused, that's why a new domain investigating knowledge transfer between firms is emerging. Then, intra and Inter-firm knowledge transfer will be both analyzed in the current literature review.
The following chapters present the main researches on knowledge sharing as emerging from multi-disciplinary literature. The method used consisted in the research of articles and publication published from 1969 to 2008 from books and high impact journals in management studies, strategic management, human resource management, innovation and new product development studies, organization studies, and knowledge management-focused studies.
From the high impact journals we browse: the *Academy of Management Review, Academy of Management Journal, MIT Sloan Management Review, Harvard Business Review, Research Policy, Strategic Management Journal, Organization Science, and Administrative Science Quarterly, Management Science, American Journal of Sociology, Journal of Marketing*. We also took into consideration: *Journal of International Business Studies*, and *Organization Studies*.
Then, for deepening the studies in the specific topic of knowledge within New Product Development we also searched key-studies within the following journals: *Journal of Knowledge Management, Knowledge and Process Management*, *R&D Management, and Journal of Product Innovation Management*.
By analyzing these factors, we have tried a categorization in order to include each of them in a greater and more inclusive dimension. In fact, as our research is multidisciplinary and it approaches knowledge sharing barriers and enablers in different field of study, we needed to build macro-dimension containing the elements identified by these authors. For this reason at the end of the literature review, it was possible to identify three typologies of knowledge sharing barriers /enablers: social, technological and organizational mechanisms.
Social barriers/enablers involve group interpersonal dynamics in the relationships between employees, while technological factors concern the technological tools and platforms used for communicating or for collaborating to the projects; finally organizational and cultural mechanisms concern the specific organization adopted by the firm such as the presence of incentives, bureaucracy level and so on.
The mechanisms identified are discussed in the next paragraph and summarized in the table below.

Dimension	Level	Factors blocking KS	Authors
Social aspects	Inter-unit	• Cultural distance between Marketing and R&D	Lorsh and Lawrence, 1965; Gupta et al. 1986; Dougherty 1992
	Nature of knowledge	• Causal ambiguity	Szulanski, 1996; Simonin 1999
	Nature of knowledge	• Tacitness of knowledge	Nonaka, 1991
	Individual	• "homemade" language	Weber and Camerer 2003
	Individual	• Intrinsic motivation and willingness	Osterloh and Frey 2000, Gupta and Govindarajan, 2000; Reagans and McEvily 2003; Hansen and Nohria, 2004
	Organization	• Resistance to change	Leonard Barthon 1996, Davenport and Prusak, 1998
	Individual	• Homophily	
	Individual	• introvert engineering personality types	Coplien and Harrison (2005)
Organizational and cultural aspects	Inter and intra-unit	• (Physical and geographical) Distance	Pelz and Andrews 1966, Mintzberg 1973, and Allen 1977; Katz R. and Allen, T. J. 1983; De Meyer and Mizushima,1989; Egido, and Galegher 1990; Zahn, 1991; Jaffe, A., Trajtenberg, M. and R. Henderson 1993; Song, 1993; Song and Parry 1992, 1993a, 1993b; Krackhardt, 1994; Song, Souder, and Dyer, 1997; Dyer and Song, 1997, 1998; McDonough, Kahn, and Barczak 2001; Parry and Song, Xie, and Dyer, 2000; Xie, Song, and Stringfellow, 1998, 2003; Singh 2005; Allen et. Al. 2007
	Inter-unit	• (rigid) Formal organizational structures	Leonard Barthon 1998; Daft, 2004; Bryan and Joyce, 2005; Brown and Duguid, 2001; Allen et al. 2007
	Inter-firm	• Belonging to other regions	Kogut and Zander 1992; Singh, 2005; Allen et al. (2007)
	Inter-unit	• Belonging to other firms	Zellmer-Bruhn (2003); Allen et al. (2007)
	Organization (intra-firm)	• learning orientation and values	Edmondson 1999
	Organization	• Culture (intolerance for mistakes or need for help, lack of time and meeting places)	Davenport and Prusak 1998
	Group	• Unwillingness to learn from others ('in group bias')	Brewer, 1979; Tajfel and Turner, 1986; Hansen and Nohria, 2004
	Group	• Not Invented here Syndrome	Hayes and Clarck, 1985; Tushman and Allen 1988
	Organization	• Differential value system for external and internally produced knowledge	Menon and Pfeffer, 2003
Technological aspects	Intra-firm and inter-firm	• ICTs and Computer-Mediated Communications	Short et al. 1976 ; Daft and Lengel, 1984; Warketin et al. (1997); Hightower, Sayeed, Warkentin, & McHaney, 1997; Hildreth & Kimble 2002

Dimension	Level	Mechanisms facilitating KS	Authors
Social aspects	Inter-unit	• Communication frequency	Allen, 1970; Allen et al. 1979; Katz and Tushman, 1979; Myers and Marquis, 1969; Robertson et al., 1972; Tushman, 1977; Utterback, 1974; Ebadi and Utterbaback 1984
	Inter-unit	• Face-to-face communication and colocation	De Meyer 1991; Van Den Bulte and Moenaert 1998; Leenders and Wierenga, 2002;
	Inter-unit and inter-firm	• Gatekeeper and boundary spanners	Lawrence and Lorsch, 1967; Allen and Cohen, 1969; Tushman, 1977; Albrecht & Ropp, 1984; Cziepel, 1975; Daft, 1978; Ghosal & Bartlett, 1987; Schwab, Ungson, & Brown, 1985; Davenport and Prusak 1998
	Individual and inter-firm	• Trust (competence and benevolence based)	Szulanski et al. 2004, Andrews and Delahay 2000, Penley and Hawkins 1985, Tsai and Ghoshal 1998, Zand 1972; Dyer and Nobeoka 2000; McEvily et al. 2003; Levin and Cross, 2004
	Individual	• Socialization	Nonaka and Takeuchi, 1994, 1995
	Nature of knowledge	• Absorptive capacity and path-dependency	Cohen and Levinthal 1990; Szulanski 1996; Van den Bosch, 1999; Lane and Lubatkin, 1998; George et al. 2001; Tsai 2001 Mowery, Oxley and Silverman 1996
	Individual	• Status and reputation	Borgatti and Cross 2003; Sine, Shane, and Di Gregorio 2003; Thomas-Hunt, Neale, and Odgen 2003
	Individual	• Informal networks	Chandler 1962; Cross and Parker, 2004; Singh 2005; Allen et al. 2007
	Group	• Communities of practice	Brown and Duguid 1991, Collinson and Gregson, 2003, Lesser et al., 2000, Liyanage et al., 1999, Powell, 1998, Seufert et al., 1999, Swan et al., 1999, Wenger et al., 2002; Cross et al. 2006
	Individual	• Strong ties	Handley, 2006; Hansen, 1999; Roberts, 2006; Uzzi, 1997, 1999; Warkentin et al. 1997
	Individual	• Weak ties	Huston and Sakkab, 2006
	Individual	• Degree centrality, Tie Strength,	Hansen, 1999

		Cohesion, Structural Equivalence	
Organizational and cultural aspects	Organization	• Awareness of the firm strategy and goals	Nonaka and Takeuchi 1995; Davenport and Prusak, 1998
	Organization	• Top down and bottom up flows	Krige, 1993; Nonaka and Takeuchi, 1995; Grant 1996
		• Knowledge codification	Ruggles 1997; Davenport and Prusak 1998; Zander and Kogut 1995
	Individual (inter-unit)	• Personnel movement	Griffin and Hauser 1996; Keys and Miller 1984; Parry and Song 1993; Saxenian 1994, Almeida and Kogut 1999, Rosenkopf and Almeida 2003; Song et- al. 2003
	Org.	• Routines	Nelson and Winter 1982; Dyer and Nobeoka, 2000
	Org.	• Incentives (extrinsic motivation)	Leonard-Barton & Deschamps, 1988; Davenport and Prusak 1998
	Org.	• Individual commitment, organizational crisis and risk-taking behavior	Van Der Bej et. Al. 2003
	Org.	• management "buy in" and knowledge diversity	Lapre and Wassenhove (2001)
Technological aspects	Org.	• ICTs and Computer-Mediated Communications	Davenport and Prusak, 1998; Pavitt, 2003; Chung 2001; Nonaka and Teece, 2001; Williams and Cothrel, 2001; Sarbaugh and Feldman, 1998; Griffin and Hauser, 1997; Leenders and Wierenga 2002
	Org.	• Knowledge quality	Kahn et al. 2002, Ryan et al. 2005
	Org.	• Quality of KMS system	Nelson et al. 2005

Table 4-5. Factors facilitating / blocking knowledge sharing

7. Analysis of the main mechanisms facilitating / blocking knowledge sharing

As we have already said, KM is a multidisciplinary domain of study, so different mechanisms have been investigated. Here we propose a list of the main studies and mechanisms identified in literature.

7.1 Communication effectiveness

Communication studies in New Product Development Process date back 1970, and we can identify in Allen and Cohen (1969) as the precursor of these studies.

As we have argued previously, knowledge sharing implies necessarily a communication act, there cannot be any transfer of knowledge without speaking or writing. In fact, the verbal speaking or the writing or the e-mailing is an example of the potential channels chosen by individuals for codifying, archiving or retrieving the knowledge produced.

Without these channels no exchange of knowledge or other resources will be possible. Even the computer or the electronic document or designs are just a medium at disposition of human being for communicating their ideas and knowledge across physical and time boundaries.

Communication is probably the most important factor affecting knowledge sharing, since communication helps a researcher with idea generation, stimulates his creativity, and results in improved problem solving (Baker et al. 1967; Ettlie 1980; Myers and Marquis 1969; Utterback, 1971). Nevertheless, research have often investigated the different mechanisms and strategies that facilitate or inhibit communication and then knowledge sharing, being recognized as the primary variable of firm's success.

7.1.1 Communication Frequency

Ebadi and Utterbaback (1984) found that the frequency of communication (of knowledge) had a positive effect on innovation project success, confirming findings from earlier research (Allen, 1970; Allen et al. 1979; Katz and Tushman, 1979; Myers and Marquis, 1969; Robertson et al., 1972; Tushman, 1977; Utterback, 1974).

Diversity had a positive effect only if accompanied by high frequency of communication, otherwise it was negatively related to project success. Similar findings are in Allen 1966; Pelz and Andrews 1966.

In this study formality is dependent of the frequency of communication, the less is communication frequency the higher is formality. Then, "…communication helps a researcher with idea generation, stimulates his creativity, and results in improved problem solving" (Baker et al. 1967; Ettlie 1980;

Myers and Marquis 1969; Utterback, 1971). At the aggregate level they found that network cohesiveness, diversity and centrality they were all related to successful technological innovation.
An other result of their research is that the nature of diverse sources of innovation is not the same for all stages of innovation process (Taylor and Utterback, 1975), "for example it might be helpful to have contacts with the government (as a source of funds) during the initiation stage with universities and development laboratories (as a source of technology) during the problem solution and with industrial firms and other potential users (as a source of needs) during project implementation".
Kidane and Gloor (2005) have visualized how communication changes and develops over time and affect group performance. Their studies about the connection between productivity and communication patterns showed that in the Eclipse open source community the development groups with high communication density seemed to be better performers than those with low density (Kidane and Gloor, 2005).
Moreover, frequent communication is needed for building trusted relationship (Daft and Lengel, 1986; Fidler and Johnson, 1984).

7.1.2 Distance between R&D's researchers (and face-to-face communication)

Distance as a communication (and knowledge sharing) impedance have been accepted as an axiom in social theory (Blau, 1977). Work dating to Pelz and Andrews (1966), Mintzberg (1973), and Allen (1977) indicates that people prefer to turn five times more frequently to other people rather than to documents or impersonal sources for information. The advent of the internet of the instant electronic communication has not yet inverted this tendency (Cross and Sproull, 2004).
Allen pioneered the stream of research dedicated to investigate how effective internal and external communications stimulate the performance of the organizations. Allen's research on the communication processes in R&D organizations describing how increasing distance between team members reduced the chances of two team members communicating for technical matters it is probably the best known of these studies in the R&D context.
Moreover, his findings were supported by a numerous researches (Allen T.J., 1977; Katz R. and Allen, T. J. 1983; A. De Meyer and A. Mizushima,1989; Egido, and Galegher 1990; Zahn, 1991; Jaffe, A., Trajtenberg, M. and R. Henderson 1993; Song, 1993; Song and Parry 1992, 1993a, 1993b; Krackhardt, 1994; Song, Souder, and Dyer, 1997; Dyer and Song, 1997, 1998; Van den Bulte and R. K. Moenaert, 1998; McDonough, Kahn, and Barczak 2001; Parry and Song, Xie, and Dyer, 2000; Xie, Song, and Stringfellow, 1998, 2003).
Moenaert and Caeldries (1994) made an experiment to see whether placing R&D specialist in proximity influenced positively the quality of communication between teams. The result showed that technological learning did not increase, but market learning and product innovation increased significantly. This result showed that even if the distance remain a barrier to knowledge sharing,

proximity, especially among researchers and marketers, not always affect positively the knowledge sharing process.
Rafii (1995) commented that co-location probably was not anymore an effective and feasible system, considering 'less costly communication mechanisms and managerial processes that can provide adequate coordination and integration' (:75).
Van Den Bulte and Moenaert (1998) used for the first time social network analysis (Wassermann and Iacobucci (1988) method) for evaluating communication's network structure within R&D and between R&D and marketing before and after co-location. Results showed that communication among R&D increased after co-location, but this not influenced the communication frequency between R&D and marketing, which remained the same.
De Meyer found that distance is the main inhibitor of face-to-face communications, which is fundamental for R&D productivity. As De Meyer noted, "one of the most important productivity problems in R&D is stimulating communication among researchers" [16, p. 1991]. . . . It becomes more difficult when laboratories are located far from each other' (1991: 49). 'Communication is central to effective R&D, and that it is made harder by geographical and cultural dispersion. De Meyer (1983, 1991) reaffirms the importance of face-to-face contacts in R&D work (Allen et. al. 2007:180).).
A variety of mechanisms, he argued, must therefore be used to circumvent the problems, including socialization of managers, formalization of systems, use of boundary-spanning individuals, a network organization, central office processing, and electronic systems.

7.1.2.1 Distance between firms belonging to different regions

Singh (2005), on the basis of precedent findings (Kogut and Zander 1992), showed that intraregional and intra-firm knowledge flows are found to be stronger than those across regional or firm boundaries. Consistently, knowledge flow between two inventors is three times as likely within as between firms.

7.1.2.2 Distance between units of different firms

Zellmer-Bruhn (2003) found that units are more likely to transfer best practices from units that are part of the same organization than from units that belong to a different organization.

7.1.2.3 Cultural distance

In analyzing the literature on product development, in fact, it is striking that interdepartmental and inter-functional communication have been identified as distinguishing successful from unsuccessful projects for over 20 years.

For example, Rothwell et al. remark in their Sappho II study that: 'failure to communicate successfully between organizational units was the hallmark of failure. (1974:283)'. Similar conclusions are drawn by Allen and Cohen (1967), Allen (1977), Cooper (1979), Souder and Chakrabarti (1979), Cooper (1983), and Maidique and Zirger (1984). Research on the interplay between marketing and R&D is quite substantial, and often integrating mechanisms and processes are suggested in order to increase the interactions between marketing and R&D departments (e.g. Souder, 1988; Moenaert and Souder, 1990; Griffin and Hauser, 1996; Moenaert and Souder, 1996; Leenders and Wierenga, 2002).

The continuity with the more recent findings of Clark, Fujimoto, Henderson, Iansiti, and Leonard-Barton et al. leaves little doubt that communication and integration are positively correlated with project success, and strongly suggests that the relationship is causal.

Abbie Griffin and John R. Hauser in 1997 viewed the lack of communication as the main cause of non collaboration between marketing and R&D units. By reviewing the literature on marketing and R&D collaboration and identify in the cultural differences the main barriers to effective integration. These barriers were related to:

- personality,
- time orientation;
- cultural barriers and stereotype (the most difficult barrier to reduce or eliminate),
- language differences,
- organizational responsibilities (emerge because of different tasks and responsibilities (Souder, 1975; Souder et al. 1993; Dougherty, 1990), perceived illegality of product development, functional success measures unsupportive of integration, lack of top management support rewarding integration)
- physical barriers

Table 3. Marketing and R&D Differences (adapted from Lorsch and Lawrence [65], Gupta et al. [44], and Dougherty [29])

	Functional Position	
Dimension	Marketing	R&D
Time orientation	Short	Long
Projects preferred	Incremental	Advanced
Ambiguity tolerance	High	Low
Departmental structure	Medium	Low
Bureaucratic orientation	More	Less
Orientation to others	Permissive	Permissive
Professional orientation	Market	Science
Professional orientation	Less	More

Table 4. Marketing and R&D differences. Source: Griffin and Hauser, 1996

They identified six types of actions (or methods) that the firm can take to achieve integration (Griffin and Hauser, 1996) and communication:

- co-location (Allen, 1986; Souder, 1984); relocate to reduce the distance between marketing and R&D by collocating both group or diminishing physical barriers.

- personnel movement (Allen, 1990; Carroad and Carroad, 1982; Roberts, 1987; Roussel, 1991; Souder, 1994), people rotation (temporal) from marketing to R&D and viceversa.
- informal social systems (Feldman and Page, 1984; Moore, 1987; Workman, 1993), informal contacts rather than formal processes. Social network foster open communication and enable cross functional contacts for solving problems or identify who have the right expertise for that problem. In addition to this, the management can establish a culture nurturing integrated innovation. Such a culture has a high tolerance for calculated risks, is open to communication, shares rewards and is decentralized (Souder, 1987; Souder, William and Sherman, 1993).
- organizational structure such as integrator (Souder and Chakabarti, 1978), dyadic relationships (Souder, 1980; 1987); coordinating groups, matrix organization, project groups.
- incentives and rewards, marketing is rewarded according to market share gains; R&D according to technology improvements, patents and publication. The authors propose to change the incentives' model, considering the profits earned from new product under development (Coombs and Gomez, 1991; Hauser and Simester, 1994; Larson and Goheli, 1986) and implement a 'joint reward system'.
- formal integrative management process. Griffin and Hauser propose an alternative to formal management process in 'artisans', people which specifies which tasks have to be completed in what order by whom.
- I&CT. E-mail, video-conferencing, and intranet provide an opportunity for contacting people easily and finding, processing and sending information in an effective way (Nonaka and Teece, 2001; Williams and Cothrel, 2001; Sarbaugh and Feldman, 1998).

7.1.2.4 Distance due to formal organizational structures and inter-functional separation

Leonard Barthon (1998) proposes that 'the ideal of well diffused and widespread knowledge is particularly threatened by the tendency of organizational boundaries, such as those between divisions or functions, to result in the formation of what she terms 'islands of knowledge' within the firm.' … formal organizational structures continue to impede, rather than to aid, knowledge transfer (Brown and Duguid, 2001). (Allen et. al. 2007:182).

Because of physical distance even planned meetings are more difficult to organize, and it solidifies the separate thought worlds of marketing and R&D, encourages technical jargons, and heightens perceptions of personality differences (Griffin and Hauser, 1996; Mazumdar, 1995).

'The traditional Mform organizational structure and its many variants are characteristically rigid and inflexible, thereby hindering horizontal communication between functions, or the separate businesses of multidivisional firms (Daft, 2004; Bryan and Joyce, 2005). The issues afflicting hierarchical systems are symptomatic of the 'mechanistic' management systems identified by Burns and Stalker (1961). These

mechanistic systems are characterized by vertical interactions, systems of superiority management and a focus upon local, rather than broad sources of knowledge, experience and skills. This demonstrates how the flow of knowledge within the corporation can be restricted through bureaucracy and the use of rigid frameworks for reporting and sharing knowledge assets. Vertical 'silos' of employees are separated by functional boundaries, or in the case of multiunit firms, by business group, increasing duplication of resources, reducing efficiency and critically impeding the exchange of knowledge assets.' Matrix structures associate professionals horizontally on shared product or competency lines across functional, divisional or

geographic boundaries (Daft, 2004; Bryan and Joyce, 2005). The approach integrates separate areas of knowledge on specialist subjects otherwise isolated from one another by vertical management systems. Modern management and organizational practices are, however, increasingly more dynamic than matrix structures, which retain much of the rigidity of M-form structures, reflected by infinite variations of formal collaborations. Retrofit structures are often found to be cumbersome, inefficient and slow to respond to changes in the business environment (Bryan and Joyce, 2005).' (Allen et. al. 2007:182).

Many researchers have advocated the use of job rotation as an important method for increasing cross-functional integration (Griffin and Hauser 1996; Keys and Miller 1984; Parry and Song 1993) and then inter-functional knowledge sharing. Researchers have used different terms for meaning the internal collaboration among units. Some of them used the term cooperation, some others the terms integration, communication and so on.

Marketing and R&D units are recognized to be the most strategic units for the innovation process, however these two functions seem to work in competition and isolated far from each other. The need of managing flows of information and knowledge between these two functions emerged in 1970 and the precursor are Rubenstein et al (1976) and Souder (1977; 1987). In their study they try to measure the impact of coordination, communication and integration on new product development. Studies on intra-firm collaboration focused on marketing-R&D cooperation, viewed as the critical units for achieving successful new product development.

Leenders and Wierenga (2002) measured the effectiveness of these mechanisms on inter-functional integration and new product development. They found that relocation and physical facilities design,

formal integrative management process, joint incentives and rewards and ICTs impacted on inter-functional integration more than other mechanisms, and ICTs impacted positively on NPP, while on the contrary formal integrative processes have a negative relationship.

7.1.3 Communication Direction

The *direction* of communication can be upward, downward or horizontal (Goldhaber, 1993). Communication is an indicator of democracy level within a firm or in a network of firm. Bottom-up flows may imply that every employee or customers may express his opinion, share his knowledge and ideas or participate to important decision, such as the ones related to NPD process.
Since the core product of innovation activities is knowledge, and knowledge can only be created through interaction between specialists with varying backgrounds of expertise, the cement of innovation activities is communication (Kratzer, Leenders and Van Engelen, 2004). Researchers have focused simply on face-to-face meetings, but they have not considered the complexity of communication process and its influence on organizational and managerial aspects.
In fact, if we take into consideration a top-down and one-way communication process, it is clear that we are dealing with a firm in which hierarchies and formalities matter. Such organizational environment influences the creativity of its employees that will perform bureaucratic tasks, and then, the innovativeness of the firm.
The balance of bottom-up and top-down flows implies the presence of a middle-top-down management (Nonaka, 1995) and a decentralized decision making.
On the contrary, the presence of contemporary top-down and bottom-up flows, and will identify a firm's culture who takes into consideration the ideas and opinions of its employees, and if there is also a two-way communication process it means that top managers interact with the lower level of the firm, where it resides specialized knowledge (Grant, 1996). The presence of bottom-up communication flows can avoid the formalization of the decision making process and it puts the basis for the "free-wheeling, creative atmosphere of the university laboratory, that has been supplanted by the constricting procedures and regimentation of the large corporation" (Krige, 1993, p. 254).
Then, the direction and not just the frequency of the communication processes can influence the organization of the firm and, by consequent, the way in which firms manage the relationship with its employees, partners and other collaborators.
The effectiveness of the relationship is significantly dependent on firm's internal communication processes, and this process also influences the sharing of tacit and explicit knowledge and then, the creation and maintenance of the network and the systemic innovation.

7.1.4 Technological gatekeepers and boundary spanners

In order to prevent problems related to rigid organizational silos within firms researches have found a new role that works on solving such a problem: the gatekeeper.

Allen and Cohen (1969) studied the internal communication in Research & Development contexts, discovering the role of the technological gatekeeper, defined as the 'internal communication stars', which is strongly connected to external sources of information than non stars. They said: 'there will always be some people who, for various reasons, tend to become more acquainted with information sources outside their immediate community. They either read more extensively than most or develop personal contacts with outsiders. A large proportion of these people in turn attract colleagues from within the community who turn to them for information and advice' (Allen and Cohen, 1969: 150). The gatekeeper acts as a bridge, linking the organization to other organizations and worker in the field, considering his capacity of transferring information through different coding schemes. These individuals were more frequently chosen for technical discussion; they used different sources of information, held more patents, and publications, and tended to be first line supervisors. The fact that the gatekeeper is related to innovators and innovations produced was confirmed by other successive studies (Pelz and Andrews, 1976; Tushman and Nadler, 1981a; Tushman and Scanlan, 1981b). The gatekeeper acquires relevant information from his extensive external contacts and filters and feeds the information into the organization (Tushman, 1977). Then, gatekeepers are like the interface between the knowledge emerging in the external environment and the internal environment of the firm. These findings were supported by several researches (Albrecht & Ropp, 1984; Cziepel, 1975; Daft, 1978; Ghosal & Bartlett, 1987; Schwab, Ungson, & Brown, 1985) and his role resulted particularly important in health care environment (Robertson & Wind, 1983).

The concept of gatekeeper is also considered important for reducing the difficulties of R&D organizations in update continuously their information and knowledge.

Then, other researcher have identified the same role differently, Myers and Marquis see the gatekeeper as *key people* or *product champions* (Myers and Marquis, 1969), since they connect the laboratory and other functions. Lawrence and Lorsh name this role *integrator* (Lawrence and Lorsch, 1967), here the gatekeeper is formally defined and they operate at the lower levels of the firm. However, it was strictly connected to the activity of knowledge acquisition and sharing within and across firms' boundaries.

For indicating external boundary spanners in literature it is preferable to use the term gatekeeper. Disputing the functional specialization explanation, some boundary spanning literature suggests that the two distinctive external and internal communication roles can be played by the same person (Aldrich & Herker, 1978; Allen, 1989; Friedman & Podolny, 1992; Katz & Tushman, 1981; Tushman & Scanlan, 1981a, 1981b). Consequently, research has also focused on boundary spanners who communicate externally as well as internally.

Tushman stated that the communication across organizational boundaries, even if it is difficult and prone to bias and distortion, it is a requirement for successful innovation. Boundary spanners play an important role in the diffusion of ideas between and within organizations (Albrecht & Ropp, 1984; Cziepel, 1975; Daft, 1978; Ghosal & Bartlett, 1987; Schwab, Ungson, & Brown, 1985).

According to the author, one way to deal with the difficulties of communicating across boundaries is to develop special boundary roles (March and Simon, 1958; Thompson, 1967; Allen and Cohen 1969; Allen, 1970; Aldrich and Herker, 1977; Schwartz and Jacobson, 1977). The author identifies three boundaries:

1) one between R&D departments,
2) one with R&D laboratories and
3) one with larger organizations.

Gatekeepers or boundary spanners monitor the external technical information and they are the interface between this knowledge and SBU.

A substantial proportion of the boundary spanning literature has implicitly adopted a two-step communication process (e.g., Katz & Lazarsfeld, 1955), with an emphasis on information flowing through boundary spanners who act as opinion leaders in their organizations.

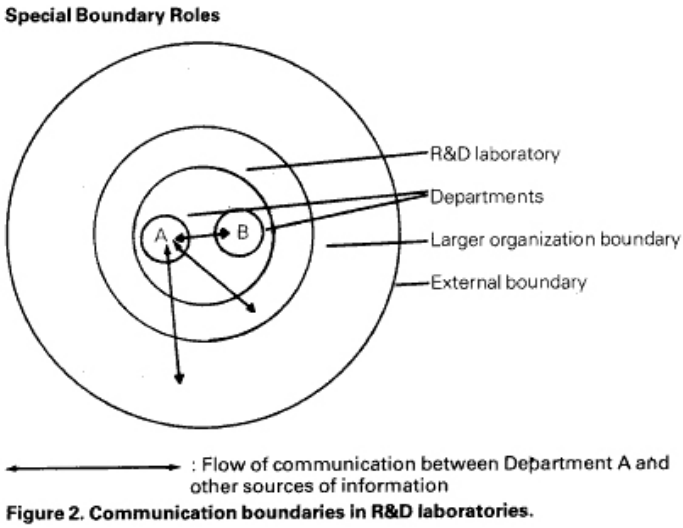


Figure 15. Special Boundary Roles. Source : Tushman 1979

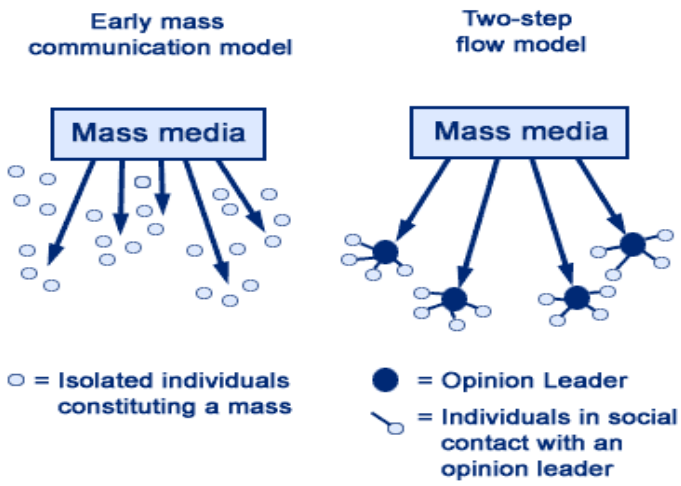


Figure 16. Opinion leader and isolated individuals networks in mass media communication. Source: adapted from Katz and Lazarsfeld, 1955. http://www.mscmvle.org.uk/vle/ncc/mod06/topic02.htm

However, in new organizational forms most individuals engage in some boundary spanning behaviour, rendering more traditional organizational boundaries increasingly arbitrary (Starbuck, 1976). While the literature suggests various types of boundary spanning communication activities, few studies simultaneously have examined internal (between organizational units) and external (with other organizations) communication patterns over time, especially in relation to innovation processes (Goes & Park, 1997).

Davenport and Prusak (1998) name the gatekeeper knowledge brokers, according to them they play the role of connectors between who is looking for knowledge and who possess it. Some managers acquire all the information about worker's expertise and then connect them to knowledge 'buyers' (E.g. librarians).

An evidence of knowledge brokers is Yahoo! answers, the service that connect worldwide people that look for information and knowledge and people that want to share their knowledge with them. Yahoo! Answers is 'a place where the world shares what they know to help each other out', Yahoo! incentive people in answering questions posted by information or knowledge buyer by providing a system of points and levels. Points are attributed to different actions such as answering, deleting an answer, choosing and voting for a best answer and so on.

7.2. Information & Communication Technologies (ICTs)

Information and communication technologies have a strong impact on knowledge sharing.

Huber (1990) defines advanced IT to include computer-assisted communication technologies (e.g., email, video conferencing) and computer-assisted decision-aiding technologies (e.g., decision support systems, expert systems). He stated that information technology impacts on organizational design, and on the quality (broadly defined) and timeliness of organizational intelligence and decision making, and it is a variable that enables organizations to be designed differently than has therefore been possible.

Kendall (1997) proposes a classification that includes production-oriented technologies, coordination-oriented technologies, and organizational-oriented technologies.

The theories of media richness and the social presence theory (Short et al. 1976) convey that ICTs eliminate normal communication cues present in face-to-face conversations, such as paraverbal (tone of voice, inflection, voice volume) and nonverbal (eye movement, facial expression, hand gestures, and other body language) cues. Generally, these cues help regulate the flow of conversation, facilitate turn taking, provide feedback, and convey subtle meanings. In face-to-face conversation, there are few interruptions or long pauses and the distribution of participation is consistent, though skewed toward higher status members (McGrath, 1990). Computer-Mediated Communications (CMCS) preclude these secondary communication modes, thus altering the orderliness and effectiveness of information

exchange (Hightower, Sayeed, Warkentin, & McHaney, 1997). These studies support also the assumption that the higher is individuals' face-to-face communication, the higher is the trust among them.

Moreover, they found that in face-to-face communications individuals convey trust warmth, attentiveness and other interpersonal affections (Javenpaa and Leidner, 1999) and that CMC generally entails greater uncertainty than face-to-face, there tends to be an intense need for response (Hawisher and Maran, 1993). Face-to-face encounters are considered irreplaceable for both building trust and repairing shattered trust (Nohria and Eccles, 1992; O'Hara–Deveraux and Johansen 1994). Social communication that complements rather than substitutes for task communication may strengthen trust. Media richness theory (Daft and Lengel, 1984)—one of the most broadly studied (e.g., Kinney & Dennis, 1994; Marhs, 1994), yet controversial theories about media choice— ranks communication media according to its capacity to process ambiguous information. Specifically, the theory ranks media based upon their ability to provide feedback, their capacity to transmit multiple cues, their availability to use natural language, and their personal focus. Accordingly, face-to-face is a richer medium than telephone, and telephone is a richer medium than e-mail. Hence, for equivocal messages, "richer" media (i.e., media higher in immediate feedback, multiple cues, natural language, and personal focus), such as face-to-face meetings or the telephone, are better choices because rich media allow shared meaning to be created between the communicators (Sosa et al., 2002).

In contrast with this tradition of studies, Pavitt found that ICT are vastly increasing the ability of firms to work across different geographic and organizational boundaries (Pavitt, 2003). Hightower and Sayeed (1995, 1996) found that virtual teams exchange information less effectively than face-to-face groups. Warketin et al. (1997) in a research conducted on an asynchronous computer conference technology found that computer-mediated communication may hinder the development of a strong sense of cohesion and satisfaction with the group's interaction process. Although virtual and face-to-face team interactions exhibited similar levels of communication effectiveness, teams using face-to-face interactions reported higher levels of satisfaction with team performance (efficiency). Second, the strength of relational links is positively associated with the effectiveness of information exchange. Therefore, the loss of relationship building in virtual teams implies that the use of traditional meetings as a supplement to the use of CMCS might be useful (preferably in an early stage) for creating a sense of belonging to a group. Similarly, Carmel (1999) suggests arranging face-to-face kick-off meetings in the beginning of a project and re-establishing trust by personal face-to-face communication later on, e.g. in the form of milestone meetings. These personal bridges can be created, by assigning cultural liaisons, rotating staff or sending expatriates. Further, relational links among team members were found to be a significant contributor to the effectiveness of information exchange. Though virtual and face-to-face teams exhibit similar levels of communication effectiveness, face-to-face team members report higher levels of satisfaction.

Virtual teamworking can get knowledge where it is needed. In the episode of the British Petroleum's Virtual Teamwork Station, a malfunctioning was solved through a tiny video-camera connected to the expert engineers that have to solve the problem quickly and without being physically present (that would have required 150.000$ per day say Davenport and Prusak, 1998 : 23). ICTs brought the expert and the situation that required his expertise together. According to Davenport and Prusak: 'IT can provide an infrastructure for moving knowledge and information about knowledge as well as for building the virtual knowledge marketplace' (:45).
In fact, Information & Communication technologies (ICTs) can facilitate collaborative work and enable the knowledge transfer process (Chung 2001); however, such technologies are inherently limited in their ability to transfer knowledge that is more tacit in nature (Hildreth & Kimble 2002). Lucas (1998) studied the positive benefits of e-mail usage on organizational efficiency, which are enhanced as higher is the access to the use e-mail by firms' employees.

7.2.1 Knowledge management systems (KMS)

Advances in computer technology and new requirements coming from businesses have enriched and extended the variety of tools and applications at disposition for the management of the firm.
These applications promise the achievement of complex tasks such as intelligent information and knowledge storage systems, platform for inter-firm an inter-unit collaboration to similar projects, user profiling and matching of profiles, marketing automation and so on…
The utilization of these tools helps firms in reducing costs, time for performing tasks and efforts.
Knowledge management systems (KMS) represent a large networked collections of contextualized data and documents linked to directories of people and skills and provide intelligence to analyze these documents, links employees' interests and behavior as well as advanced functions for knowledge sharing and collaboration (Maier, 2007:7). A KMS is an ICT system in the sense of an application system or an ICT platform that combines and integrates functions for the contextualized handling of both explicit and tacit knowledge, throughout the organization or that part of the organization that is targeted by a KM initiative. A KMS offers integrated services to deploy KM instruments for networks of participants, i.e. active knowledge workers, in knowledge-intensive business processes along the entire knowledge life cycle. Ultimate aim of a KMS is to support the dynamics of organizational learning and organizational effectiveness (Ibidem: 86).
KMS achieve several goals such as locate experts and networks, actively participate in networks and communities, create and exchange knowledge, generate, are and apply knowledge. Examples of ICTs related to knowledge management are (Maier, 2007):
- *Intranet infrastructures*
- *Document and content management systems*
- *Workflow management systems*

- *Artificial intelligence technologies*
- *Business intelligence tools,*
- *Visualization tools*
- *Groupware,*
- *e-Learning systems*

The use of KMS is growing among firms, in fact researcher have proven that these systems help organization in flexibly adapt and respond more quickly to changing market conditions, to improve decision-making and productivity and to be more innovative (Harris, 1996).
Moreover, KMS ease the integration of dispersed knowledge (Grant, 1996), speed up the replication of best practices across time and space (Nelson and Winter, 1982), avoid double invention, facilitate leveraging across uses and users (Quinn, 1992) and reduce costs of searching and transforming available knowledge for local use (Hedlund, 1994).
Elements that affect knowledge sharing in a KMS can be related to the performance of the system and to the quality of the knowledge stored within it. Different authors have given a definition of knowledge quality, Kahn et al. (2002) propose content related dimensions (accuracy, completeness, interpretability, relevancy), technical dimensions (latency, availability, synchronicity, security, timeliness…), intellectual dimensions (believability, objectivity) and instantiation related dimensions (representational consistency, representational conciseness, verifiability…). Ryan et al. (2005) suggest these dimensions: accuracy (the degree to which knowledge is correct, unambiguous, meaningful, believable, and consistent), completeness, currency (up-dated knowledge) and format (the degree to which knowledge is presented in manner that is easily understandable and interpretable to the adopters and thus helps in a task fulfillment.
Then, there are studies that measure the quality of KMS, Nelson et al. (2005) drawing on over 20 studies that define dimensions of system's quality by identifying 5 key-dimensions: accessibility, reliability, flexibility, response time and integration.
(Further information on this subject is available at p.27).

7.3 Employee's Mobility

Mobility of individuals has been shown to be an important mechanism through which knowledge diffuses (Saxenian 1994, Almeida and Kogut 1999, Rosenkopf and Almeida 2003; Song et- al. 2003). For example, Song, Almeida and Wu (2003) show how new knowledge (patent registration), is created when personnel are moved across organizations.

Many researchers have advocated the use of job rotation as an important method for increasing cross-functional integration between marketing and R&D departments (Griffin and Hauser 1996; Keys and Miller 1984; Parry and Song 1993).

7.4 Trust

Trust is a belief that the other party is good, sincere, integer and he will not try to harm or trick you (Oxford Dictionary). Trust is based on confidence in an exchange partner's reliability and integrity (Rotter, 1967) and a capable and trustworthy source is more likely to influence the behaviour of the recipient (Perloff, 1993). Trust can be defined as one party's confidence that the other party will fulfill its promises and commitments without exploiting its vulnerabilities and inter-firm trust is considered the perceived trust by a group of individuals within an organization toward a group of individuals within another organization.

Trust can serve as mechanism to reduce the complexity of human conduct in situations where people have to cope with uncertainty (Luhmann, 1989), as it reduces the apprehension about the credibility of the source.

Trust influence willingness to share useful knowledge (Andrews and Delahay 2000, Penley and Hawkins 1985, Tsai and Ghoshal 1998, Zand 1972) and to listen to and absorb others' knowledge (Carley 1991, Levin 1999, Mayer et al. 1995, Srinivas 2000). Levin (1999) found that strong, trusting ties usually helped improve knowledge transfer between scientists and engineers, but that trust alone could substitute when only weak ties existed.

Trust reduces psychological barriers and bias by making knowledge transfer more fluid and less costly (Currall and Judge 1995, Zaheer et al. 1998). These effects have been found at the individual and organizational levels of analysis in a variety of settings (Levin and Cross, 2004).

Trust derives from emotional and affective reasons, such the trust we have towards friends, our family and parents or it can have more rational reason, the trust we have towards expert and professional in a certain domain.

Levin and Cross (2004) distinguished between two typologies of trust: competence and benevolence-based trust. They found that these two constructs mediate the link between strong ties and receipt of useful knowledge. Similarly, Mayer et al. (1995) identified benevolence, which has a large affective component, and competence, which has a large cognitive component, as two key trust dimensions.

This reliability and integrity on a source is also conceptualized as a bias. Sources that have an economic interest, such as sellers of a product/service, are generally less trustworthy than parents, friends, and experts.

Several factors such as shared social norms, repeated interactions, and shared experiences have been suggested to facilitate the development of trust (Bradach and Ecccles, 1988; Mayer et al.1995; Lewis and Weigert, 1985).

McEvily et l. (2003) found that the level of trust affects the extent of knowledge disclosure, screening, and sharing between two parties.

The theories of media richness and the social presence theory (Short et al. 1976) convey that CMC is less cold and impersonal and it doesn't help in creating trusted relationship and face-to-face encounters are considered irreplaceable for both building trust and repairing shattered trust (Nohria and Eccles, 1992; O'Hara –Deveraux and Johansen 1994).

The best way to build trust at the beginning of a project is to meet face-to-face. Carmel (1999) suggests arranging face-to-face kick-off meetings in the beginning of a project and re-establishing trust by personal face-to-face communication later on, e.g. in the form of milestone meetings. Moreover, the project manager should travel to all the distributed sites several times a year to meet his distributed team members. Since travelling is expensive, face-to-face meetings are quite an expensive way to communicate. This may be the reason why the case studies presented earlier did not emphasize face-to-face meetings, but suggested arranging, e.g. videoconferences (Ebert and De Neve, 2001) and teleconferences (Battin et al., 2001).

7.5 Knowledge sharing routines (and trust)

Dyer and Nobeoka (2000), in their ethnographic study in Toyota, showed that knowledge management to be effective should be primarily focused on establishing good and trusted relationships with the network of suppliers.

Toyota relies on suppliers for more than 70 % of the value of its vehicles and, through a network, the suppliers collaborate with an energetic participation. According to researchers, thanks to its superior knowledge-transfer mechanisms, Toyota was able to increase worker productivity, lower inventories, and improve product quality at a faster rate than competitors. Further, Toyota recognized the importance of setting a strong feeling of trust between the firm and the other parts of the network, such as suppliers, manufacturers and so on.

Toyota realized these achievements through the creation of three key-divisions (such as (1) the supplier association, (2) the knowledge transfer consultants (OMCD, TSSC), and (3) *jishuken/PDA core groups* or small-group learning teams) and five learning routines. A learning routine is conceived as a regular pattern of interactions among individuals that permits the transfer, recombination, or

creation of specialized knowledge (Grant 1996). Collectively, these routines may be viewed as a capability at managing knowledge flows in inter-firm networks (Lorenzoni and Lipparini, 1999). Richard Nelson and Sidney Wintit er (1982) viewed routines as collective phenomena defining them as 'pattern of behavior that is followed repeatedly, but is subject to change if conditions change' (: 263). They range from well-specified technical routines for producing things, through procedures for hiring and firing, ordering new inventory, R&D, business strategies.

Dyer and Singh identified inter-firm knowledge sharing routines as one of four possible sources of 'relational rents' which are supernormal profit generated in an exchange relationship that cannot be generated by either firm in isolation (1998: 662). They define an inter-firm knowledge sharing routine as a pattern of interactions that permits the transfer, recombination or creation of specialized knowledge (1998: 665).

These routines were purposefully designed by Toyota to facilitate knowledge transfers and integration across organizational boundaries. The five learning routines were:

1. Supplier Association (*kyohokai*). They were established in 1943 to promote "mutual friendship" and the exchange of technical information between Toyota and its suppliers. "Toyota's *kyohokai* have general meetings every other month (e.g., general assembly, top management meetings) that are designed to enable high-level communication within the network with regard to production plans, policies, market trends, etc. Thus, these meetings primarily facilitate the sharing of explicit knowledge among members. More frequent interactions occur within the association's topic committees (cost, quality, safety, etc.)" (Dyer and Nobeoka, 2000:353). The supplier association is also an important vehicle for creating an 'identity' for the Toyota production network or 'Toyota Group.'

2. On site consulting. The OMCD is the organizational unit within Toyota assigned the responsibility to acquire, store, and diffuse valuable production knowledge that resides within Toyota's Extended Enterprise. It consists of six senior and highly experienced executives and about 50 consultants. OMCD send to supplier a team of consultants for a period from one day to many months and its assistance is for free. Toyota demands that participating supplier lets other companies to see their operations and best practices when the project is completed.

3. Voluntary learning teams (jishuken/PDA core) (Supplier learning teams). In 1977 OMCD organized a group of roughly 55–60 of its key suppliers into 'voluntary study groups' (*Jishukenkyu-kai or jishuken*) for the purpose of assisting each other with productivity and quality improvements. Each year the suppliers meet together with the responsible OMCD manager to determine a 'theme' (project) for the year. The basic idea is to help each other to increase productivity in areas of common interest. Themes are selected by suppliers (with Toyota's input) in areas believed to be important and relevant to a large number of members in the network. When a theme is established (e.g. "Eliminating supplier design defects"), the committee meets suppliers six times each year. After a theme is decided, the group establishes a schedule to visit each supplier's plant to jointly develop suggestions for

improvement. In addition to that, a quality management conference is held once each year and offers suppliers the opportunity to learn from successful supplier cases of quality improvement.

4. Problem Solving Teams. These teams were designed to bring knowledge to solve emergent problems within the network. If a supplier has a quality problem where the root cause is not easily determined, the OMCD or the QAD (Quality Assurance Division) will set up a problem solving team (including various divisions and possibly even other Toyota suppliers) to fix the quality problem. Once the problem-solving team has defined the root of the supplier's quality problem as being in product design, Toyota's Design Engineering Division (which has already been involved in the problem solving team) will be asked to take the lead in working more closely with the supplier to implement solutions to improve quality.

5. Employee transfer. The transfer of employee is realized to help large assemblers maintain control of suppliers and the opportunity to shed unwanted employees. Further, this mechanism is used for creating a network identity and transferring knowledge from Toyota to suppliers. Toyota transfers approximately 120–130 individuals per year to other firms in the value chain, most of whom go to suppliers.

The following table summarizes the five learning routines adopted by Toyota along with defining the nature of these processes either bilateral or multilateral, determining the type of knowledge that can be transferred through these processes and the functions operating these processes.

Process	**Nature of the Transfer Process**	**Type of Knowledge**	**Toyota Function Involved**
1. Supplier Association	Multilateral	Explicit knowledge (some tacit knowledge)	Purchasing
2. On-site Consulting	Bilateral	Tacit Knowledge	OMCD/TSSC
3. Voluntary Learning Teams	Multilateral	Tacit Knowledge	OMCD,LAD
4. Problem-Solving Teams	Bilateral	Tacit Knowledge	QAD,MOD OMCD,LAD
5. Employee Transfer	Bilateral	Tacit Knowledge	Purchasing, Personnel

Table 5. Knowledge Sharing Routines Source: adapted from Dyer and Nobeoka, 2000

Differently from U.S automaker that have established quite the same routines and processes, Japanese automakers have created a high level of trust that enormously facilitated the knowledge sharing process.

In Toyota experience, trust reduces transaction costs. Toyota spent only 21% of its face-to-face interaction time negotiating contracts and prices. Moreover, trust has a positive relationship with *Procurement Productivity (Value of goods purchased per procurement employee)*, and Toyota shows the best performance (higher trust and higher Procurement Productivity). Moreover, the knowledge sharing within Toyota network was reciprocal, free assistance and Toyota's knowledge and experience were exchanged with supplier's knowledge and their agreement in sharing knowledge to the other members of the network. All knowledge and capabilities of Toyota is open to Toyota's suppliers at the condition that every supplier share and open its plant to other suppliers of the network. Consistently, Toyota states that 'We will help you, but in return, you must agree to help the network.' Free assistance created a state of reciprocal obligation within suppliers. Suppliers that didn't respect these rules of openness were sanctioned by Toyota with lower commitments.

Briefly, production processes and the innovation related to these processes are not viewed as proprietary and Toyota accepts that some valuable knowledge will spill over to benefit competitors. Thus, any valued knowledge that Toyota or a supplier possesses is viewed as accessible to virtually any member of the network (with *perhaps* the exception of a direct competitor).

While outsourcing quite all its productive value chain, Toyota through its system maintains 'control' over the whole network. The knowledge-sharing processes helps to maintain its leadership role (power and relevance) in the network (Dyer and Nobeoka, 2000: 362). Toyota access to greater amount of knowledge and information than all other suppliers, it learns from the network but at the same time it monitors its activities. Then, the greater the knowledge asymmetry with the members of the network, the greater is Toyota's control and power over the network. Finally, it has been proved that the ability of Toyota in effectively create and manage network-level knowledge-sharing processes partially explain the relative productivity advantages enjoyed by Toyota and its suppliers.

The Toyota case study demonstrates that today the activity of knowledge sharing implies the management of the network of the firm in order to promote trusted-collaboration across the firm's boundaries. Knowledge sharing leads to better collaboration and to mutual benefits, reduce complexity, and make NPD successful.

7.6 Socialization

In sociology the process of socialization is the one through which the newcomers are learned about the cultural patrimony or a port of it, in order to be part of a specific society (organization). The school, the parents, the church (in some countries) are agency of socialization, as they learn to individuals how to behave, which are the norms and rules they have to respect, which is the tradition and practices of the old generation and so on.

In business socialization conceptualizes the process by which individuals come to understand the values, abilities, and social knowledge, which are essential for assuming an organizational role and for participating as an organizational member (Louis, 1980).

The key elements and dimensions of organizational culture include those of shared meanings, norms, values and beliefs (Denison, 1996). Consistently, socialization is a key mechanism for learning and understanding the organizational culture.

Nonaka and Takeuchi have defined socialization as 'a process of sharing experiences and thereby creating tacit knowledge such as shared mental models and technical skills' (Nonaka and Takeuchi, 1995:62). Socialization is fundamental for these authors, as it is the process through which tacit knowledge can be shared by interacting through imitation, observation and practice. It is conceptualized as a process of learning, similarly to the On-the-Job-Training (Nonaka and Takeuchi, 1994).

7.7 Absorptive capacity (and causal ambiguity)

Absorptive capacity is critical to the innovative capacity of a firm. Absorptive capacity is a firm's ability 'to recognize the value of new, external information, assimilate it, and apply it to commercial ends' (Cohen and Levinthal, 1990:128). Absorptive capacity is the capability to value and exploit external knowledge and it can be used to develop products that strengthen the firm's competitive and financial performance.

Cohen and Levinthal view absorptive capacity as a firm-level construct, an ability the firm develops over time by accumulating a relevant base of knowledge. 'By having already developed some absorptive capacity in a particular area, a firm may more readily accumulate what additional knowledge it needs in the subsequent periods in order to exploit any critical external knowledge that may become available' (Cohen and Levinthal, 1990: 135- 136). They suggested that an organization's absorptive capacity tends to develop cumulatively, be path-dependent, and builds on prior investments in its members' individual absorptive capacity. Understanding the relevant basic knowledge permits the student firm to understand the assumptions that shape the source knowledge and thereby be able to

evaluate the importance of the new knowledge for its own operations, processes and activities. Absorptive capacity depends on the stock of knowledge (Dierickx and Cool, 1989).

In his work examining the effectiveness of inter-organizational alliances, Walker (1995) argues that firms that emphasize their relationships with other firms will be more successful, in large part because of their ability to recognize and apply new knowledge:

'Firms operated to acquire extensive (external) technological information more rapidly…and designed to process (external) technological information better…will be more innovative and profitable.' (195:116)

This ability to sense new external knowledge and have the processes in place to then bring it quickly internally to the organization becomes a competitive advantage when translated into economic rents. This "sensemaking" is a critical function (Teece, 1998) that enables the organization to more effectively connect with its environment and allocate resources efficiently.

The paradox of absorptive capacity is that an organization that does not have it may not understand that it needs it (i.e., their knowledge is incomplete and can be augmented). Organizations with low absorptive capacity, arguably those with the least amount of knowledge, will be less likely to value external knowledge,

'…the decision maker [or organization] may not know enough to estimate the costs of his [their] ignorance…it will be difficult to evaluate knowledge [for acquisition] in the future without possessing this knowledge during the evaluation.' (Mosakowski, 1997:437)

Absorptive capacity (relevant prior knowledge) consists also of a set of shared symbols and language (Dearborn and Simon, 1958; Katz and Kahn, 1966; Allen and Cohen, 1969, Tushman, 1978; Zenger and Lawrence, 1989). These authors say that common language – have been shown to increase the speed and lower the cost of knowledge transfer.

Nonaka and Takeuchi emphasis on 'redundancy' or overlapping areas of expertise; Thomas J. Allen speaks of cultural mismatch as a barrier to technology transfer. Both recognize the importance of common ground and the importance of a shared terminology (or language). Allen (1977) emphasizes the role played by gatekeepers or boundary spanners in translating between cultures and value systems.

Different individuals have different stock of knowledge; these mechanisms imply a common knowledge (the intersection of their individual knowledge assets) for their operation. Different types of knowledge fulfill different roles:

Four types of commonalities have been suggested by Cohen and Levinthal (1990) and others (e.g., Lane and Lubatkin, 1998) to represent the primary contributors to a recipient's overall level of absorptive capacity: language, knowledge base, process, and problem solving.

- The first of these contributors involves the commonality of language. Investments in communication codes – or common language – have been shown to increase the speed and lower the cost of knowledge transfer (Cohen and Levinthal, 1990). Common language is

fundamental to integration mechanisms and is based on verbal communication (namely integration through rules and directives, integration through group problem solving and decision making). Other forms of symbolic communication, literacy, numeracy, familiarity with the same computer.

- The second contributor to absorptive capacity is common or base knowledge. Common knowledge was described by Grant (1997) in the KBV as one of the mechanisms needed to facilitate knowledge transfer. However, common knowledge translates to an intersection, not an overlap of knowledge. A complete overlap of knowledge is inefficient and represents limited opportunity for transfer. Commonality of specialized knowledge, the level of sophistication depends upon the extent of commonality of their specialized knowledge. It represents a little paradox as it says that individuals have to share different specialized knowledge otherwise there is no knowledge integration but these individuals need to have some commonality.
- The third contributing commonality for absorptive capacity is a common understanding (or utilization) of processes. As highlighted in the discussion of the KBV in Section 2.1.2, a common process coordinated through a hierarchical structure improves the efficiency of knowledge transfer while decreasing the associated costs (Grant, 1997). (formalization of processes);
- the fourth contributing commonality to absorptive capacity is one of common problem solving, '*The more [common] experience the…firms have in solving similar types of problems, the easier it will be for the [recipient] firm to be able to find…applications for the newly assimilated knowledge."* (Lane and Lubatkin, 1998:466)

Several authors have specifically researched the influence of absorptive capacity on knowledge transfer (Szulanski, 1996; Van den Bosch, 1999; Lane and Lubatkin, 1998; Boynton, 1994; George et al., 2001; Tsai, 2001; Mowery, Oxley and Silverman, 1996). All of these authors agreed the recipient's absorptive capacity is critical to an effective transfer of knowledge in an intra-organizational context. Mowery, Oxley and Silverman (1996) analyze the effect of inter-firm knowledge transfer within strategic alliances on partner firms' technological capabilities. They have found the importance of absorptive capacity in the acquisition of capabilities through alliances and bolsters the argument that experience in related technological areas is an important determinant of absorptive capacity. Then, the ability of a firm to absorb capabilities from strategic alliances depends on the pre-alliance relationship between the two firms' patent portfolios (as a quality that is path-dependent and firm specific). George et al. (2001) analyzed a sample of 2456 alliances formed by 143 biopharmaceutical firms and found that alliance portfolio characteristics and absorptive capacity jointly influence innovative and financial performance.

Tsai (2001) in a study on 24 business units in a petrochemical company and 36 business units in a food-manufacturing company found that a unit occupying a central position can access new knowledge from a broader range of other sources, and this position had a positive impact on firm's performance and innovativeness only whether it had high absorptive capacity with which transfer knowledge from other units.
Then, network position and absorptive capacity are interdependent and the first influence the level of absorptive capacity required and both affect performance and innovation.
Szulanski (1996) analyzed the difficulties in imitating best practices (or 'internal stickiness') and analyzed a data set consisting of 271 observations of 122 best-practice transfers in eight companies and found that the three most important origins of stickiness were the lack of absorptive capacity of the recipient, causal ambiguity, and an arduous relationship between the source and the recipient.
Simonin (1999) analyzed 147 multinationals in different sectors and found that causal ambiguity is a barrier to technological knowledge transfer. In fact, if a particular process or product has many interdependent components, identifying or isolating the impact of each one on the eventual outcome would be difficult, if not impossible.

7.8 Willingness (=Intrinsic Motivation)

Several authors have investigated the motivation and willingness as the main inhibitors in sharing knowledge (Osterloh and Frey 2000, Gupta and Govindarajan, 2000; Reagans and Mcevily 2003; Hansen and Nohria, 2004).
Osterloh and Frey say that motivation is *intrinsic* if an activity is undertaken for one's immediate need satisfaction. Intrinsic motivation 'is valued for its own sake and appears to be self sustained' (Calder and Staw 1975: 599; Deci 1975: 105).
The behavioral view of organization has a long tradition in motivation-based organization theory (Argyris 1964; Likert 1961; McGregor 1960). Intrinsic motivation is also drawn upon by critics of transaction cost theory (e.g., Donaldson 1995; Ghoshal and Moran 1996; Pfeffer 1997), as does the literature on psychological contracts (e.g. Morrison and Robinson 1997; Rousseau 1995). They emphasize intrinsic motivation in the form of identification with the firm's strategic goals, shared purposes, and the fulfillment of norms for its own sake.
Intrinsic motivation lowers transaction cost and raises trust and social capital (e.g., Ghoshal and Moran 1996; Kohn 1993; Nahapiet and Ghoshal 1998). They conclude that intrinsic motivation could be related to tacit knowledge sharing.
Gupta and Govindarajan (2000) in their study on intra-MNC knowledge transfer acquiring data from 374 subsidiaries within 75 MNCs headquartered in the U.S., Europe, and Japan, investigated whether the following factors worked as enablers or barriers to knowledge sharing in multinationals: (i) value

of the source unit's knowledge stock, (ii) motivational disposition of the source unit, (iii) existence and richness of transmission channels, (iv) motivational disposition of the target unit, and (v) absorptive capacity of the target unit. They found that the source unit's motivational disposition impacted strongly on knowledge outflows.

Grey and Meister (2004) explored the reasons why individuals may not be motivated to receive and use knowledge, or may not be capable of doing so. They found that the strength of knowledge sourcing (sharing) is moderated both by the strength of individuals' learning orientations and the degree to which they find their jobs to be intellectually demanding.

Szulanski (2000) list several mechanisms that affect motivation in transferring knowledge such as procrastination, passivity, feigned acceptance, sabotage, or outright rejection in the implementation and use of new knowledge (Hayes & Clark, 1985; Katz & Allen, 1982; Zaltman, Duncan,&Holbek, 1973).

7.9 Incentives (=Extrinsic motivation)

For establishing a consistent culture of knowledge sharing valuable currency are needed, such as substantial monetary rewards, salary increases, promotions and so forth (Davenport and Prusak 1998: 48).

Employees are *extrinsically* motivated if they are able to satisfy their needs indirectly, especially through monetary compensation. Money is a 'goal which provides satisfaction independent of the actual activity itself' (Calder and Staw 1975: 599). Extrinsically motivated coordination in firms is achieved by linking

employees' monetary motives to the goals of the firm. The ideal incentive system is strict pay-for-performance.

The organizational context influence play a crucial role, for example in norm and value setting (Kostova, 1999), through fiat or incentives (Leonard-Barton & Deschamps, 1988), and through counsel and support (Attewell, 1992).

7.10 Resistance to change

People resist to innovations that force them to abandon their 'signature skills', a term coined by Dorothy Leonard Barthon to describe the abilities by which a person identifies herself or himself professionally. People sense of competence and well-being at work depend on using them and when they have to abandon their old signature skills to acquire new one they will resist to change. This resistance is also evident when the objective is rational and profitable. For example Davenport and

Prusak say that Americans have all the information they need about the dangers of too much fat in their diet, but at the same time they continue to overweight. The same evidence is visible in European countries where recycling waste is a very profitable for the environment and individual safety, however only a low percentage of Europeans do it.

7.11 Homophily

Homophily explains group composition in terms of the similarity of members' characteristics: the extent to which pairs of individuals are similar in terms of certain attributes, such as age, gender, education, or lifestyle (Rogers, 1983). Homophily limits people's social worlds in a way that has powerful implications for the information they receive, the attitudes they form, and the interactions they experience (McPherson & Smith-Lovin, 1987). The similarity of individuals predisposes them toward a greater level of interpersonal attraction, trust, and understanding than would be expected among dissimilar individuals (Ruef, Aldrich, & Carter, 2003). Thus, individuals tend to affiliate with others who share similar interests or who are in a similar situation (Schacter, 1959). The same thing happens between people in increasing the likelihood of communication (Zenger and Lawrence, 1989).

7.12 Status and reputation

We often use reputation to evaluate the flow of information coming to us, but sometimes we are wrong especially if we base our decision more on status than past performance (Davenport and Prusak, 1998). Status indicates the social (or professional) position of somebody in relation to others; usually it indicates the degree of importance attributed to somebody. This importance can be based on different reasons (patrimony, salary, status symbols and so on), but surely within a business, the person that is expert on somebody or that is able to face different situations has a high status compared to other employees.

Thomas-Hunt, Neale, and Odgen (2003) describe the importance of expert status in predicting the kind of information that an individual shares with a group. Reputation is an important enabler of knowledge sharing, as workers are more willing to share knowledge if they are recognized as a knowledgeable person with valuable expertise. People that provide good quality information and knowledge enjoy better credential and prestige in the workplace (Kollock, 1999), however this is true in work environment where workers are identified and rewarded as central persons in a knowledge sharing network. Reward should not necessarily be monetary, social rewards can be just as important as monetary rewards. As many business success stories show (e.g.: Linux) people that not even know themselves may shared valuable, unique knowledge with low or no reward in exchange. Borgatti and

Cross (2003) demonstrate the importance of expert status in predicting knowledge transfer across individuals. Sine, Shane, and Di Gregorio (2003) also consider the importance of social status and find that knowledge created by a high-status institution is more likely to be licensed than knowledge created by a low-status institution, even when the institution's past performance in licensing is taken into account (Argote, McEvily, Reagans, 2003).
This was proved in several case studies, in Xerox: 'being recognized as the subject expert is what gives to the participants the credit and status in their community'. In Shell: 'appearing in the expertise Directory is the confirmation of individual's credentials to perform the service which has been brokered by a mere personal contact' (Benbya, 2005).
Good reputation is very important for career opportunities, higher salary, and for all rewards and trappings of a company guru.

7.13 Knowledge valuation (internal *vs.* external)

Many studies of interorganizational knowledge diffusion have found that many firms usually copy and transfer knowledge, strategy structures, and management practices from outsiders (e.g., Burt 1992, Davis 1991, Haunschild 1993, Haveman 1993, Mizruchi 1992) even to the point of pursuing managerial fads and fashions (Abrahamson 1996). Menon and Pfeffer (2003) argue that there is a real blind favoritism within firms towards outside knowledge, with the result that often managers undervalue internally available knowledge. They give the evidence of Xerox in 1970 when Xerox managers carefully benchmarked the activities of external competitors (Jacobson and Hillkirk 1986), ignoring and failing to introduce product innovations developed at Xerox's Palo Alto Research Center (PARC), such as the personal computer, the Ethernet, the mouse, and word-processing software, all of which other companies later commercialized profitably (Smith and Alexander 1988). Menon and Pfeffer say that this scarce value given to internal knowledge may be due to the threatening played by competent outsiders (Tesser et al. 1988) than by outsiders. 'People will sometimes ignore knowledgeable insiders to avoid the painful implications of social comparisons with them (Taylor 1983), or denigrate them to outshine them in competition for organizational rewards' (Ibidem: 499). These conditions are not present when acquiring knowledge from external competitors. Internal knowledge is more easily available, while external knowledge is not. However, external knowledge is less subject to greater scrutiny than internal knowledge sources and it is scarcer, which makes it appear more special and unique. Results drawn from two case studies (Fresh Choice and Xerox) showed that 'while market-based external competition motivated the *valuation* of external knowledge, internal competition motivated the derogation of insiders and *devaluation* of their knowledge. Companies have an incentive to benchmark, seize knowledge and advantage from a competitor, and

make improvements so that the final products pass the test of consumer choice' (Menon and Pfeffer, 2003 : 506).
Contrary to Menon and Pfeffer results, other researcher have found that knowledge coming from units perceived to be part of the same organization is more likely to transfer and improve the performance of a focal unit than knowledge coming from external sources (Darr et al. 1995, Kane et al. 2002).

7.14 Interpersonal / Informal Social networks

A rich literature in sociology has emphasized information flow through interpersonal networks (Ryan and Gross 1943, Coleman et al. 1966, Granovetter 1973, Burt 1992, Rogers 1995).
A key feature in virtual organization is the high degree of informal communication because of their lack of procedures, formal rules, clear reporting relationships, and norms (Monge and Contractor, 1998). Formal communication, which is non interactive and impersonal involves the use of media such as reports and structured meetings (Ahuja and Carley, 1999). Informal communication is personal, peer oriented and interactive; it involves CMC and face-to-face media.
They are also representative of the communication channels that facilitate downward transmission of orders and upward transmission of information (Weber, 1947). By contrast, informal communication is personal, peer oriented, and interactive; it involves media such as face-to-face meetings and email (Ahuja and Carley, 2006). It was found that informal communications explain the working of an organization better than formal organizational structures (Krackhardt and Hanson, 1993). This is due to different reasons, such as a low influence of role and status (Sproull & Kiesler, 1986). Informal communications create real networks of people that frequently exchange insights, knowledge, information within and across firms' boundaries.
Researchers had previously tried to study the structure of social networks. The pioneer of these studies was Granovetters (1973). He found two typologies of ties, strong and weak ties, depending on the closeness and interaction frequency of a relationship between two actors.
Each tie provided different resources, weak ties were characterized by low interaction frequency and low level of intimacy, these ties were maintained at a low cost in terms of time and effort, and provided new information and knowledge coming from distant part of the social system. Successive studies provided that weak ties favour search benefits (Hansen, 1999), and autonomy (Perry-Smith and Shalley, 2003).
Strong ties are our close friends with whom we interact very frequently, such interaction requires more time and effort, and provide us only provincial news common to our local friends' network. However, successive studies have found that strong ties were more accessible and willing to be helpful (Krackhardt 1992), created trust (Reagans and McEvily, 2003) and mutual understanding (Gilsing and Nooteboom, 2005), which facilitated the transfer and construction of knowledge, especially more

complex knowledge (Handley, 2006; Hansen, 1999; Roberts, 2006; Uzzi, 1999). Warkentin et al. (1997) found that the strength of relational links is positively associated with the effectiveness of information exchange.

The ethnographic study of Uzzi (1997) revealed that strong ties develop relationship specific heuristics that ease the transfer of knowledge. Similarly, Hansen's (1999) study of product development teams indicated that strong ties are conducive to the transfer of complex knowledge, while weak ties aid in the search for new knowledge.

In a society where there are few weak ties: 'new ideas will spread slowly, scientific endeavours will be handicapped, and subgroups separated by race, ethnicity, geography, or other characteristics will have difficulty reaching a *modus Vivendi* (Granovetter 1983,:202). This happens also in R&D settings, P&G' 'Connect and Develop' strategy showed that exploiting researchers' weak ties produced positive pitfalls in enterprises' innovativeness and productivity. Exploiting knowledge and ideas present across these weak ties 'more than 35% of P&G new products are originated from outside…; 45% of P&G initiatives in product development portfolio have key elements that were discovered externally…and the productivity has increased by nearly 60%' (Huston, Sakkab, 2006: 61). P&G launched more than 100 new products for which some aspect of development came from outside the company.

Knowledge creation and sharing within organizations is fundamental for increasing productivity and managers have to promote them (Kogut and Zander 1992).

One theme emerging out of knowledge management research is the increasing importance of the informal networks of relationship across functions and divisions to accomplish their work. Many managers failed to successfully comprehend, support and ultimately exploit the informal exchange of knowledge assets within their organizations (Krackhardt and Hanson, 1993; Hansen et al., 1999; Cross and Parker, 2004; Anklam, 2005; Bryan and Joyce, 2005).

These studies highlight a crucial distinction between the formal organizational structures by which companies attempt to manage and direct the transfer of knowledge and the complex informal social networks through which it flows in practice (Cross and Parker, 2004; Allen et al. 2007: 179).

The distinction between formal and informal organization is an old concept; in 60s Burns and Stalker (1961) distinguished the 'formal structure' of the organization, that was considered as a set of well-defined management systems and structures; from the 'informal structure' or 'private organization', that was (the processes by which individuals communicate on issues not directly laid down and governed by management. According to Chandler (1962) networks were the essential structures upon which both formal and informal communication and knowledge transfer were based.

Informal social networks, or emergent networks, are unsanctioned and ungoverned organic structures connecting a potentially unbounded group of individuals (Mintzberg, 1973; Tichy, 1981). They include the working relationships, collaborations and exchanges of knowledge between individuals which are not found in organizational structures, but are the result of the personal initiative of employees (Cross and Parker, 2004).

The formal organization is conceptualized as the skeleton of a company; the informal is the central nervous system driving the collective thought, processes, actions, and reactions of its business units (Krackhardt and Hanson, 1993:104).

Personal communications and interactions within a firm and across its boundaries aimed at transferring knowledge and information constitute the informal social networks within R&D, marketing and other business units (Cross et al., 2002a; Allen et al. 2007).

These communications often cross firms, regional and national's boundaries by improving firm's productivity and innovativeness (Cross and Parker, 2004). Then, a new competitive goal for managers is to learn and understand the central nervous systems of organization and its functioning.

In his study, Allen et al. (2007) using social network analysis found that significantly, the informal problem-solving network within ICI's R&D function was found to differ significantly from the formal structures put in place by the company to manage knowledge transfer. Instead, this study found that technical personnel appear to collaborate most closely with those people in close organizational and geographical proximity to them, rather than with colleagues located in other businesses or regions. It is considered likely that such structures might be more effective and productive if their membership were instead advised by social network analysis studies.

Such an approach would potentially reveal more fruitful collaborative relationships and areas where Group wide collaborations may be nurtured and extended.

If the true extent and membership of an informal network is understood, then it may be supported and nurtured to increase the wider effectiveness and innovatory capacity of the firm (Cross and Parker, 2004).

By the investigation of informal networks it is possible to identify critical personnel who may otherwise go unrecognized. This includes both technology gatekeepers and boundary-spanning individuals, but may also include staff who may be acting as bottlenecks to knowledge transfer (Anklam, 2005).

Singh (2005) studied the role of interpersonal networks in determining knowledge diffusion patterns; he used collaboration information for patents registered with the United States Patent and Trademark Office (USPTO) to construct a rich longitudinal database of interpersonal relations among all inventors recorded by USPTO since 1975.

Moreover, direct relationships fosters induce more trust, improving willingness of individuals to share knowledge (Tsai and Ghoshal 1998, Levin and Cross 2004). The transmission of complex technical knowledge increased by increasing the distance of the two individuals involved in the process. He says that geography matters for knowledge diffusion, at least in part because interpersonal networks tend to be regional in nature. Furthermore, a firm could learn more from its environment by encouraging its employees to build collaborative links across regions or clusters.

The success of alliances and joint ventures as a means for knowledge transfer also depends on fostering close interpersonal ties between employees from the two sides, an argument consistent with findings of Mowery et al. (1996), Rosenkopf and Almeida (2003), and Gomes-Casseres et al. (2005). Tsai (2002) investigates the effectiveness of coordination mechanisms on knowledge sharing in intra-organizational networks in various parts of the organization. It is argued that social interaction allows individual units to accumulate social capital that can help them gain access to new knowledge or new information and that the flows of information or knowledge through inter-unit networks require social interaction to promote trust. The findings indicate that formal hierarchical structure, in the form of centralization, has a significant negative effect on knowledge sharing. In contrast, informal lateral relations, in the form of social interaction, have a significant positive effect on knowledge sharing. Similarly, Hansen (2002) used survey data collected from business units of a multi-unit electronics company and found *centrality* to be a key determinant of knowledge transfer difficulty, particularly when the knowledge in question was tacit.

7.14.1 Developing and recognizing Communities of practice

Communities of practice (CoP) represent a particular organization model enabling knowledge sharing and creation.

This new model originates from social constructivist approaches to learning (see chapter 4.5.1, p.64) and it consists of a group of workers that share information, insight, experience, and tools about an area of common interest (Wenger, 1998). CoPs are:

> *"... a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping Communities of Practice." (Lave & Wenger, 1991, p98)*

Communities of practice focus on group learning within functions or disciplines, sharing information and insight, collaborating on common problems, stimulating new ideas (Wenger, 1998; McDermott, 1998).

> *"You are an engineer working on two projects within your business unit. These are demanding projects and you give them your best. You respect your teammates and are accountable to your project managers. But when you face a problem that stretches your knowledge, you turn to people like Jake, Sylvia, and Robert. Even though they work on their own projects in other business units, they are your real colleagues. You all go back many years. They understand the issues you face and will explore new ideas with you. And even Julie, who now works for one of your suppliers, is only a phone call away. These are the people with whom you can discuss the latest developments in the field and troubleshoot each other's most difficult design challenges. If only you had more time for these kinds of interactions."* (Wenger, *Systems Thinker*, June 1998)

Or again:

> *"Communities of practice are everywhere. We all belong to a number of them–at work, at school, at home, in our hobbies. Some have a name, some don't. We are core members of some and we belong to others more peripherally (Wenger, Systems Thinker, June 1998)."*

During problem solving, communities' members reciprocally help each other, give advice, and develop new methodologies for their area of investigation.

Apparently, Communities of practice could be confused with informal network or formal group work. In order to overcome this confusion Wenger and Snyder (2000) have described the characteristics that distinguish each type of group that share knowledge.

	What's the purpose?	Who belongs?	What holds it together?	How long does it last?
Community of practice	To develop members' capabilities; to build and exchange knowledge	Members who select themselves	Passion, commitment, and identification with the group's expertise	As long as there is an interest in maintaining the group
Formal work group	To deliver a product or service	Everyone who reports to the group's manager	Job requirements and common goals	Until the next reorganization
Project team	To accomplish a task	Employees assigned by senior management	The project's milestones and goals	Until the project has been completed
Informal network	To collect and pass on business information	Friends and business acquaintances	Mutual needs	As long as people have a reason to connect

Figure 17. Characteristics of Communities of Practice, formal Work groups, teams, and informal networks. Source: Wenger E.C., Snyder W.M., 2000.

Research on CoPs documented how workers with similar working or research interests often group together within an organization (either physically, or increasingly in the case of widely distributed firms, by making use of information technologies) to collaborate and share information and experiences (Wenger, 1998; Hildreth et al., 2000; Orlikowski, 2002; Allen et al. 2007)

The main characteristics of these communities are the informality and spontaneity of its creation and belonging; in fact there is no management or formal contracts between the members. They share their time and efforts mainly for learning and increasing the knowledge on their domain, with the result of improving their work applications.

Communities can be known and 'instituzionalized' by the formal organization (explicit) or on the contrary be tacit, it is existing but it not known by the organization. Between these stages there are two intermediary stages, which are: segmented and implicit community.

Explicit	**Segmented**	**Implicit**	**Tacit**
The CoP exists and it is known by the formal organization	The CoP is not acted but it is identified by the organization on the basis of specific indicators (or areas of expertise)	The CoP is not acted but it could be if there'd be the relational and interpersonal communication conditions.	The CoP exists but the formal organization doesn't know about it.

Figure 18. Stages of a CoPs

The transition from one stage to another is possible but it implies the verification of certain conditions:

From tacit to explicit: through formalization processes such as the social network analysis;

From implicit to tacit: through systems of communication enabling continuous interactions and the development of relationships;
From implicit to explicit: through processes of codification (storytelling, workshop…) enabling the emergence of the value of the Community and their recognition by the whole organization.
From segmented to explicit: it depends from the segnmentation criteria used.

Benefits of CoPs are different; Wenger (2002) found that knowledge of other's knowledge can be facilitated through Communities of Practice (Brown and Duguid, 1991, Collinson and Gregson, 2003, Lesser et al., 2000, Liyanage et al., 1999, Powell, 1998, Seufert et al., 1999, Swan et al., 1999, Wenger et al., 2002).
A CoP is a social group composed by employees that is charged of searching and organizing the tacit knowledge produced within and across the firm in order to not lose it and everyone can have again access to it.
Communities of practice mitigate the isolation of cross-functional teams, and provide information and insight on tools, analyses, and approaches current in the discipline.
The community coordinators typically know who is working on what and who is expert in each topic area. Managers at leading companies—such as IBM, Accenture, Procter & Gamble, Hewlett-Packard, Xerox, and BP—are increasingly supporting these lateral networks and deriving substantial organizational performance and innovation benefits (Wenger and Snyder, 2000).
Cross et al. (2006) show an other evidence of the benefits of a CoP in multinational firms like Halliburton:
'Consider Halliburton, one of the world's largest providers of products and services to the petroleum and energy industries. An industry leader in the knowledge management realm, Halliburton has regularly employed SNA in many of its efforts to systematically build 19 communities of practice across a variety of business disciplines and technical services. Halliburton did not implement these communities in an ad hoc fashion: senior management demanded more than loosely defined or difficult to measure objectives such as "improved collaboration" or "better knowledge sharing." Rather, the community initiatives had to show measurable results directly linked to financial performance. By applying targeted interventions based on SNA assessments, Halliburton has been able to do just that across a number of communities. As an example, a global community of practice within a critical business unit produced the following measurable results in one year:
▪ lowered customer dissatisfaction by 24 percent,
▪ reduced cost of poor quality by 66 percent,
▪ increased new product revenue by 22 percent, and
▪ improved operational productivity by 10 percent.'

Communities of practice can be also composed of members belonging to other business units or firms. Inter-Units CoPs are generally created between departments of the EE:

- Helping Communities (Wenger. McDermott, and Snyder, 2000): for example, Schlumberger's technical communities, composed of scientists and engineers, post requests for help or ideas on a customized, threaded discussion.
- Cross-Functional communities for learning (McDermott, 1998): for example, Shell's deepwater division, in order to share learning, has hold regular informal meetings among learning community members.
- Innovative communities of practice (Creation & Brainstorming): for example, Unilever international manufacturer of leading brands in foods, home care and personal care.

The inter-organizational communities of practice play also an important role in the interaction between the EE and its strategic actors of the network. The interdependence occurring between the EE and its partners have pushed multinationals in creating inter-organizational communities of practice for improving collaboration, sharing of knowledge, and innovation. In fact, for innovation, there must be exchange of ideas and insights through trusted relationships, which depend on knowing the persons with whom collaborate effectively.

The inter-organizational communities of practice are therefore used for both exploitation and exploration purposes. According to the organizational level of the EE model, the CoPs are different and have different functions according to the relationship needed among the EE and its partners. Following are some examples communities of practice that are created to support collaboration and innovation in the EE.

CoPs (Wenger, 2002; McDermott and Snyder, 2000) focus also on developing, validating, and disseminating best practices. For example, Ford Motor Company's best-practice replication (BPR) process includes a structure for operators and engineers to describe a new practice and its value then distribute and seriously review them in each of Ford's 150 manufacturing plants worldwide.

The Knowledge-Stewarding Communities (Wenger, 2002; McDermott, and Snyder, 2000) which main intent is to organize, upgrade, and distribute the knowledge that their members use every day. For example, Cap Gemini Ernst & Young estimates that they have 1.2 million documents in their general, unfiltered repositories; 875,000 documents in their discussion databases; and 50,000 documents in comprehensive packs of materials on specific topics. The primary focus of their 150 communities is to find, organize, and distribute this information throughout the organization.

Inter-firm CoP are also aimed at increasing innovation rate. For example, Chrysler connects 240 world experts from many different parts to encourage engineers to be innovative and provides a channel for their ideas to be realized in new or improved products.

A CoP can be created also for solving problems and share ideas. The intent of helping communities is to make peer-to-peer connections among colleagues. For example, IBM's system consultants develop proposals on large systems for clients around the world. IBM developed a website that contains an edited and organized proposal developed by other consultants.

Company	Community name	Community role	Role in the enterprise
DaimlerChrysler	The Tech Clubs	Innovation communities of Practice	Connects world experts to encourage engineers to be innovative and provides a channel for their ideas to be realized in new or improved products.
Shell	Deepwater Division	Cross-Functional communities/ Learning Communities	Share learning
Apple	Apple Digital Campus Exchange	Collaboration and communities of practice	Offers a resource center open to faculty, academic leaders, and other education professionals in higher education institutions.
World Bank	The Knowledge Bank's Thematic Groups	Inter-governmental communities	For collaboration and learning within a network of other bodies dedicated to development.
Ford Motor	best-practice replication (BPR)	The best-practice communities	Focus on developing, validating, and disseminating specific practices.
Ernst & Young		Knowledge-Stewarding Communities	To organize, upgrade, and distribute the knowledge that members use every day.
Schlumberger/ IBM/ Toyota		Helping Communities	Schlumberger: Post requests for help or ideas on a customized, threaded discussion. IBM: to make peer-to-peer connections among colleagues. Toyota: helping people to improve the quality of life in their communities.
Unilever		Innovative communities of practice (Creation & Brainstorming)	Innovative manufacturer in foods, home care and personal care
Intel	Enterprise Server Acceleration Alliance	Aggregation communities	To collaborate with complete confidence to provide reliable solutions.

Table 6. Evidence of the role of CoP in Multinational Organization

By identifying the potential employees that can compose a community of practice it is important to analyse the knowledge sharing network of the business units involved in the process.
Social network analysis (SNA) has been demonstrated of being a valid tool in recognizing communities of practice (Cross et al., 2006). SNA enables to uncover the key members of the community as well as assess overall wealth in terms of connectivity. This technique is useful in determining the most central people within a unit or a group and by identifying the ego-centric network of every worker.
This information will result interesting also for mapping the actual network of relationship present within and across the platforms. For this purpose, the selection of the employees belonging to the two

different business units considered in the present analysis is particularly well-suited for those actors more frequently involved in the processes of knowledge sharing.

7.15 Knowledge codification

Ruggles (1997) and Davenport and Prusak (1998) view codification as the primary vehicle by which knowledge becomes 'portable', 're-usable' or 'transferable' within the organisation. Knowledge that has not been codified is more difficult to transfer than codified knowledge (Zander and Kogut 1995)

7.16 Individual commitment

In their study, Van der Bej et al. (2003) identified 17 potential facilitators of the knowledge dissemination in new product development. Results indicated that individual commitment to the firm is very important to facilitate knowledge dissemination as well as organizational crises and risk-taking behavior. Individual commitment was found to have the greatest impact on the level of knowledge dissemination, followed by organizational crisis and risk-taking behavior.

7.17 Hierarchy

Hierarchy is argued to be beneficial on the one hand because it avoids knowledge transfer by exercising authority and directing the actions of others (Conner and Prahalad 1996, Demsetz 1988), and on the other hand because it facilitates knowledge transfer through established communication codes, shared languages, and routines (Grant 1996; Kogut and Zander 1992, 1996; Monteverde 1995).

7.18 Culture of the company

Davenport and Prusak (1998) identify other inhibitors to knowledge sharing related to the culture of the company such as intolerance for mistakes or need for help, lack of time and meeting places. These inhibitors can be solved through accept and reward creative errors and collaboration and avoid the loss of status of people that don't know everything.

8. Measuring knowledge sharing effectiveness

8.1 Best practice transfer

'One of the most prevalent and effective practical manifestations of organizational learning is the so-called transfer of knowledge and best practices within the firm' (O'Dell, Grayson, & Essaides, 1998: 224). Upon discovering differences in the performance of similar units, firms multiply attempts to leverage existing knowledge through transfers of best practice.

Transfers of best practice are seen as dyadic exchanges of organizational knowledge between a source and a recipient unit in which the characteristics of the source and the recipient both matter.

The expression transfer of best practice inside the firm connotes the replication of a superior internal practice within the organization that provides better results than any known alternatives. Practice refers to the organization's routine use of knowledge. The word "transfer" is used—instead of "diffusion"—to emphasize that the movement of knowledge within the organization is a distinct experience, not a gradual process of dissemination. The transfer of best practices provides a propitious setting to observe transfers of knowledge within organizations.' (Szulanski, 2000:16-17)

Bibliography

Alavi, M. and Leidner, D., (1999) "Knowledge Management Systems: A Descriptive Study of Key Issues, Challenges, and Benefits," *Communications of the AIS*. February, 1999.

Alavi, M., D. E. Leidner. 2001. Review: Knowledge management and knowledge management systems: Conceptual foundations and research issues. *MIS Quarterly* 25(1) 105–136.

Allen, T. J., Cohen, S. I.: "Information Flow in Research and Development Laboratories"; Administrative Science Quarterly, 14, 1 (1969), 12-19.

Allen, T. J.: "Managing the Flow of Technology. Technology Transfer and the Dissemination of Technological Information within the R&D Organization", MIT Press, Cambridge/MA (1977).

Allen, T.J. (1984) Managing the Flow of Technology: Technology Transfer and the Dissemination of Technological Information within the R&D Organisation. Cambridge: The MIT Press.

Allen, T.J., Lee, D.M.S., and Tushman, M.L. (1980) R&D Performance as a Function of Internal Communication, Project Management, and the Nature of the Work. *IEEE Transactions on Engineering Management*, Vol. EM-27, No 1, February.

Allen J., James A.D., and Gamlen P. (2007). Formal versus informal knowledge networks in R&D: a case study using social network analysis. *R&D Management* 37, 3, 2007.

Amabile, T. M. 1996. Creativity in Context. Westview, Boulder, CO.

Anklam, P., (2005) "The Social Network Toolkit: Building Organisational Performance through Collaborative Communities", Ark Group 2005

Argote L., McEvily B., Reagans R., (2003). "Managing Knowledge in Organizations: An Integrative Framework and Review of Emerging Themes", *Management Science*, 2003, Volume 49, Issue 4

Argote, L., P. Ingram (2000) "Knowledge transfer: A basis for competitive advantage in firms". *Organ. Behavior Human Decision Processes* 82(1) 150–169.

Badaracco, J.L. (1991) The Knowledge Link. Boston, MA: Harvard Business School Press.

Berends H., van der Bij H., Debackere K. and Mathieu Weggeman (2006). "Knowledge sharing mechanisms in industrial research", *R&D Management* 36, 1, 2006.

Biemans, W. G. (1992) Managing Innovation Within Networks, Routledge, London, New York.

Blackler, F. (1995) "Knowledge, knowledge work and organizations: An overview and interpretation". *Organization Studies* 16(6) 1021–1046.

Borgatti, S. & Cross, R. (2003). "A Social Network View of Organizational Learning: Relational and Structural Dimensions of 'Know Who'". *Management Science*, 49 pp. 432-445.

Brown, J. S., & Duguid, P.(1991) "Organizational learning and communities-of-practice: Toward a unified view of working, learning, and innovation." *Organization Science*, 2: 40-57.

Burt, R.S., (1987). "Social contagion and innovation: cohesion versus structural equivalence". *American Journal of Sociology* 92, 1287–1335.

Cohen, W. M. and D. A. Levinthal (1990). "Absorptive capacity: A new perspective on learning and innovation", *Administrative Science Quarterly*, 35, pp. 128-152

Coleman, J. S. (1988) "Social capital in the creation of human capital." *American Journal of Sociology,* 94 (Suppl.) S95–S120.

Collinson, S.C. and Gregson, G. (2003) "Knowledge Networks for New Technology-based firms: An International Comparison of Local Entrepreneurship Promotion", *R&D Management*, Vol.33, No.2, pp.189-209

Cradwell, D. (1995) The Norton history of technology. London: Norton.

Cross, R., Laseter, T., Parker, A. & Velasquez, G. (2006). "Using Social Network Analysis to Improve Communities of Practice". *California Management Review* 49(1) pp. 32-60.

Cross, R., Borgatti, S. & Parker, A. (2002). "Making Invisible Work Visible: Using Social Network Analysis to Support Human Networks". *California Management Review* 44(2), pp. 25-46.

Cross, R., Parker, A., Prusak, L & Borgatti, S. (2001). "Knowing What We Know: Supporting Knowledge Creation and Sharing in Social Networks." *Organizational Dynamics* 3(2), pp. 100-120.

Cummings, J. & Cross, R. (2003). Structural Properties of Work Groups and their Consequences for Performance. *Social Networks* 25(3), pp. 197-210.

Daft, R. L. and R. H. Lengel (1986). "Organizational information requirements, media richness, and structural design", *Management Science* , 32, pp. 554-571

Davenport, T. H., Prusak, L. (1998), Working knowledge: How organizations manage what they know. Massachusetts, Boston: Harvard Business School Press

D'Aveni, R. A. 1995. Hypercompetition: Managing the dynamics of strategic manoeuvring. New York: Free Press. 696

De Meyer A., "Tech talk: How managers are stimulating global R&D communication," *Sloan Management Review*: Spring, 1991, pp. 49–58.

Dierickx I, Cool K. (1989). Asset stock accumulation and sustainable competitive advantage. *Management Science* 35: 1504–1511

Dougherty, D. (1992). Interpretive barriers to successful product innovation in large firms. *Organ. Sci*. 3 179–202.

Dyer H. and Nobeoka K., (2000). "Creating and Managing a High-Performance Knowledge-Sharing Network: The Toyota Case". *Strategic Management Journal*, 21, 345:367.

Eisenhardt, K. M. (1989) "Building theories from case study research". *Acad. Management Rev*. 14(4) 532–550.

Gabbay, S. M., Zuckerman, E. W.: "Social Capital and Opportunity in Corporate R&D: The Contingent Effect of Contact Density on Mobility Expectations", *Social Science Research*, 27, 2 (1998), 189-217.

Galbraith, J.R. (1973) Designing Complex Organizations. Reading, MA: Addison-Wesley.

Garcia-Muina F.E., Pelechano-Barahona E., Navas-Lopes J.E., Knowledge Codification and Technological Innovation Success: Empirical Evidence from Spanish Biotech Companies. *PICMET 2007 Proceedings*, 5-9 August, Portland, Oregon - USA

George,G., Zahrab S. A., Wheatleyc K. K., Khan R., (2001). The effects of alliance portfolio characteristics and absorptive capacity on performance. A study of biotechnology firms. *Journal of High Technology*
Management Research 12 (2001) 205–226

Ghoshal, S. and C. A. Bartlett (1990). "The multinational corporation as an interorganizational network", *Academy of Management Review*, 15, pp. 603-625.

Grey P.H., Meister D.B., Knowledge Sourcing Effectiveness, *Management Science*, Vol. 50, No. 6, June 2004, pp. 821–834

Griffin A., Hauser J., Integrating R&D and Marketing: A review and analysis of the literature, *Journal of Product Innovation Management*, 1996, 13:191-215.

Gummesson, E. (1998). "Implementation Requires a Relationship Marketing Paradigm", *Journal of the Academy of Marketing Science*, Vol. 26, No. 3, July.

Gummesson, E., (2000). "Internal Marketing in the Light of Relationship Marketing and Network Organizations", in Lewis, Barbara and Varey, Richard (eds.), Internal Marketing. London: Routledge

Gupta, A. K. and V. Govindarajan (1991). "Knowledge flows and the structure of control within multinational corporations", *Academy of Management Review*, 16(4), pp. 768-792.

Hansen, M. 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Admin. Sci. Quart*. 44 82–111.

Hargadon, A. and Sutton, R.I. (1997) "Technology brokering and innovation in a product development firm". *Administrative Science Quarterly*, 42, 4, 716–749.

Hedlund, G. (1994), "A model of knowledge management and the n-form corporation", *Strategic Management Journal*, Vol. 15 pp.73-90.

Henderson, R. M., & Clark, K. B. 1990. Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms. Administrative Science Quarterly, 35: 9-30.

Hoopes, D.G. and Postrel, S. (1999) Shared knowledge, "glitches" and product development performance.
Strategic Management Journal, 20, 9, 837–865.

Ibarra, H., 1993. Network centrality, power, and innovation involvement: determinants of technical and administrative roles. *The Academy of Management Journal* 36 (3), 471–501.

Katz, R. and Allen, T.J. (2004a) How project performance is influenced by the locus of power in the R&D matrix. In Katz, R. (ed.), The Human Side of Managing Technological Innovation. Oxford: Oxford
University Press, pp. 198–214.

Katz, R. and Allen, T.J. (2004b) Managing dual Ladder systems in RD&E settings. In Katz, R. (ed.), The Human Side of Managing Technological Innovation. Oxford: Oxford University Press.

Katz, R. and Allen, T.J. (2004c) Organizational issues in the introduction of new technologies. In Katz, R. (ed.), The Human Side of Managing Technological Innovation. Oxford: Oxford University Press, pp. 450–477.

Katz, R. and Tushman, M.L. (1979) Communication patterns, project performance, and task characteristics: an empirical evaluation and integration in an R&D setting. *Organizational Behavior and Human Performance*, 23, 139–162.

Katz, R. and T. J. Allen (1982). Investigating the Not Invented Here (NIH) syndrome: A look at the performance, tenure and communication patterns of 50 R&D project groups, *R&D Management*, 12, 7-19

Kotabe, M., Martin, X., Domoto, H., (2003). Gaining from vertical partnerships: knowledge transfer, relationship duration, and supplier performance improvement in the U.S. and Japanese automotive Industries. *Strategic Management Journal* 24 (4), 293–316.

Jarvenpaa, S. and Leidner, D., "Communication and Trust in Global Virtual Teams," *Organization Science*, Winter, 1999, pp. 791-815.

Johnson-Cramer, M., Parise, S. & Cross, R. (2007). Managing Change Through Networks and Values: How a Relational View of Culture Can Facilitate Large Scale Change. California Management Review 49(3) pp. 85-109.

Lane, P. J., & Lubatkin, M. (1998). Relative absorptive capacity and interorganizational learning. *StrategicManagement Journal*, 19, 461–477.

Lapré, M. A., L. N. Van Wassenhove (2001). Creating and transferring knowledge for productivity improvement in factories. *Management Science* 47(10) 1311–1325.

Leenders M.A.A.M., Wierenga, B., The effectiveness of different mechanisms for integrating marketing and R&D, The Journal of Product Innovation Management, 19 (2002), 305-317

Leonard, D. (1999), *Wellsprings of Knowledge – Building and Sustaining the Sources of Innovation*, Harvard Business School Press, Boston, MA.

Leonard, D., S. Sensiper. 1998. The role of tacit knowledge in group innovation. *California Management Rev.* 40(3) 112–131.

Leonard-Barton & Deschamps, (1988). Managerial influence in the implementation of new technology. Vol. 34, Issue 10 (October 1988) Pages: 1252-1265

Lesser, E. L., Slusher, J., Fontaine, M.: "Knowledge and Communities", Butterworth-Heinemann, Boston (2000).

Levin, D., R. Cross (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science* 50 1477–1490.

Liebowitz, J. (2000), Building Organizational Intelligence: A Knowledge Management Primer, CRC Press, Boca Raton, FL

Lipnack J., and Stamps J., "Virtual teams. Reaching across space, time and organizations with technology". John Wiley and Sons 1997

Liyanage, S., Greenfied, P. F., Don, R.: "Towards a fourth generation R&D management model - research networks in knowledge management"; *International Journal of Technology Management*, 18, 3/4 (1999), 372-394.

Louis, M.R., 1980. Surprise and sense making: what newcomers experience in enterprising unfamiliar organizational settings. *Administrative Science Quarterly* 25, 226–248.

Luhmann, Niklas (1989), Ecological Communication. The University of Chicago Press

Macintosh A., Ian Filby, John Kingston. "Knowledge management techniques: teaching and dissemination concepts". *International Journal of Human-Computer Studies* 51(3): 549-566 (1999)

Majchrzak A., Cooper L.P., Neece O.E., "Knowledge Reuse for Innovation", *Management Science*, Vol. 50, No. 2, February 2004, pp. 174–188

Marsden, P. 1988. Homogeneity in confiding relations. *Social Networks*, 10: 57-76

Matusik, S.F., Hill W.L. (1998), The Utilization of Contingent Work, Knowledge Creation, and Competitive Advantage, *The Academy of Management Review*, Vol. 23, No. 4 (Oct., 1998), pp. 680-697

Mayer, R. C., Davis, J. H., & Schoorman, F. D. 1995. An integration model of organizational trust. *Academy of Management Review*, 20: 709-734.

Mead, G. H. (1934). Mind, Self, and Society: From the Standpoint of a Social Behaviorist. Chicago, IL: University of Chicago Press

Merton, R.K., (1949), Social Theory and Social Structure, Glencoe, Illinois, The Free press

Menon T., Pfeffer J., Valuing Internal vs. External Knowledge: Explaining the Preference for Outsiders. *Management Science* Vol. 49, No. 4, April 2003, pp. 497–513

Moenaert, Rudy K.and Lievens A., "Communication flows during financial service innovation."*European*
Journal of Marketing 34.9/10 (2000): 1078-1110

Moenaert, Rudy K. and Van den Bulte C. "The effects of R&D team co-location on communication pattern among R&D, marketing, and manufacturing." *Management Science* 44.11 (part 2) (1998): 1-18

Moenaert R.K., Caeldries F., Lievens A., Wauters E. **"**Communication flows in International product development teams", *Journal of Product Innovation management* 17; 360-377, 2000

Moenaert, R. K., & Souder, W. E. 1990. An information transfer model for integrating marketing and R&D personnel in new product development projects. *Journal of Product Innovation Management*, 7(2): 91-107.

Mosakowski, E. 1997. Strategy making under causal ambiguity: Conceptual issues and empirical evidence. *Organization Science*, 8(4): 414-442.

Mowery, D., and Oxley, J. 1996. Strategic alliances and interfirm knowledge transfer. *Strategic Management Journal*, 17: 77-92.

Nahapiet, J., Ghoshal, S., 1998. Social capital, intellectual capital and the organizational advantage. *Academy of Management Review* 23, 242–266.

Nadler, D. A. and M. L. Tushman (1987). Strategic Organization Design. Scott, Foresman, New York.

Nishiguchi, T., 1994. Strategic Industrial Sourcing: The Japanese Advantage. Oxford University Press, Oxford, UK.

Nobel R. and Birkinshaw J., “In multinational corporations: control and communication patterns in international R&D operations”, *Strategic Management Journal,* Vol. 19, 479–496 (1998)

Osterloh, M., B. S. Frey. 2000. Motivation, knowledge transfer, and organizational forms. *Organization Science* 11(5) 538–550.

Penley, L. E, & Hawkins, B. 1985. Studying interpersonal communication in organizations: A leadership application. *Academy of Management Journal*, 28: 309-326.

Pfeffer, J. 1994. Competitive advantage through people. Boston: Harvard Business School Press.

Powell, W. W.: “Learning From Collaboration: Knowledge and Networks in the Biotechnology and Pharmaceutical Industries”, *California Management Review*, 40, 3 (1998), 228-240.

Powell, W. W., Koput, K. W., & Smith-Doerr, L. (1996). Interorganizational collaboration and the locus of innovation: networks of learning in biotechnology. *Administrative Science Quarterly*, 41, 116–145.

Quigley E.J. and Debons A. (1999). Interrogative theory of information and knowledge. *Proceedings of the 1999 ACM SIGCPR Conference on Computer Personnel Research,* ACM Special Interest Group on Computer Personnel Research, New York, Usa.

Reagans R. and Bill McEvily (2003). Network Structure and Knowledge Transfer: The Effects of Cohesion and Range, *Administrative Science Quarterly*, Vol. 48, No. 2, (Jun., 2003), pp. 240-267

Reed, R. and Defillippi, R. J. 1990. Causal ambiguity, barriers to imitation, and sustainable competitive advantage. *Academy of Management Review*, 15 (1): 88-102.

Rogers, E., M., Shoemaker F.F., Communication of Innovation: A Cross-Cultural Approach, New York, The Free Press, 1971

Rosenkopf L., Almeida, P., Overcoming Local Search Through Alliances and Mobility. *Management Science* Vol. 49, No. 6, June 2003, pp. 751–766

Ruggles, R.L., ed. (1997a). Knowledge management tools. London: Butterworth-Heinemann.

Savage, C.M. (1990) Fifth Generation Management: Co-creating Through Virtual Enterprising, Dynamic Teaching, and Knowledge Networking. Butterworth-Heinemann, Newton, MA.

Schramm W., (1973). Men, Messages and Media. New York, Harper and Row.

Senge, P.M. (1990) The Fifth Discipline. Doubleday Currency, New York.

Seufert, A., Back, A., Krogh, G. von: “Towards a Reference Model for Knowledge Networking”, Working Paper, Research Center Knowledge Source, BE HSG/ IWI 3 Nr. 5/ IfB Nr. 34, University of St. Gallen (1999)

Simonin, B. (1999). Ambiguity and the process of knowledge transfer in strategic alliances. *Strategic Management Journal*, 20 (7), 595–624.

Singh J., (2005) Collaborative Networks as Determinants of Knowledge Diffusion Patterns, *Management Science* Vol. 51, No. 5, May 2005, pp. 756–770

Song, J., P. Almeida, G. Wu. 2001. Mobility of engineers and cross-border knowledge building: The technological catchingup case of Korean and Taiwanese semiconductor firms. H. Chesbrough, R. Burgelman, eds. Research in Technology and Innovation Management. JAI Press, New York.

Sosa M.E., Steven D. Eppinger, Michael Pich, David G. McKendrick, and Suzanne K. Stout "Factors That Influence Technical Communication in Distributed Product Development: An Empirical Study in the Telecommunications Industry", *IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT*, vol. 49, no. 1, February 2002

Spender, J. C. 1996. Making knowledge the basis of a dynamic theory of the firm. *Strategic Management Journal* 17 (Special Issue) 27–43.

Szulanski, G. (1996). "Exploring internal stickiness: Impediments to the transfer of best practice within the firm", *Strategic Management Journal*, Winter Special Issue, 17, pp. 27-44

Szulanski, G. 2000. The process of knowledge transfer: A diachronic analysis of stickiness. *Behavior Human Decision Processes* 82(1) 9–27.

Teece D.J., Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-How, *The Economic Journal*, Vol. 87, No. 346, (Jun., 1977), pp. 242-261

Thomas-Hunt, M. C., T. Y. Ogden, M. A. Neale. 2003. Who's really sharing? Effects of social and expert status on knowledge exchange within groups. *Management Science* 49(4) 464–477.

Thompson, J. 1967. Organizations in action. New York: McGraw Hill.

Tiwana, A. 2002. The Knowledge Management Toolkit. Prentice Hall, Upper Saddle River, NJ.

Tsai, W., S. Ghoshal (1998). Social capital and value creation: The role of intrafirm networks. *Academy of Management Journal* 41: 464–476.

Tsai, W. 2001. Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *Academy of Management Journal* 44(5) 996-1004.

Tsoukas, H. (1996). The firm as a distributed knowledge system. *Strategic Management Journal*, 17, Winter Special Issue, 11–25.

Tuomi, 2002. Networks of Innovation. Oxford University Press

Tushman, M. L. (1977). "Communications across organizational boundaries: Special boundary roles in the innovation process", *Administrative Science Quarterly*, 22, pp. 587-605

Ulrich K. T. and S. D. Eppinger, Product Design and Development. New York: McGraw-Hill, 2000.

Uzzi, B. (1996). "The sources and consequences of embeddedness for the economic performance of organizations: The network effect." *American Sociological Review*, 61(4): 674-699.

Uzzi, B., R. Lancaster (2003). "Relational embeddedness and learning: The case of bank loan managers and their clients". *Management Science* 49, 383–399.

Valente (1995). Network models of the diffusion of innovations. Hampton Press

Van den Bosch, F., Volberda, H. W. and de Boer, M. (1991)."Coevolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities". *Organization Science*, 10(5): 551-568

Van der Bij H., X. Michael Song, and Mathieu Weggeman (2003) An Empirical Investigation into the Antecedents of Knowledge Dissemination at the Strategic Business Unit Level, *Journal of Product Innovation Management* 2003;20:163–179

Waldrop, M.M., "Complexity at the Edge of Order and Chaos," Touchstone Books, New York 1992

Walker, Kogut & Shan (1997). Social Capital, Structural Holes and the Formation of an Industry Network. *Organization Science*, 8(2):109-125.

Watzlawick, P., Beavin, J. H., Jackson D.D. (1967). Pragmatics of human communication. A study of interactional patterns, pathologies, and paradoxes, W.W. Norton e Co., Inc., N.Y.

Wellman, B., Berkowitz, S. D.: "Social Structures", Cambridge University Press, Cambridge/MA (1988).

Wenger, E., and Snyder, W. M. (2000). Communities of Practice: An Organizational Frontier, *Harvard Business Review*, January-February.

Wenger, E., McDermott, R., Snyder, W. M.. "Cultivating Communities of Practice. A Guide to Managing Knowledge", Harvard Business School Press, Boston/MA (2002)

Wheelwright S. C. and K. B. Clark. Revolutionizing Product Development. Quantum Leaps in Speed, Efficiency, and Quality. New York: Free Press, 1992.

Wiig, K. (1993), Knowledge Management Foundations: Thinking about Thinking – How People and Organizations Create, Represent and Use Knowledge, Schema Press, Arlington, TX.

Workman, John P. Jr., Homburg C., and Jensen O., "Intra-organizational Determinants of Key Account Management Effectiveness", *Journal of the Academy of Marketing Science*, Vol. 31, No. 1, 3-21 (2003)

Zaheer, A., McEvily, B., and Perrone, V. (1998). Exploring the effects of interorganizational and interpersonal trust on performance. *Organization Science*, 9: 141-159.

Kogut, B. e U., Zander, (199). "Knowledge of the firm, combinative capabilities, and the replication of technology". *Organization Science*, 3, 383-397.

Zakaria, N., Amelinckx, A., Wilemon, D., "Working Together Apart? Building a Knowledge-Sharing Culture for Global Virtual Teams", *Creativity and Innovation Management*, Volume 13 Issue 1 Page 15 - March 2004

Zander, U., B. Kogut (1995). Knowledge and the speed of the transfer and imitation of organizational capabilities: An empirical test. *Organization Science* (1) 76–92.

Zucker, L. G., M. R. Darby, M. B. Brewer. (1998). "Intellectual human capital and the birth of U.S. biotechnology enterprises". *American Economics Review*, 88(1) 290–306.

3rd part

Methodology and Research

9. Methodology

9.1 Ontology of the study

In the present study we are going to adopted different techniques of analysis, quantitative (multivariate data analysis), qualitative (interviews with top manager, case study) and mixed (social netowork analysis).

The constructs and variables in the analysis were identified through the analysis of the multidisciplinary literature on knowledge management and specifically on knowledge sharing. Moreover, informal field in-depth interviews helped us in reducing the number of factors to take into account.

Questionnaire, statistics (mean, mode, median, standard deviation, and variance) and multivariate data analysis (factor analysis and multiple regression analysis) belong to the quantitative techniques of analysis and were employed in order to understand which dimensions and variables among the three considered for the present analysis (such as organizational, technological and social) were strong predictors of knowledge sharing effectiveness.

One of the barriers to knowledge sharing was related to the effectiveness of the historical knowledge retrieval and reuse. Hence, we decided to analyze, through case study, a process that clearly emphasezed the impact of this problematic on product development performance.

Finally, in order to solve this problem we advise Elasis on the possibility to create community of practice in order to collect all the information and knowledge present within the firm, to codify it according to a shared terminology, to make it easier to retrieve in knowledge management systems and to search and disseminate best practices. Thus, one of the functions of these informal groups is to identify tacit knowledge and archive it in a way that is easily retrievable and accessible.

For mapping the potential member sof a CoP, we adopted social network analysis, as it was found in literature as the most suited tool for indentifying informal communities and knowledge sharing networks (Cross et al., 2006).

Data for social network analysis were consistent with our goal of creating the knowledge sharing map of the company, which is also useful for locating barriers to knowledge sharing.

The incoherence from the ontological point of view is evident, as we have adopted both quantitative and qualitative methods that imply different approaches to problems and different views of the world.

However, it seemed that a statistical analysis whether accompanied by a qualitative research could deepen our knowledge on how knowledge flows within the two strategic business units considered in the present analysis and also for furnish a practical and viable solution to the same problems identified.

In fact, the present study is not only limited in identifying a problem or its weight in knowledge sharing process, rather it provides a viable and easy solution to such problems.

9.2 Case Study analysis

Case studies are used for many purposes, e.g. to provide a description, to test a theory or to generate a theory. Case studies can be exploratory, descriptive, explanatory or confirmatory, they can consist of one (single case study) or several cases (multiple-case study) and they can be based on qualitative or quantitative data collection. Usually, they combine several data collection methods. Actually, a major strength of the case study method is the opportunity to use many sources of evidence (data triangulation), and many data collection methods (methodological triangulation). Multiple sources of evidence and multiple methods provide a better validity for the findings. (Eisenhardt, 1989; Jick, 1979; Robson, 1997; Yin, 1994)

'We used purposeful sampling for choosing the cases, which means selecting information-rich cases for in-depth study (Patton, 2002). Information-rich cases are those from which we can learn a lot about the issues that are important to the purpose of our research. From that kind of cases we can get in-depth understanding of a phenomenon rather than empirical generalizations. Patton (2002) presents fifteen different strategies for purposefully selecting information-rich cases. Our sampling strategy is closest to a strategy that Patton calls "intensity sampling", which according to him means choosing cases that "manifest the phenomenon of interest intensely". In other words, it means searching for cases that are rich examples of the studied phenomenon, but are not extreme or highly unusual cases. This strategy was used for selecting our case study.

Multiple case study have not to be confused with sampling logic where a selection is made out of a population, as a matter of fact this type of sample selection is improper in a case study. Each individual case study consists of a "whole" study, in which facts are gathered from various sources and conclusions drawn on those facts. Yin (1993) presented Giddens' view that considered case methodology "microscopic" because it "lacked a sufficient number" of cases. Hamel (1993) and Yin (1984, 1993, 1994) forcefully argued that the relative size of the sample whether 2, 10, or 100 cases are used, does not transform a multiple case into a macroscopic study. The goal of the study should establish the parameters, and then should be applied to all research. In this way, even a single case could be considered acceptable, provided it met the established objective. Construct validity is especially problematic in case study research. It has been a source of criticism because of potential investigator subjectivity. Yin (1994) proposed three remedies to counteract this: using multiple sources of evidence, establishing a chain of evidence, and having a draft case study report reviewed by key informants. To overlook subjectivity, we will adopt the ethnographic observation and we used knowledge sharing barriers proposed in literature.

9.3 Elasis S.c.p.a.

ELASIS S.c.p.a. is an enterprise of the Fiat Auto Group and it focuses on Basic Research and advanced engineering in the automotive sector. This enterprise account for more than 800 employees, the majority has graduated, and is one of the most important private Research Centers in Europe.

Working with ELASIS are researchers of new ideas, solutions experimenters and skills developers- for a total of over 800 staff, with an average age of just over 35 and a very high-level educational background.

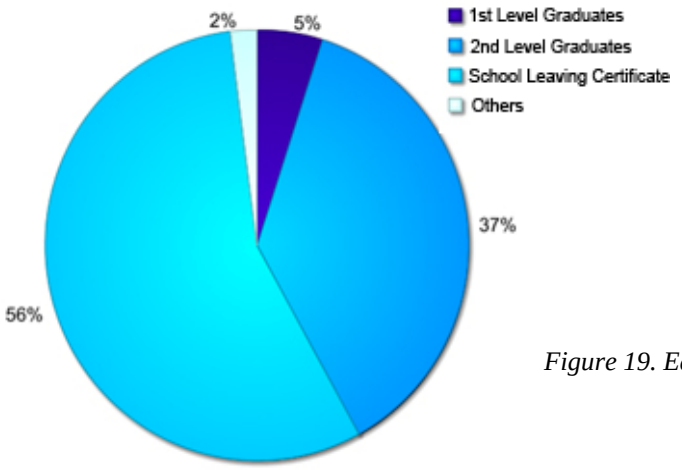


Figure 19. Education Level in Elasis

Set up in 1988 by the Fiat Group as a company dedicated to research work in the framework of development programs for Southern Italy, Elasis has grown into a highly specialized research centre whose work addresses technological innovation, complete Vehicle development, mobility and its environmental impact, and traffic safety. As a partner of the Fiat Group, knowledge should be more likely to transfer between establishments that are owned by the same parent organization than across independent organizations (Darr et al. 1995, Baum and Ingram 1998).

The Centre has two sites, one in Pomigliano d'Arco and one Lecce, both located in Southern Italy, and is provided with sophisticated computer-aided design and calculation tools and advanced physical and virtual testing equipment which are based on an ability to develop and manage information systems that puts Elasis in the front ranks of the world's R&D centers. As it is possible to see one of the characteristics highlighted by the manager of the firm is the presence of advanced CAD and virtual testing equipment, showing immediately a strong focus on advanced technologies for performing its task.

At Elasis, work on engines and transmissions is carried out as part of FPT, which is Fiat Powertrain Technologies' development projects.

ELASIS today is trying to use its analysis and design know-how in new sectors (e.g. farm and earth-moving machinery, trade Vehicles, rail transport) and in new fields of application (e.g. urban environment, road network and territorial development systems analysis). Furthermore, it develops a collaboration network with universities and research institutes for the deepening and continually updating knowledge in its areas of interest. The firm has extended its area of interest, accepting the

complexity of the product, which has to satisfy new needs and respect new rules, such as from product innovation to "mobility system" analysis, from process innovation to territorial development dynamics.

In fact in 2007, Elasis continued to pursue its strategic objectives for forging new links in the research/innovation system's value chain and of promoting local development. In pursuing this objective, Elasis worked within consortia including universities and private institutions in basic research and training, continuing to sharpen its focus on the issues related to mobility and its environmental impact.

In addition, Elasis cooperated with the Naples Employers' Association and chambers of commerce in Southern Italy to help the area's small and medium enterprises make the most of their skills.

During the year 2007, significant achievements were made in the following areas:

- *Innovative methods for products and processes*. New methods for the Fiat Group companies' products and processes were developed using a synergistic approach whose goal is to reduce time to market and build design and product quality. Research focused on numerical modeling methods for products and manufacturing facilities, simulation of product performance, and automated testing.

  In numerical product modeling, parametric models (archetypes) of body shell systems were developed which make it possible to reduce the modeling and revision time required, and are also an effective means of conserving corporate know-how. New virtual reality methods were also developed that enable researchers to assess the appearance, functional aspects and perceived quality of new car interiors and exteriors in a realistic environment.

  In virtual simulation of product performance, the methods used to simulate aerodynamic, ergonomics and biomechanical performance were extended and improved. As part of its work to improve Vehicle service, Elasis developed an inter-sectorial method for analyzing maintainability and generating service documentation that will help determine optimal disassembly sequences and improve the quality of repair manuals and owner's handbooks.

  In the area of processing methods, Elasis continued its work with virtual manufacturing, developing methods and tools for ergonomic analysis and for optimizing workstations in a virtual environment.

- *Vehicle research*. Vehicle research work concentrated on the Alfa 8 C (C is for Competition) project and development of the new Fiat Fiorino. In developing the Alfa 8 C Elasis followed up on the experience it gained in building the prototype for this car in 2004. To streamline the development process, Elasis employed a virtual approach. Elasis also introduced innovative steel/carbon fiber body shell technologies. For the new Fiat Fiorino, Elasis worked together with

Tofas to develop body shell systems, closure panels, interior and exterior trim, wiring, body computer, and body packaging.

- *Electronic control systems*. Together with the Centro Ricerche Fiat, Elasis developed a drive ability simulation method that allows for an evaluation of a Vehicle's handling performance during the manoeuvres called for by Fiat test standards. Hardware-In-the-Loop systems were developed together with automated procedures for testing the self-diagnostics software used in electronic engine management, ABS and ESP system control units. For Magneti Marelli Electronic Systems, Elasis validated the software for a number of body computers. For the Ferrari Manufacturing Division (Gestione Industriale), Elasis updated the Hardware-In-the-Loop Vehicle dynamics simulator used to test the electronic control unit for the Delphi Magneride active suspension system based on innovative dampening fluids. Elasis also provided support in developing the control system for the new dual clutch transmission. For CNH, the centre continued in 2007 to provide support in validating the control software for the CVT transmission featured on the Cobra tractor, and began development of a simulator for CNH which will be used to validate the electro-hydraulic drive control system on the equipment maker's Grader Vehicle.

- *Fire engines*. Elasis assisted in production startup for the FIRE T-Jet engine and in the launch of the Bravo 150 HP T-Jet, Grande Punto 120 HP T-Jet and 120 HP Linea cars. For the T-Jet power plant, Fiat Group Automobiles' first application of the downsizing concept, Elasis developed the initial concept and was also responsible for design and testing. This engine served as the basis for developing the high-power 180 HP, 270 Nm version for the Punto Abarth Esseesse. Development and product engineering work was also completed on the Fire 8 and 16 valve versions for the Fiat 500, Fiat Group Automobiles' first application to comply with Euro 5 emissions regulations. Development and product engineering work is now under way on naturally aspirated and turbocharged version of the new 1.4 liter Multiair engine, which uses an innovative intake valve control technology to improve performance and fuel economy. In addition, Elasis is working together with the 'Centro Ricerche Fiat' in developing and validating the two-cylinder spark ignition engine, as well as in product engineering for this unit.

9.3.1 Know-how areas

Elasis is structured in processes and it is subdivided in 7 business lines, such as :

1.1 Technologies,
1.2 Vehicle,
1.3 Motor propulsion;
1.4 Methodologies for New Product Development;
1.5 Control Systems;
1.6 Mobility and on the road safety;
1.7 Information & Communication Technology

The activities and sub-activities related to these business lines are:

1) ADVANCED DESIGN FROM BLANK SHEET TO FINISHED GOODS

Product concept

- Concept selection
- Trade-off performances, costs, product manufacturability
- Concept definition

System integration

- Supporting structure (loading platform, chassis-body, mobile parts)
- System for Vehicle dynamics (Vehicle and motor suspensions, brakes)
- Electric and electronic systems (electric structure, control system and infotainment)

Skills integration

- Engineering product (design, virtual testing, physical testing)
- Process engineering

2) VEHICLE

(research and development of Vehicle system, design and production engineering of finished Vehicles)

Integrated design

- Digital mock-up of the Vehicle and its system
- Design of chassis-body and mobile parts
- Design of various systems and mechanical components
- Electric structure, power system dimensioning and check-up of energy balance
- Interiors and external trim

Test and verification

- Virtual ergonomics
- Systems and Vehicle components structural characterization
- Anticipatory check of components and systems overworking
- Elastomeric and kinematic check
- Handling and NVH check
- Aerodynamic check and HVAC
- Reliability check-up

Bench trial

- Functional characterization of the systems and bench Vehicle elements
- Overworking of systems and bench Vehicle components (crash strain test)
- Dimensional survey of systems and Vehicle components
- Anechoic and reverberating room for acoustic characterization (NVH)
- EMC room for the confirmation of electromagnetic compatibility
- Reverse engineering of Vehicle systems

Road test

- Reliability test of Vehicle on the road
- Objective and subjective characterization on the road of Vehicle behaviour
- Set up of Vehicle aimed towards the tune-up during the development

3) POWERTRAIN

(design, development and industrialization of inside combustion engines and drive systems)

Engines and Drives

- Design (solid modeling; digital mock-up, analysis of tolerance under standard running)
- Computation (thermo-dynamic fluid, thermo-structural, dynamic, hydraulic)
- Engines test (performances development, consumption, emissions, functionality, reliability, components qualification, application to the Vehicle)
- Drive test (reliability of the whole gear, reliability of the synchronizers and inside controls, objective and subjective evaluation of gear controls and clutch behaviour, remarks on gear performance)
- Components test (stable fluxing during induction and exhaust phases, characterization of both engine and components frictions, water circuit, fuel supply equipment)
- UnitMotor application (with manual or automatic gears): calibration, integration, running of possible anomalies, support to the plants)
- NVH : vibro-acoustic development of a power unit and its components (calculated mock-up and monitoring on performances in action); characterization and study of problems concerning coupled or uncoupled drives of the heat engine (gear rattle, gear whine, shift lever vibrations).

Power unit control systems

- Specification of system requirements in terms of:
- expected performance of the system;
- single component requirements
- HW & SW requirements
- Observance of reference rules (FIAT Regulations, emission rules, interfacing specifications, electro-magnetic compatibility, etc.)
- Design of various control algorithms
- Test and confirmation of the control system through prototyping techniques, power unit mock-up (example HH), test on the bench and in the car
- Product quality in action for technicalities related to Elvis and ICS perimeter

Engine systems

- Formulation and designing of Cooling, Exhaust, Feed and Intake Systems depending on the technical specifications of an engine
- Realization of computational models 1D/3D and systems performance forecasting
- Prediction of thermal maps and air flows in the motor housing depending on the thermal power produced by the power unit and other components
- Numerical/experimental analysis of full hot-end (mani-fold, catalyst, particulate filter)
- Experimental characterization of water line completed with pressure and capacity measures

4) PROCESS ENGINEERING

(Development of full industrial processes with a high level of efficiency, quality and technological innovation)

Process design

- Evaluation of style models in terms of manufacturability and inexpensiveness
- Formulation and definition of process archetypes
- Simulation of production process and workstation ergonomics
- Evaluation of necessary costs and investments for the production (for the unit and for each component)
- Formulation of the pre-method for production process

Process engineering

- Definition of the method
- Identification of work tools
- Virtual simulation of ergonomics for each position
- Production start and process certification

5) RESEARCH, DEVELOPMENT AND EXPERIMENTAL TESTING ON VEHICLES TO BE BUILT

R&D

- Product research
- Design engineering of control hydraulic systems
- Electric/electronic systems and integration architecture of Vehicles
- Simulation and theoretical verification of models
- Prototyping

Testing

- Tests on power transmission and control systems
- Verification of hydraulic and electro-hydraulic systems
- Tests and measures of large welded units
- Fatigue test and vibrations
- Climatic test
- Analysis and mock-up noise and vibrations
- Performance test and check
- Acquisition and processing of experimental data
- Product certification (Car instructions)

6) MOBILITY AND ROAD SAFETY

New technology applied to mobility and systems supporting a decision on the subject of traffic and transport:

Mathematical models

- Evaluation of mobility demand and supply (and their interaction)
- Modeling of the process of goods distribution to optimize routes, loading and staff)
- Mock-up of air and acoustic pollution
- Evaluation of traffic impact on urban environment quality

Telematics applied to the traffic

- Info and reporting systems for traffic data management
- New type of traffic sensors
- New techniques concerning traffic forecast
- New control technology on crossings (adaptive control system on traffic lights)

Road safety

- Multidisciplinary analysis of road accidents
- Creation of data bank regarding accidents incidence and its outcomes
- Settlement of the procedures for the reckon of statistical markers
- Settlement of the procedures for spot and the map of the accidents
- Development of methods evaluating the efficiency of different devices in terms of safety
- Training for remarks, monitoring and analysis of accidents incidence

10. Empirical Research

10.1 Pre-test phase

A questionnaire containing all the potential factors identified in literature as potential barriers (or facilitators) to knowledge sharing was built.

However, this questionnaire resulted too long and in order to reduce the risk of a high percentage of returns of non-finished questionnaires, we decided to reduce the variables considered in the present analysis. In doing so, we decide to conduct 6 in-depth interviews with R&D managers, responsible of the business unit, project manager and other professionals.

The field research was designed to reduce the number of potential factors and select the most important ones in the eyes of the interviewees.

The standard format of the structured open-response interview was used. This is based on an interview schedule which is in format rather like the structured interview, with questions included in a set of order. However, many questions were flexibility adapted to the responses of the interviewees. Managers were asked to rank the variables indentified previously in the literature according to their experience and judgment.

Finally, a conceptual model composed by three independent and one dependent variable emerged. Each independent variable presents a list of variables (called also items or factors), partly identified in the literature and partly extrapolated from the analysis of the current situation in Elasis.

The resulting variables are present in the conceptual model below.

Several researchers have recommended triangulating qualitative methods with quantitative ones to ensure that the richness afforded by qualitative methods is supported by quantitative analysis (Gable, 1994, Markus, 1994). Then, interviews were combined with a questionnaire. The questionnaire was administered in order to understand whether there is one construct that predicts more strongly than others the effectiveness of knowledge sharing in Elasis. Moreover, we want to determine which factor/variable among the constructs considered, has the strongest prediction value. For this purpose we have chosen the questionnaire for acquiring data and multivariate data analysis for analyzing these data.

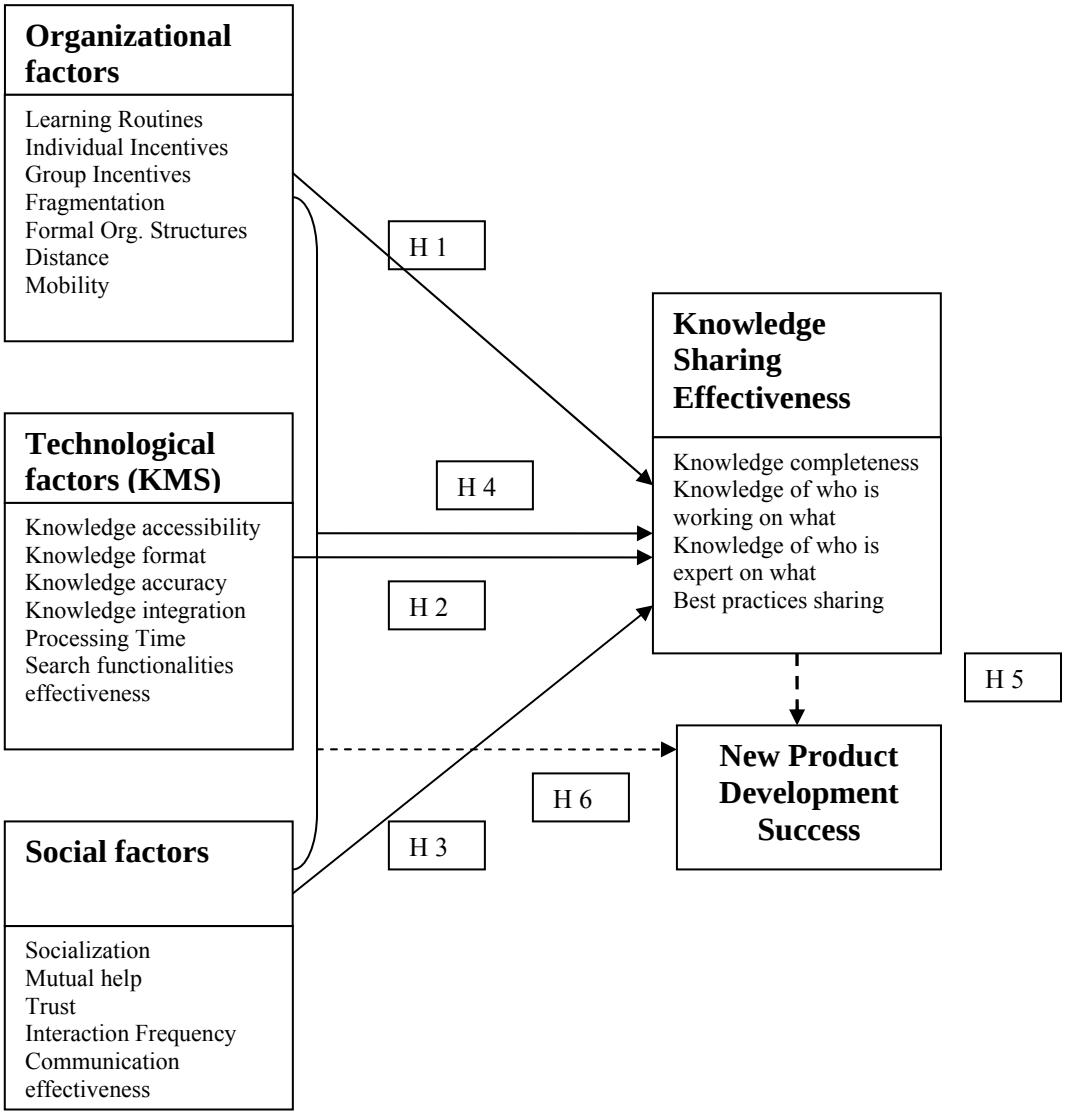


Figure 20. Preliminary Conceptual Model

10.2 Conceptualization of the constructs

The table below show the definition of each variable used in the analysis with the reference of the author that have already used and measured it in previous studies.

In some case these variables will be measured adopting questions already developed and validated in literature (Stone, 1978). Nevertheless, new questions will be developed according to the definitions and meaning given by the authors to the construct/variable.

Table 7. Constructs, variables and authors of the research

Dimensions	Variable/Constructs	Authors
Organizational factors	Knowledge Sharing Routines	Nelson and Winter, 1982; Dyer and Nobeoka, 2000
	Individual Incentives	Leonard-Barton & Deschamps, 1988; Davenport and Prusak 1998
	Group Incentives (joint reward system)	Griffin and Hauser, 1996, Leenders and Wierenga, 2002
	Cross-Boundary Knowledge Sharing	…
	Fragmentation	…
	Formal Organizational Structures	Leonard Barthon 1998; Daft, 2004; Bryan and Joyce, 2005; Brown and Duguid, 2001; Allen et al. 2007
	Distance	Pelz and Andrews 1966, Mintzberg 1973, and Allen 1977; Katz R. and Allen, T. J. 1983; De Meyer and Mizushima,1989; De Meyer, 1983, 1991…
	Mobility	Griffin and Hauser 1996; Keys and Miller 1984; Parry and Song 1993; Saxenian 1994, Moenaert et al. 1994 Almeida and Kogut 1999, Rosenkopf and Almeida 2003; Song et- al. 2003
Technological factors		
KMS effectiveness	Knowledge Accessibility	Nelson, 2005
Knowledge quality	Knowledge Format	Ryan et al. 2005
Knowledge quality	Knowledge accuracy and reuse	Ryan et al. 2005
KMS effectiveness	Knowledge Integration	Nelson, 2005
KMS effectiveness	Response time	Nelson, 2005
KMS effectiveness	Search functionalities effectiveness	Nelson, 2005
Social Factors		
	Socialization	Nonaka and Takeuchi, 1994, 1995
	Mutual help	…
	Trust	Szulanski et al. 2004, Andrews and Delahay 2000, Penley and Hawkins 1985, Tsai and Ghoshal 1998, Zand 1972; Dyer and Nobeoka 2000; McEvily et al. 2003; Levin and Cross, 2004
	Communication effectiveness (frequency, direction, informality,	Allen, 1970; Allen et al. 1979; Katz and Tushman, 1979; Myers and Marquis, 1969;

	many –to-many communications frequency)	Robertson et al., 1972; Tushman, 1977; Utterback, 1974...

10.3 Sampling decisions

We decided to take into account two business lines within Elasis for comparative purposes. Vehicle and Information & Communication Technology (ICT) business lines were asked to participate to the study. We asked to involve other business lines but our request was refused for reasons of time and difficulties in contacting the responsible of the other business lines. The research started within the business line ICT, contacting the other business line and asking to the responsible their involvement for the study was not easy.

These business units appeared to play a key-role in new product development, as the first directly create and manage the knowledge for Vehicle development, whereas the second define and develop the methodologies and the applications for knowledge archival and sharing.

The sample was quantitatively composed of 200 among employees of the two different business units, (Vehicle and ICT). Only 52 questionnaires were returned, 2 were excluded because they were not correctly filled, accounting for a return rate of 25%.

In total, 28 workers belonging to the Vehicle business units and 22 belonging to ICT participated to the study.

Respondents were selected for participating to the study with an attempt to concentrate on the Business Units that have the strongest impact on product development. In order to ensure the appropriateness of participants, the sample was selected along purposive lines with an attempt to concentrate on different roles within each Business Unit.

Respondents were solicited through means of personal contact in the first instance; however, snowballing was also used to expand the sample and generate additional contacts.

10.4 Questionnaire Administration

The questionnaire was administered via e-mail as a Word attachment, which took 15-18 minutes to complete. Of the targeted 62 individuals, 52 responses were received, 2 were excluded because not filled correctly. The 50 responses represented a response rate of 88%.

In order to elicit honest answer from employees, we assured that their answer will not damage them or other employees and that their immediate colleagues will not access to the responses. Moreover, anonymous responses were guaranteed nominating an external responsible for questionnaires collections.

As we have said, we have used the technique of the questionnaire in order to investigate the mechanisms blocking/facilitating knowledge transfer within the firm and between the firm and other external firms (suppliers, strategic alliances, research centers and universities).
We have subdivided the questionnaire in 5 parts, distinguished as follows:
1st part dedicated to *personal information* such as age, position, years of work in Elasis, years occupying the position;
2nd part dedicated *to organizational factors* such as Knowledge Sharing Routines, employees' relocation frequency…;
3rd part dedicated to *social factors* such as socialization, trust…;
4th part dedicated to *technological factors* such as KMS effectiveness (knowledge format, knowledge retrieval, search functionalities effectiveness…)
5th part dedicated *to knowledge sharing performance measures* such as best practice sharing, knowledge completeness for their work and so on.
6th part dedicated to *new product development performance measures*, such as time, efficiency, effectiveness.

After the questionnaire data were analyzed and short interviews were adopted for validating results.
The items in the questionnaire were selected from the analysis of the literature on knowledge sharing in international journals.
The questionnaire then was tested in the research center and later within the firm. After this test with manager and employees of the firm, some items were excluded from the present analysis as it was found that they did not fit with the case study or that they were not consistent with the situation in Elasis.
Finally, SPSS 15.0 software was used for analyzing the answers.

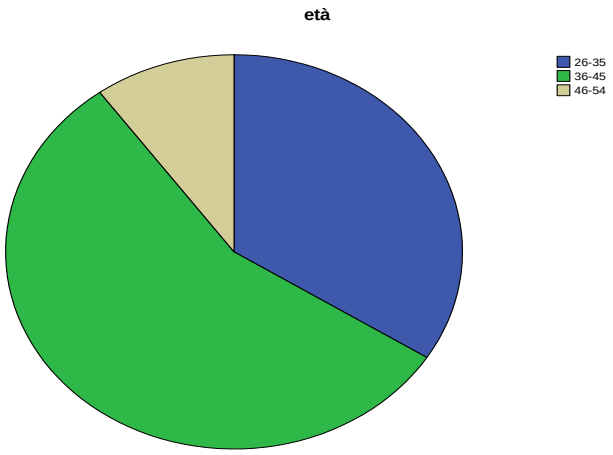
10.5 Sample profile

Respondent's average age of the sample perfectly represent the average age within the firm which is just over 35. The respondents were not equally distributed among both genders and the majorities among them was male, but this did not affect the validity of the results, as the percentage of female within the firm is very low.
As we can see from the table 1, only 3 on 50 respondents are female (6%).

SEX		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	d	3	6,0	6,0	6,0
	u	**47**	**94,0**	**94,0**	100,0
	Total	50	100,0	100,0	

Socio-demographic data include also participant's age. The enterprise has a very young age range, the sample perfectly represent this situation, while the majority of respondents range from 26 to 34 years old (34%) and between 36 and 45 years old (56%), cumulatively representing 90% of the age cohorts of the toal sample.

AGE		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**26-35**	**17**	**34,0**	**34,0**	34,0
	36-45	**28**	**56,0**	**56,0**	**90,0**
	46-54	5	10,0	10,0	100,0
	Total	50	100,0	100,0	



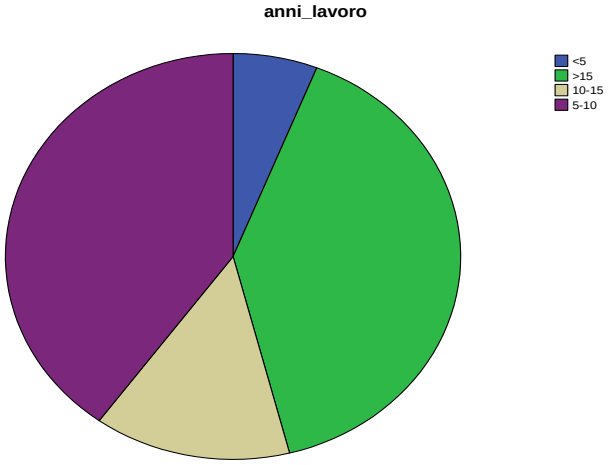
The nationality of respondents is exclusively Italian (100%).

We asked also the years of work experience within the firm. This question was aimed at monitor the experience and the knowledge of the firm and of its problems of respondents. A high percentage of respondents with low years of experience within Elasis could have biased the results.

On the contrary, we found that the majority of people composing the sample have been working in Elasis from 5 -10 years (40%) or from more than 15 years (40%).

The fact of having a sample composed by people that know very well the reality of the enterprise is certainly a good indicator of the accuracy of the estimates.

YEARS OF WORK		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<5	3	6,0	6,0	6,0
	>15	**20**	**40,0**	**40,0**	46,0
	10-15	7	14,0	14,0	60,0
	5-10	**20**	**40,0**	**40,0**	100,0
	Total	50	100,0	100,0	

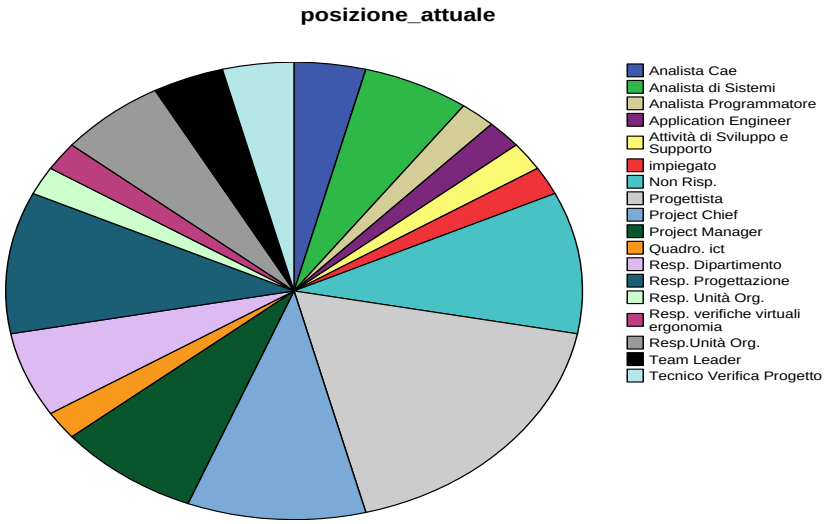


For what concerns the occupation, we have found the sample is very heterogeneous.

The majority of respondents are designers (9 accounting for 18%, progettista), project chiefs (5 accounting for 10%), project managers (4 accounting for 8%), responsibles of the SBU (4 accounting for 8 %), responsibles of design' components (4 accounting for 8%). Then, we have some Responsible of SBU (3 accounting for 6%) some system's analysts (3 accounting for 6%), Cae analysis (2, 4%), non respondents(5, 10%).

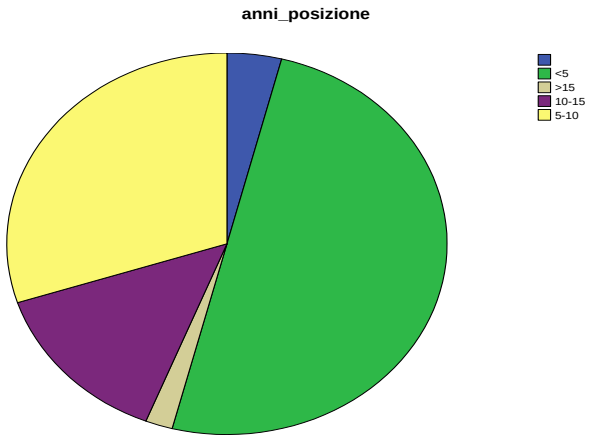
ACTUAL POSITION		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Analista Cae	2	4,0	4,0	4,0
	Analista di Sistemi	3	6,0	6,0	10,0
	Programmer	1	2,0	2,0	12,0
	Application Engineer	1	2,0	2,0	14,0
	Support and Development	1	2,0	2,0	16,0
	Impiegato	1	2,0	2,0	18,0
	Non Risp.	**5**	**10,0**	**10,0**	28,0
	Designer	**9**	**18,0**	**18,0**	46,0
	Project Chief	**5**	**10,0**	**10,0**	56,0
	Project Manager	**4**	**8,0**	**8,0**	64,0
	Quadro (administrative task)	1	2,0	2,0	66,0
	Resp. Area project development	1	2,0	2,0	68,0
	Resp. Department	3	6,0	6,0	74,0
	Resp. Design	**4**	**8,0**	**8,0**	82,0
	Resp. Verifiche Virtuali Ergonomia	1	2,0	2,0	84,0
	Resp. Unità Org.	**4**	**8,0**	**8,0**	92,0
	Team Leader	2	4,0	4,0	96,0

	Tecnico Verifica Progetto	2	4,0	4,0	100,0
	Total	50	100,0	100,0	



Then we asked from how long the respondents occupied their position; here the highest percentage is shared between those who occupy their position from less than 5 years (25 accounting for 50%), and thosee who occupy it from 5-10 years (15 respondents, accounting for 30 %).

YEARS OCCUPYING THE POSITION		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	N.R.	2	4,0	4,0	4,0
	<5	**25**	**50,0**	**50,0**	54,0
	>15	1	2,0	2,0	56,0
	10-15	7	14,0	14,0	70,0
	5-10	**15**	**30,0**	**30,0**	100,0
	Total	50	100,0	100,0	



10.6 Statistical Analysis

This part of the research is dedicated to the analysis of statistical results for each construct and variable considered in the present analysis. The variable identified in literature and considered for the present analysis will be first described. Then, for each business unit, we will analyze the percentage, mean, mode, std. deviation, variance for each variable (knowledge sharing routines, communication effectiveness…) and constructs (organizational, technological and social mechanisims). Finally, we will see the whole performance of both business units, comparing the data.
Results will be commented and compared in order to highlight the presence of significant indicators.

10.7 Organizational Mechanisms

The organizational mechanisms comprise the second part of the questionannire and include the following constructs:

Dimension	Constructs	Number of Items
Organizational factors	Knowledge Sharing Routines	2
	Cross-Boundary Knowledge Sharing	2
	Individual Incentives	1
	Group Incentives (joint reward system)	1
	Fragmentation	2
	Formal Organizational Structures	4
	Distance	1
	Mobility	1

10.7.1 Knowledge Sharing Routines

Results show clearly that many employees don't recognize the presence of internal Knowledge Sharing Routines for feedback sharing. In fact, 54 % of employees declare the absence of these kinds of mechanisms against a 32% that manifest an opposite opinion (Mean=2.72).
For what concerns Internal Knowledge Sharing Routines, there is not a great difference among both business lines, both confirm the scarce awareness of these stystems; it is important to note that the business line ICT disagree stronger than the business line Vehicle about the presence of knowldgfe sharing routines (Mean ICT=2.54, Vehicle=2.85).

Comparison Table

		Overall	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**2.72**	**2.85**	**2.54**
Median		2.0000	3.0000	2.0000
Mode		2.00	2.00	2.00
Std. Deviation		1.16128	1.26825	1.01076
Variance		1.34857	1.60847	1.02165

Overall

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**6**	**12.0**	**12.0**	**12.0**
	2.00	**21**	**42.0**	**42.0**	**54.0**
	3.00	7	14.0	14.0	68.0
	4.00	13	26.0	26.0	94.0
	5.00	3	6.0	6.0	100.0
	Total	50	100.0	100.0	

Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**4**	**14.3**	**14.3**	**14.3**
	2.00	**9**	**32.1**	**32.1**	**46.4**
	3.00	5	17.9	17.9	64.3
	4.00	7	25.0	25.0	89.3
	5.00	3	10.7	10.7	100.0
	Total	28	100.0	100.0	

ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**2**	**9.1**	**9.1**	**9.1**
	2.00	**12**	**54.5**	**54.5**	**63.6**
	3.00	2	9.1	9.1	72.7
	4.00	6	27.3	27.3	100.0
	Total	22	100.0	100.0	

10.7.2 Cross-Boundary Knowledge Sharing

For external routines there is not a clear indication from statistics (Mean=3.16), even if median (=4) and mode (=4) confirm the presence of external Knowledge Sharing Routines. From interviews, we realized external Knowledge Sharing Routines are present, but they are not very frequent and involve only a small group of employees. Here there is big difference between the two business line; in fact 77% of ICT's employees recognize the presence of external Knowledge Sharing Routines (Mean=3.59), whereas in Vehicle the percentage is very low, only 32.1% and 50% among them declare the inexistence of these routines (Mean=2.82). It is possible to assume that ICT employees are more involved in this kind of learning activities than their colleagues of Vehicle.

		Cross-Boundary Knowledge Sharing		
		Overall	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**3.16**	**2.8214**	**3.5909**
Median		4.0000	2.5000	4.0000
Mode		4.00	2.00	4.00
Std. Deviation		1.05676	1.12393	.79637
Variance		1.11673	1.26323	.63420

Overall Statistics

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	4.0	4.0	4.0
	2.00	**16**	**32.0**	**32.0**	36.0
	3.00	6	12.0	12.0	48.0
	4.00	**24**	**48.0**	**48.0**	96.0
	5.00	2	4.0	4.0	100.0
	Total	50	100.0	100.0	

Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**2**	**7.1**	**7.1**	**7.1**
	2.00	**12**	**42.9**	**42.9**	**50.0**
	3.00	5	17.9	17.9	67.9
	4.00	**7**	**25.0**	**25.0**	92.9
	5.00	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	4	18.2	18.2	18.2
	3.00	1	4.5	4.5	22.7
	4.00	**17**	**77.3**	**77.3**	100.0
	Total	22	100.0	100.0	

10.7.3 Incentives (Individual and Group)

As we have seen in the first of this work, incentives have been recognized as an important enabler of knowledge sharing.

Consistently, we have distinguished between individual and group incentives and we asked their presence to respondents in two different questions (quest.3 and 4). Individual and group incentives in fact are not explicitly recognized within the firm, incentives are distributed by the firm only in form of money and privately to more profitable employees.

Results show that individual incentives are used rarely (mean 2.18, median 2, mode 2), on the contrary group incentive are more diffused (Mean 3.62). This scenario is confirmed by both business units, in general only 7 respondents (12%) have confirmed the presence of individual incentives and 5 among them belong to the ICT business Unit.

More than half of respondents confirm the presence of group incentives (54%, Mean= 3.62, Median= 4), however, many respondents have never got group incentives (40%, Mode =3), while 6% of respondents say that group incentives are not used in the firm. These data are confirmed by both SBUs.

Finally, individual incentives are rarely used, while group incentives are very frequent.

		Individual Incentives		
		Overall	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**2.1800**	**1.9286**	**2.5000**
Median		2.0000	2.0000	2.0000
Mode		2.00	1.00	2.00
Std. Deviation		1.02400	1.01575	.96362
Variance		1.04857	1.03175	.92857

Overall Individual Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**13**	**26.0**	**26.0**	**26.0**
	2.00	**23**	**46.0**	**46.0**	**72.0**
	3.00	7	14.0	14.0	86.0
	4.00	6	12.0	12.0	98.0
	5.00	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Vehicle Individual Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**11**	**39.3**	**39.3**	**39.3**
	2.00	**11**	**39.3**	**39.3**	**78.6**
	3.00	4	14.3	14.3	92.9
	4.00	1	3.6	3.6	96.4
	5.00	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

ICT Individual Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	9.1	9.1	9.1
	2.00	12	54.5	54.5	63.6
	3.00	3	13.6	13.6	77.3
	4.00	**5**	**22.7**	**22.7**	100.0
	Total	22	100.0	100.0	

		Group Incentives		
		Overall	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**3.6200**	**3.7143**	**3.5000**
Median		4.0000	4.0000	3.0000
Mode		3.00	4.00	3.00
Std. Deviation		.80534	.85449	.74001
Variance		.64857	.73016	.54762

Group Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	3	6.0	6.0	6.0
	3.00	**20**	**40.0**	**40.0**	**46.0**
	4.00	**20**	**40.0**	**40.0**	**86.0**
	5.00	**7**	**14.0**	**14.0**	100.0
	Total	50	100.0	100.0	

Vehicle Group Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	7.1	7.1	7.1
	3.00	9	32.1	32.1	39.3
	4.00	**12**	**42.9**	**42.9**	82.1
	5.00	**5**	**17.9**	**17.9**	100.0
	Total	28	100.0	100.0	

ICT Group Incentives

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	4.5	4.5	4.5
	3.00	**11**	**50.0**	**50.0**	54.5
	4.00	8	36.4	36.4	90.9
	5.00	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

10.7.4 Work fragmentation and knowledge dispersion

In order to evaluate the fragmentation of the work and the dispersion of knowledge, two items were defined. Generally, fragmentation doesn't fit well with effective performance and knowledge sharing. That's why we asked employees if they are aware of the whole structure of what they do, the whole process, the goal the firm is achieving in doing that work, the persons and the knowledge necessitated to develop a product and so on.

Moreover, business units adopt different KMS, contributing to the dispersion of knowledge within different systems. As we have found through interviews and questionnaires, the different business units adopt different platforms and applications for doing their job and for archiving data, information and knowledge. This proliferation of systems for knowledge archival may lead to knowledge fragmentation in different applications without a rationale, leading to problems in knowledge

accessibility and sharing, considering that the same or different business units will have difficulties in sharing materials and knowledge that need much time for their retrieval.

These items highlight the presence of a problem that emerged during interviews, that was the fragmentation of knowledge. In fact, from both questions we got that the majority of people working in Elasis have difficulties in perceiving the whole picture of what they do (Mean= 2.68, Median =2; Mode=2). The perception of the part on which each employee have to work and this condition is common in both business lines.

Finally, fragmentation is due partly to the characteristic of the work in an automotive R&D center, where employees' activities are divided into modules and each module is divided into sub-parts of work. Partly, this is also due to the proliferation of knowledge management systems and workstations, where knowledge is archived and retrieved. The distribution of knowledge in this platform is barrier to intra-and especially to inter-departmental knowledge accessibility and sharing.

Statistics

	Fragmentation	Overall	Vehicle	ICT
N	Valid	50	28	22
	Missing	107	0	0
Mean		**2.68**	**2.64**	**2.73**
Median		2.00	2.00	2.00
Mode		2.00	2.00	2.00
Std. Deviation		.93547	.98936	.88273
Variance		.87510	.97884	.77922

Fragmentation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	1.3	4.0	4.0
	2.00	**26**	**16.6**	**52.0**	**56.0**
	3.00	8	5.1	16.0	72.0
	4.00	**14**	**8.9**	**28.0**	100.0
	Total	50	31.8	100.0	
Missing	System	0	68.2		
Total		50	100.0		

ICT_Fragmentation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**12**	**54.5**	**54.5**	**54.5**
	3.00	4	18.2	18.2	72.7
	4.00	6	27.3	27.3	100.0
	Total	22	100.0	100.0	

VEHICLE_5 Fragmentation

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	7.1	7.1	7.1
	2.00	**14**	**50.0**	**50.0**	**57.1**
	3.00	4	14.3	14.3	71.4

	4.00	8	28.6	28.6	100.0
	Total	28	100.0	100.0	

10.7.5 Formal Organizational Structures

The traditional Mform organizational structure and its many variants are characteristically rigid and inflexible, thereby hindering horizontal communication between functions, or the separate businesses of multidivisional firms (Daft, 2004; Bryan and Joyce, 2005). The issues afflicting hierarchical systems are symptomatic of the 'mechanistic' management systems identified by Burns and Stalker (1961). These

mechanistic systems are characterized by: vertical interactions, systems of superiority management and a focus upon local, rather than broad sources of knowledge, experience and skills. This demonstrates how the flow of knowledge within the corporation can be restricted through bureaucracy and the use of rigid frameworks for reporting and sharing knowledge assets. Vertical 'silos' of employees are separated by functional boundaries, or in the case of multiunit firms, by business group, increasing duplication of resources, reducing efficiency and critically impeding the exchange of knowledge assets.' Matrix structures associate professionals horizontally on shared product or competency lines across functional, divisional or

geographic boundaries (Daft, 2004; Bryan and Joyce, 2005). In order to measure the degree of formality or

bureaucracy, we adopt three items, one relating to the presence of vertical and horizontal communications (bottom-up and top-down), one item related to the rigid or self-organized nature of communications and an other one related to the informality degree between units.

The degree of bureaucracy of the organization was measured through a five point Likert scale and these points represent different weights of bureaucracy, ranging from: high bureaucratic company (1) to lean company (5).

Results show that Elasis is not a bureaucratic firm (mean =3.81), on contrary the work environment is very informal, inter-unit knowledge exchange and communications are frequent, and bottom-up communications are very frequent too.

Statistics

Org.Factors.Rigid_Org_Structures

Mean	3,81
Median	3,66
Mode	4,33
Std. Deviation	,52636
Variance	,277

Org.Factors.Rigid_Org_Structures

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,67	1	2,0	2,0	2,0
	3,00	4	8,0	8,0	10,0
	3,33	12	24,0	24,0	34,0
	3,67	10	20,0	20,0	54,0
	4,00	6	12,0	12,0	66,0
	4,33	**13**	**26,0**	**26,0**	92,0
	4,67	4	8,0	8,0	100,0
	Total	50	100,0	100,0	

10.7.6 (Geographical) Distance

Distance, as a major barrier to knowledge transfer, had received probably the highest attention, since 1977, when Allen described how increasing distance between team members reduced the chances of two team members communicating for technical matters. Moreover, his findings were supported by a huge number of researches (Allen, 1977; Katz and Allen, 1982; De Meyer and Mizushima, 1989; Zahn, 1991; Song, 1993; and others).

As matter of fact, we measured the distance of the person with whom employees in Elasis share knowledge more frequently. For measuring distance we used the scale used by Leenders and Wierenga (2002):

1) he is located in an other nation (highest distance); 2) he is located in the same nation but in an other area; 3) he is located in the same area but in an other establishment; 4) he is located in the same establishment but in a different business line; 5) he is located in the same establishment and in the same business line (lowest distance).

As it is possible to observe from statistics, the majority of employees with whom Elasis' employees share knowledge are located mainly in the same business line (56%; Median =5; Mode=5), but there is very high percentage of collaborators with whom respondents share knowledge that are located in other geographical areas (32%). From ego-network we found that these persons are mostly persons that work in other firms belonging to the Fiat Group, such as Fiat Auto, Iveco, Fiat Powertrain Technologies, which are located in the industrial area of Turin (table below).

We measured also the inter-firm network and we found that Elais interact frequently with other firms like GS, Tower, ASM, Marelli and so on. Less frequent are the interactions with research centres, such as with the Isufi, Università Federico II di Napoli, the Università del Sannio, the Politecnico di Torino, the Università di Catania.

There is not a certain difference while comparing ego network emerging within both business lines, ICT is certainly more collaborative across boundaries than Vehicle (Mean ICT = 4.18, Vehicle=3.71), they share more frequently knowledge with other partners of the Fiat Group located outside the firm or with employees of other business lines than the business line Vehicle. On the contrary the business

line Vehicle is more focused within firm boundaries, sharing knowledge with departments/offices of the same business line.

	Distance	**Overall**	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**3.92**	**3.71**	**4.18**
Median		5.00	4.00	5.00
Mode		5.00	5.00	5.00
Std. Deviation		1.36785	1.35693	1.36753
Variance		1.87102	1.84127	1.87013

Overall Distance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**16**	**32.0**	**32.0**	32.0
	4.00	6	12.0	12.0	44.0
	5.00	**28**	**56.0**	**56.0**	100.0
	Total	50	100.0	100.0	

Vehicle.Distance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**10**	**35.7**	**35.7**	35.7
	4.00	6	21.4	21.4	57.1
	5.00	12	42.9	42.9	100.0
	Total	28	100.0	100.0	

ICT.Distance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	6	27.3	27.3	27.3
	5.00	**16**	**72.7**	**72.7**	100.0
	Total	22	100.0	100.0	

Location of the collaborators (Overall)

		Frequency	Percent	Valid Percent
Valid		1	,6	,6
	CRF Fiat, Orbassano (TO), Business Information Technologies	1	,6	,6
	CRF, Orbassano (TO), Veicoli	1	,6	,6
	Elasis	1	,6	,6
	Elasis Pomigliano, E 27, T, Veicolo	1	,6	,6
	Elasis, Pomigliano, consulente	1	,6	,6
	Elasis, Pomigliano, E 14, T, Veicolo	1	,6	,6
	Elasis, Pomigliano, E 21, T, Veicolo, Sperim. Banco	1	,6	,6
	Elasis, Pomigliano, E 27, 1, Veicolo	**11**	**7,0**	**7,0**
	Elasis, Pomigliano, E 27, 2, Veicolo	**18**	**11,5**	**11,5**
	Elasis, Pomigliano, E 27, T, Veicolo	**9**	**5,7**	**5,7**
	Elasis, Pomigliano, E 5, T, Veicolo	**6**	**3,8**	**3,8**
	Elasis, Pomigliano, E1, 1, ICT	**42**	**26,8**	**26,8**

	Elasis, Pomigliano, E1, 1, M.S.S.	1	,6	,6
	Elasis, Pomigliano, E14, T, Veicolo	1	,6	,6
	Elasis, Pomigliano, E21, 1, Sperimentazione Trasmissione Affidal	1	,6	,6
	Elasis, Pomigliano, E27, T, Veicolo. Advanced Methodologies. Resp.Ente	3	1,9	1,9
	Elasis, Pomigliano, E27, T, M.S.P.	1	,6	,6
	Elasis, Pomigliano, E3, T, Sperimentazione Motori	1	,6	,6
	Elasis, Pomigliano, E4, T, Sperimentazione Trasmissione Affidal	1	,6	,6
	Elasis, Pomigliano, E4, T, Veicolo, Sperim. Banco	2	1,3	1,3
	Elasis, Pomigliano, Veicolo. Resp. Business Line. Chassis	1	,6	,6
	Fiat Auto, Arese, Vehicle Integration	1	,6	,6
	Fiat Auto, Arese, Vehicle Integration, Proget. sistemi tela	1	,6	,6
	Fiat Auto, Dir. Produz. Veic., Tec.Lastr.scocca	1	,6	,6
	Fiat Auto, engineering design, PR Interiors progetti 147/GT	1	,6	,6
	Fiat Auto, Orbassano, Vehicle Integration, CFD	2	1,3	1,3
	Fiat Auto, Pomigliano, Stabilimernto Carrozzeria	3	1,9	1,9
	Fiat Auto, Quality, Corpo 4	1	,6	,6
	Fiat Auto, Torino, Body, Body Exterior	1	,6	,6
	Fiat Auto, Torino, Body, PR Croma	2	1,3	1,3
	Fiat Auto, Torino, Chassis	1	,6	,6
	Fiat Auto, Torino, Dir. produz. Veicolo, T.Lam Met	1	,6	,6
	Fiat Auto, Torino, E&D Interiors – Restraints	1	,6	,6
	Fiat Auto, Torino, E&D, Vehicle Integration	1	,6	,6
	Fiat Auto, Torino, Information Systems & Logistic Metho	**7**	**4,5**	**4,5**
	Fiat Auto, Torino, Interiors	1	,6	,6
	Fiat Auto, Torino, Vehicle Integration	1	,6	,6
	Fiat Group, E&D, Vehicle concepts and integration	1	,6	,6
	Fiat Powertrain technologies, Torino, IT	**4**	**2,5**	**2,5**
	Fiat Purchasing	1	,6	,6
	Fiat Purchasing Italia, Poland	1	,6	,6
	Fiat Revi, Torino	1	,6	,6
	Iveco Italia, Torino, Information Systems	**14**	**8,9**	**8,9**
	Polimatica, Torino	1	,6	,6
	Teksid, Ghisa Italia	1	,6	,6
	Torino	1	,6	,6
	Total	157	100,0	100,0

ICT's network of collaborators

		Frequency	Percent	Valid Percent
Valid		1	1,2	1,2
	CRF Fiat, Orbassano (TO), Business Information Technologies	1	1,2	1,2
	Elasis, Pomigliano, E 5, T, Veicolo	2	2,3	2,3
	Elasis, Pomigliano, E1, 1, ICT	**42**	**48,8**	**48,8**
	Elasis, Pomigliano, E1, 1, M.S.S.	1	1,2	1,2
	Elasis, Pomigliano, E21, 1, Sperimentazione	1	1,2	1,2

	Trasmissione Affidal			
	Elasis, Pomigliano, E27, T, Veicolo. Advanced Methodologies. Resp.Ente	3	3,5	3,5
	Elasis, Pomigliano, E27, T, M.S.P.	1	1,2	1,2
	Elasis, Pomigliano, E3, T, Sperimentazione Motori	1	1,2	1,2
	Elasis, Pomigliano, E4, T, Sperimentazione Trasmissione Affidal	1	1,2	1,2
	Elasis, Pomigliano, E4, T, Veicolo, Sperim. Banco	2	2,3	2,3
	Elasis, Pomigliano, Veicolo. Resp. Business Line. Chassis	1	1,2	1,2
	Fiat Auto, Torino, Information Systems & Logistic Metho	**7**	**8,1**	**8,1**
	Fiat Group, E&D, Vehicle concepts and integration	1	1,2	1,2
	Fiat Powertrain technologies, Torino, IT	**4**	**4,7**	**4,7**
	Fiat Revi, Torino	1	1,2	1,2
	Iveco Italia, Torino, Information Systems	**14**	**16,3**	**16,3**
	Polimatica, Torino	1	1,2	1,2
	Teksid, Ghisa Italia	1	1,2	1,2
	Total	86	100,0	100,0

Vehicle network of collaborators

		Frequency	Percent	Valid Percent
Valid	CRF, Orbassano (TO), Veicoli	1	1,4	1,4
	Elasis	1	1,4	1,4
	Elasis Pomigliano, E 27, T, Veicolo	1	1,4	1,4
	Elasis, Pomigliano, consulente	1	1,4	1,4
	Elasis, Pomigliano, E 14, T, Veicolo	1	1,4	1,4
	Elasis, Pomigliano, E 21, T, Veicolo, Sperim. Banco	1	1,4	1,4
	Elasis, Pomigliano, E 27, 1, Veicolo	**11**	**15,5**	**15,5**
	Elasis, Pomigliano, E 27, 2, Veicolo	**18**	**25,4**	**25,4**
	Elasis, Pomigliano, E 27, T, Veicolo	**9**	**12,7**	**12,7**
	Elasis, Pomigliano, E 5, T, Veicolo	**4**	**5,6**	**5,6**
	Elasis, Pomigliano, E14, T, Veicolo	1	1,4	1,4
	Fiat Auto, Arese, Vehicle Integration	1	1,4	1,4
	Fiat Auto, Arese, Vehicle Integration, Proget. sistemi tela	1	1,4	1,4
	Fiat Auto, Dir. Produz. Veic., Tec.Lastr.scocca	1	1,4	1,4
	Fiat Auto, engineering design, PR Interiors progetti 147/GT	1	1,4	1,4
	Fiat Auto, Orbassano, Vehicle Integration, CFD	2	2,8	2,8
	Fiat Auto, Pomigliano, Stabilimento Carrozzeria	**3**	**3,2**	**3,2**
	Fiat Auto, Quality, Corpo 4	1	1,4	1,4
	Fiat Auto, Torino, Body Exterior	1	1,4	1,4
	Fiat Auto, Torino, Body, PR Croma	2	2,8	2,8
	Fiat Auto, Torino, Chassis	1	1,4	1,4
	Fiat Auto, Torino, Dir.produz. Veicolo, T.Lam Met	1	1,4	1,4
	Fiat Auto, Torino, E&D Interiors – Restraints	**3**	**4,2**	**4,2**

	Fiat Auto, Torino, E&D, Vehicle Integration	1	1,4	1,4
	Fiat Purchasing	1	1,4	1,4
	Fiat Purchasing Italia, Poland	1	1,4	1,4
	Torino	1	1,4	1,4
	Total	71	100,0	100,0

10.7.7 Employees' mobility

Moving personnel across functions reduces the probability that employees isolate themselves within their office. Moenaert et al. (1994) found that job rotation increased interaction and led to concomitant information flows and thus integration. Griffin and Hauser (1996) and later Leenders and Wierenga (2002) found that employees' relocation was necessarily related to Marketing and R&D integration and NPD performance. Thus, the rotation of employees increases the interaction between departments and probably also the transfer of knowledge.

As we can see from overall statistics, the rotation of employees is very frequent as confirmed by the majority of employees (68% Mean=3.86). Only a percentage of respondents comprised between 8.5% and 14.6% affirm that rotation is infrequent. Both business line confirm the high frequency of rotation and movement for sharing knowledge (Vehicle Mean=2.40, ICT 2.72). However, this frequency is also affected by the typology of organizational design adopted by the firm. Elasis is a 'matrix organization', employees are often relocated in other offices and departments for contributing to other projects or for working in distance and more efficiently with other colleagues.

		Overall	**Vehicle**	**ICT**
N	Valid	50	28	22
	Missing	0	0	0
Mean		**3.86**	**4.14**	**3.50**
Median		4.00	5.00	4.00
Mode		5.00	5.00	4.00
Std. Deviation		1.22907	1.23871	1.14434
Variance		1.51061	1.53439	1.30952

Employees Mobility Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	6.0	6.0	6.0
	2.00	5	10.0	10.0	16.0
	3.00	8	16.0	16.0	32.0
	4.00	**14**	**28.0**	**28.0**	60.0
	5.00	**20**	**40.0**	**40.0**	100.0
	Total	50	100.0	100.0	

Employees' Mobility Frequency_Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	7.1	7.1	7.1
	2.00	1	3.6	3.6	10.7
	3.00	4	14.3	14.3	25.0
	4.00	5	17.9	17.9	42.9

	5.00	16	57.1	57.1	100.0
	Total	28	100.0	100.0	

Employees' Mobility Frequency_ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	4.5	4.5	4.5
	2.00	4	18.2	18.2	22.7
	3.00	4	18.2	18.2	40.9
	4.00	9	40.9	40.9	81.8
	5.00	4	18.2	18.2	100.0
	Total	22	100.0	100.0	

10.7.8 Communities of practice

As shown in the literature review, communities of practices are recognized to be an important enabler of knowledge sharing. In order to help employees to understand what a community of practice is, we gave them full of information such as a definition, a listing of the main characteristics of a CoP and some practical examples.

From question 18 to 25, we asked whether there are communities of practice within the firm, how they are named, what they do and which are theirs characteristics.

Question 18 asks whether communities of practice are present and 82 % of respondents answered negatively. Only 18% (10 respondents) confirmed the presence of communities of practice.

Nevertheless, through interviews we understood that within the firm there are informal groups of experts, but they are exactly communities of practice. People, who answered positively to this question, would mean the presence of an informal network of relationship between them and the expert on their favorite subject/issue/area of expertise. In Elasis there are a lot of informal communication and collaboration that help people in graduating the experience of the other members so that everybody knows who is expert on what. However, these people meet only for mutual help on common problems, for information and knowledge requirements for fulfilling a given task. However, outside the formal job tasks, these members don't meet for achieving the 'normal' tasks ascribed to the CoPs, such as analyzing and producing the meta-knowledge, identifying and record best practice and so on. Their collaboration limits within the hours of work and consists in the temporary requirement of help for a task. Finally we can say that the CoPs in Elasis are mainly at a tacit stage, they exist but they are not known by the organization and it is not supporeted as such (for further information on this argument sees chapter 14.1, p.113).

QUEST_18

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	40	80,0	80,0	80,0
	Yes	**10**	**20,0**	**20,0**	100,0
	Total	50	100,0	100,0	

Question 19 investigate the typology of the Cop, that is or intra-organizational or inter-organizational. Then we asked how many people of the Fiat group are involved within these communities. Only 4 respondents declare that in these communities are present employees of other firms/organization of the Fiat Group.

QUEST_19

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	2	4,0	20,0	20,0
	3,00	**4**	**8,0**	**40,0**	60,0
	4,00	2	4,0	20,0	80,0
	5,00	2	4,0	20,0	100,0
	Total	10	20,0	100,0	
Missing	System	40	80,0		
Total		50	100,0		

Question 20 have the goal to understand whether the employees involved in CoPs have good relationships with the other employees in Elasis. Quite all respondents confirm (90%) the presence of good relationships.

QUEST_20

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	1	2,0	10,0	10,0
	4,00	**9**	**18,0**	**90,0**	100,0
	Total	10	20,0	100,0	
Missing	System	40	80,0		
Total		50	100,0		

The question 21 has the goal to investigate one other problematic linked with the presence of CoPs within a firm, which is the isolation of its members and the identification with the community rather than with the corporate identity. Here 50% of respondents declare to strongly identify with the CoP, whereas 30% disagree with this statement. This data, however, represents an element to take under control as it can mine the climate of collaboration present within a firm.

QUEST_21

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	3	6,0	30,0	30,0
	3,00	2	4,0	20,0	50,0
	4,00	**5**	**10,0**	**50,0**	100,0
	Total	10	20,0	100,0	
Missing	System	40	80,0		
Total		50	100,0		

QUEST_22

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1,00**	**1**	**2,0**	**10,0**	10,0
	2,00	**2**	**4,0**	**20,0**	30,0
	3,00	**2**	**4,0**	**20,0**	50,0
	4,00	**5**	**10,0**	**50,0**	100,0
	Total	10	20,0	100,0	

Missing	System	40	80,0		
Total		50	100,0		

Question 22 has the goal to investigate whether the CoPs are supported by the management. It emerges that the majority of the communities are supported by the management (50%), while some are not.

The following questions are directed to identify the specific Cops. From the answers provided we could recognize the existence of the following CoP:

- methodologies initiatives;
- sviluppatori (developers);
- trend e tecnologie web (trend in ICTs);
- competence centre;
- technical committee;
- general purpose meeting;

From interviews we realized that only the first two groups look like CoP and its specific object is :

methodologies initiatives; it is built to create transversal methodologies for the different sectors of the group;

- sviluppatori; they work on application development ;
- trend e tecnologie web; they monitor trends and ICTs.

Then we asked if the belonging to the Cop have brought some benefit to their members, such as :

- increase of the knowledge capital (24);
- should have more support by management (25).

QUEST_24

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	1	2,0	10,0	10,0
	3,00	2	4,0	20,0	30,0
	4,00	**6**	**12,0**	**60,0**	90,0
	5,00	1	2,0	10,0	100,0
	Total	10	20,0	100,0	
Missing	System	40	80,0		
Total		50	100,0		

QUEST_25

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	2	4,0	20,0	10,0
	3,00	3	6,0	30,0	50,0
	4,00	**4**	**8,0**	**40,0**	90,0
	5,00	1	2,0	10,0	100,0
	Total	10	20,0	100,0	
Missing	System	40	80,0		
Total		50	100,0		

10.7.9 Synthesis of Organizational Mechanisms

From our analysis several conclusions can be drawn. First we saw that routines for sharing feedback are scarcely present or used.

The organizational aspects that should be taken into account by the organization are related to lack of individual incentives, scarce use of feedback sharing routines, compartmentalization and low interaction frequency.

The lack of individual incentives seems to be substituted by a system of group incentives, but the firm should implement routines for sharing feedback about the work done. Moreover, employees strongly lack the vision of the whole, they do their work but they are not aware of how that piece of work will contribute to the whole project/product. Employees are not aware of the complexity existing in the processes that lead to the building of a Vehicle. Such complexity should be reduced by the adoption of application that enables the reduction of time for integrating the different modules or projects in order to verify the presence of anomalies/errors. Today, these activities are pusher in the first part of the product development process mainly because of the digital mock-up, a tool that reduce development times and help employees to perceive the complexity due to the integration of the different parts a Vehicle is constituted. However, this virtual integration is difficult since knowledge is dispersed in different applications/KMS and inter-departmental communications are not possible in real time during the work.

This necessity of sharing knowledge is also represented by the high frequency with which Elasis employees participate to workshops, conferences and other external learning activities, even if in our analysis they were more diffused within ICT rather than in Vehicle.

The contribution of communities of practice was not present in our analysis; we found that real CoPs are not present in Elasis. However, through interviews we found that informal groups of expert on different aspects, such as ‘methodologies initiatives’; it is built to create transversal methodologies for the different sectors of the group; ‘sviluppatori’; they work on application development;

‘trend e tecnologie web’; they monitor trends and ICTs. The first is a typical CoP, but no one of our interviews was a member of that community. The other two are group of experts that interact much more frequently than with others in order to solve problems related to the specific area of expertise. These informal groups of experts are at the embryonic stage but they are susceptible to become a real CoP but only after the recognition and support of the management of the firm. In fact, the members of these groups affirmed that the work-hour at their disposition was not sufficient even to end their work, showing the necessity of more time for performing the typical activities of a CoP.

	Knowledge Sharing Routines	Knowledge Sharing Routines	Individual Incentives	Group Incentives	Fragmentation
N	50	50	50	50	50
Missing	0	0	0	0	0
Mean	**2.72**	**3.16**	**2.18**	**3.62**	**2.68**
Median	2.00	**4.00**	2.00	4.00	2.00
Mode	2.00	**4.00**	2.00	3.00	2.00
Std. Deviation	1.16128	1.05676	1.02400	.80534	.93547
Variance	1.34857	1.11673	1.04857	.64857	.87510

	Formal_Org_Structures	Distance	Employees relocation	**Overall Mean**
N	50	50	50	
Missing	0	0	0	
Mean	**3,81**	**3.94**	**3.68**	**3.22**
Median	3,66	**5.00**	**4.00**	
Mode	4,33	**5.00**	**5.00**	
Std. Deviation	,52636	1.38990	1.36419	
Variance	,277	1.93181	1.86100	

10.8 Social Mechanisms

The social mechanisms that facilitate knowledge sharing comprise the third part of the questionannire and include the following constructs:

Dimension	Constructs	N° items
Social Factors	Socialization	1
	Mutual help	2
	Trust	1
	Communication effectiveness (frequency, direction, informality, many – to-many communications frequency)	4

10.8.1 Trust

As we have seen in the literature numerous are the social causes of knowledge sharing effectiveness. However, after interviews and a period of observation we focus mainly on three items that could represent a social barrier in Elasis. Consistently, interpersonal trust, mutual help and socialization were selected for measuring the overall influence of social barriers/enablers.

Trust is a fundamental element that can accelerate or block the sharing of knowledge within a firm. Trust is reliability in someone else and is determined by his credibility and Distance.

Trust can easily facilitate knowledge transfer, however a high level of distrust is a strong barrier to knowledge sharing and it is very difficult to overcome. A high level of trust can be due to frequent face-to-face communications, mutual help, and socialization.

Trust is measured through a five point Likert scale and these points represent different weights of trust, ranging from: I trust him blindness (5), I trust him very much (4), It depends from situations (3), I don't trust him (2), I don't trust him at all (1).

As it is possible to see from overall statistics the level of trust within the firm is very high (Mean = 1.76). There is a strong gap between the twp business line (Mean: ICT= 1.82, Vehicle=2.22), while in ICT the highest score for trust account for 25.9%, while in Vehicle only for 14.1%. Moreover, in Vehicle a high percentage of respondents declare to trust in colleagues depending on the situations they encounter (33.8%) whereas in ICT this percentage is lower (5.9%).

Social.Factors.Trust

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2,00	3	6,0	6,0	6,0
	3,00	17	34,0	34,0	40,0
	4,00	26	52,0	52,0	92,0
	5,00	4	8,0	8,0	100,0
	Total	50	100,0	100,0	

Social.Factors.Trust

N	Valid	50
	Missing	0
Mean		3,6200
Median		4,0000
Mode		4,00
Std. Deviation		,72534
Variance		,526

10.8.2 Mutual Help

Mutual help is measured through a five point Likert scale from very rarely to very frequently. Employees in Elasis mutually help each other; a cumulative percent of 88% declare to help colleagues informally during their job. This result doesn't show strong differences between both business lines as Vehicle (85.7%) and ICT (90.9%) cumulative percentages don't differ too much.

		Vehicle	**ICT**
N	Valid	28	22
	Missing	0	0
Mean		**4.03**	**4.27**
Median		4.00	4.00
Mode		4.00	4.00
Std. Deviation		.69293	.63109
Variance		.48016	.39827

Overall Mutual Help

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	2.0	2.0	2.0
	3.00	5	10.0	10.0	12.0
	4.00	**30**	**60.0**	**60.0**	**72.0**
	5.00	**14**	**28.0**	**28.0**	**100.0**
	Total	50	100.0	100.0	

Mutual Help_Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	1	3.6	3.6	3.6
	3.00	3	10.7	10.7	14.3
	4.00	**18**	**64.3**	**64.3**	**78.6**
	5.00	6	21.4	21.4	100.0
	Total	28	100.0	100.0	

Mutual Help_ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	2	9.1	9.1	9.1
	4.00	**12**	**54.5**	**54.5**	**63.6**
	5.00	**8**	**36.4**	**36.4**	**100.0**
	Total	22	100.0	100.0	

10.8.3 Socialization

Socialization is measured through a five point Likert scale from low frequency to high frequency.

Finally, socialization is a strong reality within Elasis. This aspect emerged also from interviews in which respondents told us about a wised range of social activities, such as football tournament or organization of events, supported by the firm.

The overall percentage say that 80% of respondents are ware or participate to such activities, whereas 20 % don't know about it or have never participated. Both business line align with these results and don't present particular differences.

Overall

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	4.0	4.0	4.0
	3.00	8	16.0	16.0	20.0
	4.00	**33**	**66.0**	**66.0**	**86.0**
	5.00	**7**	**14.0**	**14.0**	**100.0**
	Total	50	100.0	100.0	

Socialization_Vehicle

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	2	7.1	7.1	7.1
	3.00	3	10.7	10.7	17.9
	4.00	**19**	**67.9**	**67.9**	**85.7**
	5.00	**4**	**14.3**	**14.3**	**100.0**
	Total	28	100.0	100.0	

Socialization_ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	5	22.7	22.7	22.7
	4.00	**14**	**63.6**	**63.6**	**86.4**
	5.00	**3**	**13.6**	**13.6**	**100.0**
	Total	22	100.0	100.0	

10.8.4 Communication effectiveness

It has been widely assumed that the role communication plays in an organization is vital. Moreover, it is very difficult to determine when communication is effective. There are multiple variables that affect communication effectiveness; moreover different approaches can be also selected. In this research we consider four items, such as the frequency of interaction (both face-to-face and CMC), the degree of informality of the communication process, the frequency of many-to-many interactions (forums) and finally the presence of bottom-up flows. By the way, the selected factors generally impact strongly on the organization of a firm. For example, it has been widely demonstrated that a very formal communication process has a negative impact on knowledge sharing and innovativeness. A

predominance of an orientation towards the first point in the different items will determine the effectiveness of the communication process.

Generally, we observed that communication is very effective within Elasis (Overall Mean=3.72) and this result is confirmed also by both business lines. The highest points are registered for communication informality and many-to-many interactions frequency.

The term interaction is voluntarily adopted instead of communication for meaning the bidirectional nature of the flow as every knowledge exchange imply the acceptance or refuse of the receiver, otherwise we have to use the term information transmission. For this item the media used did not matter, as such we meant both face-to-face and computer mediated communication interactions.

The Likert scale comprises 5 scales, these are: 1) very frequently (more than ones weekly); 2) frequently (once a day); 3) sometimes (weekly); 4) rarely (monthly); 5) quite ever.

Interaction frequency results very moderated (Mean=3.02). This result is due mainly to the high number of individuals located in other geographical areas and belonging to the other partners of the Fiat Group with whom Elasis employees are very usual to interact.

A percentage of 38% of respondents have declared to interact sometimes with these actors, which means weekly, while for 36% the interaction is rare, it happens about once a month. Consistently, with our hypotheses, employees of the vehicle business line interact less frequently than their colleagues within ICT, since their network is composed by several external actors located in other geographical areas (Mean).

Communication process in Elasis is completely self-organized (Mean =4.54, 60%), and there are no formal rules that establish who communicates with whom. For 34% of the sample, these rules are present but they are informal. This result is equal for both business lines.

The frequency of many-to-many interactions, such as forums, collective brainstorming and other initiatives is high (Mean=3.72), 29.2% affirm to participate very frequently. Cumulatively, this communication sees the participation of 68 % of Elasis' employees, whereas only 12 % don't participate or participate rarely to forums.

Finally, bottom-up flows are also moderately frequent, 60 % of respondents declare that these flows are frequent, whereas 32% are convinced that they are rare (Mean=3.36). However, observation and interviews confirmed the presence of frequent communication among employees of different level especially at the Business Line ICT.

N	Interaction frequency	Informality of Communication	Many-To-Many_Interaction_Frequency	Bottom-Up Communication	**Overall Mean**
	50	50	50	50	
Mean	0	107	107	107	
Median	**3.02**	**4.54**	**3.72**	**3.36**	**3.72**
Mode	3.00	5.00	4.00	4.00	
Std. Deviation	3.00	5.00	4.00	4.00	
Variance	.99980	.61312	1.17872	1.08346	
	.99959	.37592	1.38939	1.17388	

VEHICLE Statistics

	Interaction Frequency	Informality of Communication	Many-To-Many_Interaction _Frequency	Bottom-Up Communication	**Overall Mean**
N	28	28	28	28	
	0	0	0	0	
Mean	**3.1429**	**4.5000**	**3.6071**	**3.1071**	**3.59**
Median	3.0000	5.0000	4.0000	3.0000	
Mode	3.00	5.00	4.00	2.00	
Std. Deviation	.89087	.63828	1.25725	1.16553	
Variance	.79365	.40741	1.58069	1.35847	

ICT Statistics

	Interaction frequency	Informality of Communication	Many-To-Many_Interaction _Frequency	Communication_ Bottom-Up	**Overall Mean**
N	22	22	22	22	
	0	0	0	0	
Mean	**2.8636**	**4.5909**	**3.8636**	**3.6818**	**3.75**
Median	2.5000	5.0000	4.0000	4.0000	
Mode	2.00	5.00	4.00	4.00	
Std. Deviation	1.12527	.59033	1.08213	.89370	
Variance	1.26623	.34848	1.17100	.79870	

(*Face-to-face and CMC) Interaction frequency*

Interaction frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**18**	**36.0**	**36.0**	**36.0**
	3.00	**19**	**38.0**	**38.0**	**74.0**
	4.00	7	14.0	14.0	88.0
	5.00	6	12.0	12.0	100.0
	Total	50	100.0	100.0	

Vehicle Interaction frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	7	25.0	25.0	25.0
	3.00	**12**	**42.9**	**42.9**	67.9
	4.00	7	25.0	25.0	92.9
	5.00	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

ICT Interaction frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**11**	**50.0**	**50.0**	**50.0**
	3.00	7	31.8	31.8	81.8
	5.00	4	18.2	18.2	100.0
	Total	22	100.0	100.0	

Communication informality

Informality of Communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	3	1.9	6.0	6.0
	4.00	**17**	**10.8**	**34.0**	40.0
	5.00	**30**	**19.1**	**60.0**	100.0
	Total	50	31.8	100.0	
Missing	System	107	68.2		
Total		157	100.0		

Vehicle_ Informality of Communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	2	7.1	7.1	7.1
	4.00	10	35.7	35.7	42.9
	5.00	**16**	**57.1**	**57.1**	100.0
	Total	28	100.0	100.0	

ICT_Informality of Communication

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	3.00	1	4.5	4.5	4.5
	4.00	7	31.8	31.8	36.4
	5.00	**14**	**63.6**	**63.6**	100.0
	Total	22	100.0	100.0	

Many-to-many communication frequency

Many-To-Many Communication Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	1.9	6.0	6.0
	2.00	6	3.8	12.0	18.0
	3.00	7	4.5	14.0	32.0
	4.00	**20**	**12.7**	**40.0**	72.0
	5.00	**14**	**8.9**	**28.0**	100.0
	Total	50	31.8	100.0	
Missing	System	107	68.2		
Total		157	100.0		

Vehicle_Many-To-Many Communication Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	7.1	7.1	7.1
	2.00	4	14.3	14.3	21.4
	3.00	5	17.9	17.9	39.3
	4.00	**9**	**32.1**	**32.1**	71.4
	5.00	**8**	**28.6**	**28.6**	100.0
	Total	28	100.0	100.0	

ICT_Many-To-Many Communication Frequency

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	4.5	4.5	4.5
	2.00	2	9.1	9.1	13.6
	3.00	2	9.1	9.1	22.7
	4.00	**11**	**50.0**	**50.0**	72.7
	5.00	**6**	**27.3**	**27.3**	100.0
	Total	22	100.0	100.0	

Bottom-up communications frequency

Bottom-Up

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	.6	2.0	2.0
	2.00	15	9.6	30.0	32.0
	3.00	4	2.5	8.0	40.0
	4.00	**25**	**15.9**	**50.0**	90.0
	5.00	**5**	**3.2**	**10.0**	100.0
	Total	50	31.8	100.0	
Missing	System				
Total		50	100.0		

VEHICLE Bottom-Up

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.6	3.6	3.6
	2.00	**11**	**39.3**	**39.3**	**42.9**
	3.00	3	10.7	10.7	53.6
	4.00	**10**	**35.7**	**35.7**	89.3
	5.00	3	10.7	10.7	100.0
	Total	28	100.0	100.0	

ICT Bottom-Up

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	4	18.2	18.2	18.2
	3.00	1	4.5	4.5	22.7
	4.00	**15**	**68.2**	**68.2**	90.9
	5.00	**2**	**9.1**	**9.1**	100.0
	Total	22	100.0	100.0	

10.8.5 Synthesis of Social Mechanisms

As it possible to see from statistics the overall point of the social factors is very good, the overall mean is 3.75. It is possible to infer that social conditions are an important enabler of knowledge sharing within Elasis. The items that reached the highest point were informal mutual help and socialization. Mutual help was emphasized also by interviewees, where respondents affirmed that the level of harmony and reciprocal knowledge exchange within the firm was so good that many employees are also friend. This condition was equally present in both business lines.

Socialization activities managed by employees and through the support of the firm are of different kind. There are different tournament of football and other sports, moreover NatalElasis is a party organized before Christmas where employees' families bring their son for receiving Christmas presents offered by the firm. These activities are important occasions for meeting and knowing employees and their work, which is not possible during the week. In fact, from observation and interviews we noticed that interactions are always friendly and people are used to manage for going out together during the night.

Finally, interaction for knowledge sharing is very moderate, even if it involves a large number of subjects belonging to the other firms of the Fiat Group Automobiles.

The process of communication in this firm is very effective, it is predominantly informal, it is very frequent especially through the face-to-face channel. Very frequent are also collective brainstorming and forums due also to the adoption of the digital mock-up, a platform that digitalizes the car building process. The use of this typology of communications is also useful for getting other employees informed and involved in the activities of the firm.

Elasis is a lean organization; communication is done informally, frequently and they follow different directions. Top down but also bottom-up communication flows are much diffused. The responsible of the business unit helps often other employees in important activities, configuring a participative leadership through which employees are always aware of the goal and the strategy of the group.

Communication then, it is organized in a way to facilitate the sharing of knowledge both horizontally and vertically.

The communication process is not formalized by rigid rules; everyone can potentially start a communication process without following a rigid procedure, a condition confirmed also by observation of the high degree of informality among colleagues.

		Trust	Mutual Help	Socialization	Interaction Frequency
N	Valid	50	50	50	50
	Missing	0	0	0	0
Mean		**3,62**	**4.14**	**3.90**	**3.02**
Median		4,0000	4.00	4.00	3.00
Mode		4,00	4.00	4.00	3.00
Std. Deviation		,72534	.67036	.67763	.99980
Variance		,526	.44939	.45918	.99959

	Informality of Communication	Many-To-Many Communications	Bottom-Up Flows	**Overall Mean**
N	50	50	50	
Missing	0	0	0	
Mean	**4.54**	**3.72**	**3.36**	**3.75**
Median	**5.00**	**4.00**	**4.00**	
Mode	**5.00**	**4.00**	**4.00**	
Std. Deviation	.61312	1.17872	1.08346	
Variance	.37592	1.38939	1.17388	

10.9 Technological Factors

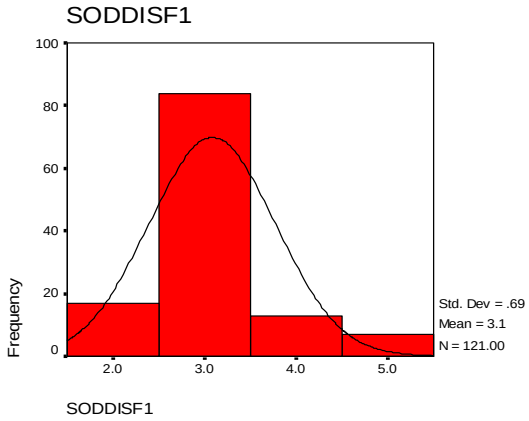
For 'technological factors' we mean systems that enable knowledge storage, retrieval, and reuse. These systems are also known as knowledge management systems.

Elements that affect knowledge sharing in a KMS can be related to the performance of the system and to the quality of the knowledge stored within it.

After interviews we decided to add in the questionnaire some factors related to content quality (Ryan et al. 2005), such as format and accuracy and others related to system quality (Nelson et al. 2005) were: response time, integration, search capabilities.

In order to measure KMS' effectiveness we try to get some information on the application used by employees and their level of satisfaction. We used a five point Likert scale for measuring the satisfaction level towards knowledge management systems applications, ranging from very unsatisfied to very satisfied.

The level of satisfaction was very moderated (Mean=3), the vast majority of respondents declared to be neither satisfied nor unsatisfied (69.4%) and only 5.8% declared to be very satisfied.



N	Valid	121
	Missing	0
Mean		**3.08**
Median		3.00
Mode		3.00

Satisfaction Level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	17	14.0	14.0	14.0
	3.00	**84**	**69.4**	**69.4**	83.5
	4.00	13	10.7	10.7	94.2
	5.00	7	5.8	5.8	100.0
	Total	121	100.0	100.0	

Through interviews we identified the applications more used by both R&D business lines in order to understand the satisfaction level for each single application used.

Employees in Elasis have declared to be very satisfied of outlook express and they use it is the only tool that enables rapid interactions and asynchronous interactivity. It was highlighted that no messaging system exist within the firm and the media more used to communicate among employees are the telephone and e-mail. However, this is the most rapid way to interact, but it is the only way employees in Elasis have to quick exchange information and suggestions.

Office is adopted very frequently too and it is mainly used to write reports and to formalize knowledge. Then, we found that within each business line in Elasis different application exist, depending on the work and activities performed by each.

It was found that within the business line vehicle two specific applications are used: Ug/Imam and Codep. These are used for knowledge accessibility and for having a longitudinal view on projects. The level of satisfaction for these applications is not high.

The business line ICT adopts different applications more internet-based, such as Kman, the intranet and the search engine on the World Wide Web. Kman is the firms' portal for the Knowledge Management, and is used mainly for knowledge archival and retrieval, it is not interactive and employee's satisfaction level for this application is medium-high.

Within this business line the intranet and the discussion forum are used very frequently for retrieving knowledge and information demonstrating a higher confidence in the use of the web and its applications.

Nevertheless, this part of the questionnaire has also the objective of evaluating the performance of Knowledge Management Systems according to their experience. During interviews some elements emerged as more interesting for a product development laboratory. In particular, some problems were highlighted as major difficulties to knowledge sharing due to KMS. The elements concern mainly the archival of knowledge and the creation of specific folders/repositories for facilitating specific knowledge retrieval and use, the adoption of templates from employees in order to codify knowledge, the nature of the terms and schema used to codify knowledge, the integration of knowledge produced in different parts of the firm, the time needed to search for knowledge, and finally the effectiveness of search functionalities.

From the majority of these items, the focus of investigation is the effectiveness of knowledge management system and the capabilities of employees in knowledge formalization, archival and retrieval. These are the basics phases enabling the transfer of knowledge, without them there is no transfer. The items proposed are:

Dimension	**Constructs**	**N°items**
Technological factors (KMS effectiveness and Knowledge quality)	Knowledge Accessibility	2
	Knowledge Format	2
	Knowledge accuracy and reuse	2
	Knowledge Integration	2
	Response time	1
	Search functionalities effectiveness	1

10.9.1 Knowledge accessibility

Knowledge accessibility is measured through a five point Likert scale from strongly disagree to strongly agree. Statistics confirmed that Knowledge in Information Management System is not listed in a way that facilitates its retrieval. This was confirmed by a cumulative percent of 48%, whereas 38% express an opposite opinion. There is a strong gap between the two business lines. ICT respondents affirm that knowledge in KMS is listed in a way that facilitates its retrieval (54.5% Mean =3.09)), whereas Vehicle is more oriented to affirm the contrary (57.1%).

Knowledge Accessibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**4**	**8.0**	**8.0**	**8.0**
	2.00	**20**	**40.0**	**40.0**	**48.0**
	3.00	7	14.0	14.0	62.0
	4.00	**17**	**34.0**	**34.0**	**96.0**
	5.00	**2**	**4.0**	**4.0**	**100.0**
	Total	50	100.0	100.0	

ICT_ Knowledge Accessibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	9.1	9.1	9.1
	2.00	6	27.3	27.3	36.4
	3.00	2	9.1	9.1	45.5
	4.00	**12**	**54.5**	**54.5**	100.0
	Total	22	100.0	100.0	

Vehicle_ Knowledge Accessibility

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**2**	**7.1**	**7.1**	**7.1**
	2.00	**14**	**50.0**	**50.0**	**57.1**
	3.00	5	17.9	17.9	75.0
	4.00	5	17.9	17.9	92.9
	5.00	2	7.1	7.1	100.0
	Total	28	100.0	100.0	

10.9.2 Knowledge format

Knowledge format is measured through a five point Likert scale from strongly disagree to strongly agree. The overall percentage gives us a very contradictory scenario of what concerns the use of templates for codifying knowledge (Mean=3.06), even if the majority of respondents have declared to adopt templates (44% against 38%).

It is interesting to note the high percentage of who have preferred to not express a clear judgment, choosing the neutral value (24%). However, a strong difference exists in the evaluation of the two different business units. The business line Vehicle is more oriented in affirming that knowledge is not codified in into templates (mean = 2.89) a cumulative percent of 35.7% say that employees don't use templates, 35.7% are neutral and only 28.6% affirm that templates are used within the business line.

Instead, it is possible to infer that in ICT templates are more used (Mean=3.27) as a 63.6% of respondents affirm. However for 27.3% of respondents templates are not widely used.

Knowledge format

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**3**	**6.0**	**6.0**	**6.0**
	2.00	**13**	**26.0**	**26.0**	**32.0**
	3.00	12	24.0	24.0	56.0
	4.00	**22**	**44.0**	**44.0**	100.0
	Total	50	100.0	100.0	

Vehicle_ Knowledge format

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.6	3.6	3.6
	2.00	**9**	**32.1**	**32.1**	**35.7**
	3.00	**10**	**35.7**	**35.7**	**71.4**
	4.00	8	28.6	28.6	100.0
	Total	28	100.0	100.0	

ICT_ Knowledge format

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	9.1	9.1	9.1
	2.00	4	18.2	18.2	27.3
	3.00	2	9.1	9.1	36.4
	4.00	**14**	**63.6**	**63.6**	100.0
	Total	22	100.0	100.0	

10.9.3 Knowledge accuracy and reuse

The degree of understanding of historical knowledge is measured through a five point Likert scale from strongly disagree to strongly agree. In the question we mention also a process in which employees are involved within the firm that is called Issue Management, the identification of errors/malfunctioning.

Results show clearly that the predominance of the sample don't agree on the fact that knowledge is explicated clearly (mean=2.50). If the knowledge present in KMS is not explicated in a clear way, its reuse and retrieval become problematic. This question is particularly interesting as from interviews we realized that employees at Elasis have some difficulties in understanding and deciphering the knowledge that other colleagues have entered.

The majority of respondents (56% cumulative percentage, 28 individuals) affirm that knowledge in Elasis is codified subjectively, in a way that affects negatively its reuse in other projects.

It is interesting to note that 30% of respondents (15 individuals) don't answer ('don't know'), but in reality this non answer reinforces the assumption that old knowledge is not used in new projects, losing important efficiencies of scope. Only 14% agree with the statement. This result is confirmed by both business lines, which express a similar judgment.

Qualitative interviews in fact confirmed that as the knowledge accessibility and its codification takes too much time, actually it is more useful and easy to recreate the knowledge for every new project or product in both business lines.

Knowledge Accuracy and reuse

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	5	10.0	10.0	10.0
	2.00	**23**	**46.0**	**46.0**	56.0
	3.00	15	30.0	30.0	86.0
	4.00	7	14.0	14.0	100.0
	Total	50	100.0	100.0	

VEHICLE_ Knowledge Accuracy and reuse

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	3	10.7	10.7	10.7
	2.00	**12**	**42.9**	**42.9**	**53.6**
	3.00	10	35.7	35.7	89.3
	4.00	3	10.7	10.7	100.0
	Total	28	100.0	100.0	

ICT_ Knowledge Accuracy and reuse

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	9.1	9.1	9.1
	2.00	**11**	**50.0**	**50.0**	**59.1**
	3.00	5	22.7	22.7	81.8
	4.00	4	18.2	18.2	100.0
	Total	22	100.0	100.0	

10.9.4 Knowledge integration

The knowledge integration through KMS is measured through a five point Likert scale from strongly disagree to strongly agree.

The lack of perception of the whole process of NPD enabling employees to understand how the fragment of work integrates with the whole product itself is intensified by KMS. Respondents in fact, affirm that KMS don't integrate knowledge produced by different departments, units or business lines, on the contrary knowledge is distributed in different KM systems (Mean=2.40, Mode = 2; Median =2), impeding a rapid retrieval of the knowledge needed.

In fact, 62% of respondents agree on the fact that the knowledge is dispersed among different KMS, and only 18% disagree with this condition. This situation is strongly emphasized by the business line ICT, where a cumulative 81, 8% of respondents agree that KMS contribute to disperse the knowledge of the firm (Mean=1.95), against 46, 4% of the business line Vehicle (Mean=2.40).

Knowledge Integration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	8	5.1	16.0	16.0
	2.00	**23**	**14.6**	**46.0**	**62.0**
	3.00	10	6.4	20.0	82.0
	4.00	9	5.7	18.0	100.0
	Total	50	31.8	100.0	
Missing	System	107	68.2		
Total		157	100.0		

VEHICLE Knowledge Integration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**13**	**46.4**	**46.4**	**46.4**
	3.00	9	32.1	32.1	78.6
	4.00	6	21.4	21.4	100.0
	Total	28	100.0	100.0	

ICT Knowledge Integration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	8	36.4	36.4	36.4
	2.00	**10**	**45.5**	**45.5**	**81.8**
	3.00	1	4.5	4.5	86.4
	4.00	3	13.6	13.6	100.0
	Total	22	100.0	100.0	

10.9.5 Response time

The time needed for knowledge accessibility is measured through a five point Likert scale from strongly disagree to strongly agree. Employees agree that the time needed to search for knowledge is not very high (46%), 14% briefly say that KMS are rapid. A 20% of employees is not able to judge and an other 20% of respondents say that information processing is slow. It is interesting to note that more than 80% of these employees that say that information retrieval time is high belong to the business line Vehicle.

In this business line, cumulatively 39.3 % of respondents say that time needed for knowledge accessibility is not high, 32.1 % don't express an opinion and 20% express an opposite opinion. Within ICT, the percentage of those who say that information retrieval in KMS is rapid account for 86.4%, 4.5% don't know, and 9.1% say that too much time is needed to retrieve information.

Response Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	7	14.0	14.0	14.0
	2.00	**23**	**46.0**	**46.0**	60.0
	3.00	**10**	**20.0**	**20.0**	80.0
	4.00	9	18.0	18.0	98.0
	5.00	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Vehicle_ Response Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**3**	**10.7**	**10.7**	**10.7**
	2.00	**8**	**28.6**	**28.6**	**39.3**
	3.00	**9**	**32.1**	**32.1**	71.4
	4.00	7	25.0	25.0	96.4
	5.00	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

ICT_ Response Time

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**4**	**18.2**	**18.2**	**18.2**
	2.00	**15**	**68.2**	**68.2**	**86.4**
	3.00	1	4.5	4.5	90.9
	4.00	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

10.9.6 Search functionalities effectiveness

Search functionalities effectiveness is measured through a five point Likert scale from strongly disagree to strongly agree.

Finally, we asked to evaluate the perceived effectiveness of search functionalities. Here we found very mixed answers. There is a very soft predominance of respondents that affirm that search functionalities are effective (38%), but 34 % express a contradicting opinion, and 28% remain neutral. There was no difference between the two business lines.

Search functionalities effectiveness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	5	10.0	10.0	10.0
	2.00	**12**	**24.0**	**24.0**	34.0
	3.00	**14**	**28.0**	**28.0**	62.0
	4.00	**18**	**36.0**	**36.0**	98.0
	5.00	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Vehicle_Search functionalities effectiveness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.6	3.6	3.6
	2.00	7	25.0	25.0	28.6
	3.00	**10**	**35.7**	**35.7**	64.3
	4.00	**9**	**32.1**	**32.1**	96.4
	5.00	**1**	**3.6**	**3.6**	100.0
	Total	28	100.0	100.0	

ICT_Search functionalities effectiveness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**4**	**18.2**	**18.2**	18.2
	2.00	**5**	**22.7**	**22.7**	40.9
	3.00	4	18.2	18.2	59.1
	4.00	**9**	**40.9**	**40.9**	100.0
	Total	22	100.0	100.0	

10.9.1 Synthesis of Technological Mechanisms

Knowledge management systems represent a weakness in the process of knowledge sharing within Elasis (overall mean = 2.70). Informal networks, mutual help, face-to-face interactions still represent the easier and quicker enabler of knowledge transfer. Problems concerning KMS emerge for every item, especially for knowledge integration, historical knowledge understanding, and time needed to retrieve knowledge.

Problems in knowledge integration are due mainly in the adoption of different KMS in different business lines or units, with the consequent proliferation of platforms and application that don't interact. Moreover, it is recognized the lack of an instant messaging application, whereas to overcome this problem employees adopt an asynchronous and less rapid communication tool, such as the e-mail.

The subjectivity with which knowledge is codified and archived makes knowledge understanding and reuse very difficult. Moreover, as templates and other standard for codification are not very frequently used, it is possible to imagine that historical knowledge is not even searched.

The analysis highlighted several differences in the perception of knowledge management systems effectiveness among respondents of both business lines. Comparing the mean for both business lines they have in common a critical attitude towards firms' KMS (Vehicle mean= 2.77 ICT mean = 2.61). Employees of the Vehicle business line criticize more than their colleague of the business line ICT the organization of knowledge and its codification through templates, whereas employees of the business line ICT are more critical towards knowledge integration through KMS and time needed for searching for knowledge.

Knowledge management systems in Elasis are old and lack of several important applications. For example through the intranet is not possible to get information on market or macroeconomic trends or improvements done by competitors in the automative domain and so on.

Overall Statistics

		Knowledge accessibility	Knowledge format	Knowledge Accuracy	Knowledge integration	Time needed	Search functionalities effectiveness	MEAN
N	Valid	50	50	50	50	50	50	50
	Missing	0	0	0	0	0	0	0
Mean		2.86	3.06	**2.48**	**2.40**	**2.48**	2.96	**2.70**
Median		3.00	3.00	2.00	2.00	2.00	3.00	
Mode		2.00	4.00	2.00	2.00	2.00	4.00	
Std. Deviation		1.10675	.97750	.86284	.96890	1.01499	1.04900	
Variance		1.22490	.95551	.74449	.93878	1.03020	1.10041	

Vehicle Overall Statistics

		Knowledge accessibility	Knowledge format	Knowledge Accuracy	Knowledge integration	Time needed	Search functionalities effectiveness	Mean
N	Valid	28	28	28	28	28	28	
	Missing	0	0	0	0	0	0	
Mean		**2.67**	2.89	**2.46**	**2.75**	2.82	3.07	**2.77**
Median		2.00	3.00	2.00	3.00	3.00	3.00	
Mode		2.00	3.00	2.00	2.00	3.00	3.00	
Std. Deviation		1.09048	.87514	.83808	.79931	1.05597	.94000	
Variance		1.18915	.76587	.70238	.63889	1.11508	.88360	

ICT Overall Statistics

		Knowledge accessibility	Knowledge format	Knowledge Accuracy	Knowledge integration	Time needed	Search functionalities effectiveness	Mean
N	Valid	22	22	22	22	22	22	
	Missing	0	0	0	0	0	0	
Mean		3.09	3.27	**2.50**	**1.95**	**2.04**	2.82	**2.61**
Median		4.00	4.00	2.00	2.00	2.00	3.00	
Mode		4.00	4.00	2.00	2.00	2.00	4.00	
Std. Deviation		1.10880	1.07711	.91287	.99892	.78542	1.18065	
Variance		1.22944	1.16017	.83333	.99784	.61688	1.39394	

10.10 Knowledge Sharing Performance

As we can see from statistics the overall evaluation of the performance of knowledge sharing is low (overall mean=2.77).

Knowledge sharing performance suffer more on two variables, the knowledge of who is working on what (Mean= 2.52, mode=2, median =2) and the transfer of best practice (Mean= 2.42, mode=2, median =2).

A 66% of employees don't know what their colleagues are doing during the hour of work, and only 20% among them declare of knowing who is working on what.

A small difference exist between the two business lines, whereas in Vehicle 71.4% (mean=2.39 mode=2, median =2 of respondents disagree on the statement, while in ICT this percentage is lower (59.1% Mean=2.68, mode=2, median =2).

For what concerns best practice, from interviews we got that no routines exist for sharing best practice among firms' employees. Even on the KM platform no space for them is present. In fact, 60% confirm this situation, while 18% don't know about best practice and 20% confirm to have gotten best practice somewhere within the firm.

The two business lines manifested a common judgment on this tem (Mean Vehicle 2.46, mean ICT 2.36)

Moreover, from interviews was evident that both best practice sharing and knowledge of who is working on what are two kind of knowledge available only by informal communication by the coffee machine. No organizational routine exist for making circulating these information. Also for this item the two business lines expressed the same opinion (Mean Vehicle 2.39, mean ICT 2.68)

In addition, it was found that the Knowledge at disposition to employees is scarcely sufficient, since the majority of respondents 48% declare that the information at his disposition through Knowledge management systems and person-to-person knowledge exchange is not sufficient for his work, 42% doesn't agree with that and 10% don't know.

Here we found a contradicting evaluation from the two business lines. The majority of respondent by the business line Vehicle declared that the knowledge at their disposition was not sufficient (53.6%, mean =2.64) whereas the majority of respondents among ICT (59.1%, mean=3.32) judged sufficient the knowledge at their disposition.

The knowledge of who is expert on what is more developed than other items (Mean=3.20). Even for this variable there is a strong percentage of people who declare to having difficulties in identifying who is expert on what (cumulative percent = 34%), even if the majority have a different opinion (48%).

The business lines manifested here a contradicting opinion, where the respondents among Vehicle confirmed more strongly their knowledge of the experts within their business line (3.28) than the business line ICT (3.08).However, the difference was not significant.

KS Who is working on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	4.0	4.0	4.0
	2.00	**31**	**62.0**	**62.0**	66.0
	3.00	7	14.0	14.0	80.0
	4.00	9	18.0	18.0	98.0
	5.00	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Vehicle KS Who is working on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	2	7.1	7.1	7.1
	2.00	**18**	**64.3**	**64.3**	71.4
	3.00	4	14.3	14.3	85.7
	4.00	3	10.7	10.7	96.4
	5.00	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

ICT KS Who is working on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**13**	**59.1**	**59.1**	**59.1**
	3.00	3	13.6	13.6	72.7
	4.00	6	27.3	27.3	100.0
	Total	22	100.0	100.0	

KS Who is expert on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	2.0	2.0	2.0
	2.00	**16**	**32.0**	**32.0**	**34.0**
	3.00	9	18.0	18.0	52.0
	4.00	**20**	**40.0**	**40.0**	92.0
	5.00	**4**	**8.0**	**8.0**	100.0
	Total	50	100.0	100.0	

Vehicle KS Who is expert on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1.00	1	3.6	3.6	3.6
	2.00	6	21.4	21.4	25.0
	3.00	7	25.0	25.0	50.0
	4.00	**12**	**42.9**	**42.9**	92.9
	5.00	**2**	**7.1**	**7.1**	100.0
	Total	28	100.0	100.0	

ICT KS Who is expert on what

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**2.00**	**10**	**45.5**	**45.5**	**45.5**
	3.00	2	9.1	9.1	54.5
	4.00	8	36.4	36.4	90.9
	5.00	2	9.1	9.1	100.0
	Total	22	100.0	100.0	

KS Knowledge completeness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**3**	**6.0**	**6.0**	**6.0**
	2.00	**21**	**42.0**	**42.0**	**48.0**
	3.00	5	10.0	10.0	58.0
	4.00	**18**	**36.0**	**36.0**	94.0
	5.00	**3**	**6.0**	**6.0**	100.0
	Total	50	100.0	100.0	

Vehicle KS Knowledge completeness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**3**	**10.7**	**10.7**	**10.7**
	2.00	**12**	**42.9**	**42.9**	**53.6**
	3.00	5	17.9	17.9	71.4
	4.00	8	28.6	28.6	100.0
	Total	28	100.0	100.0	

ICT KS Knowledge completeness

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	2.00	9	40.9	40.9	40.9
	4.00	**10**	**45.5**	**45.5**	86.4
	5.00	**3**	**13.6**	**13.6**	100.0
	Total	22	100.0	100.0	

KS Best practice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**11**	**22.0**	**22.0**	**22.0**
	2.00	**19**	**38.0**	**38.0**	**60.0**
	3.00	9	18.0	18.0	78.0
	4.00	10	20.0	20.0	98.0
	5.00	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Vehicle KS Best practice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**6**	**21.4**	**21.4**	**21.4**
	2.00	**10**	**35.7**	**35.7**	**57.1**
	3.00	6	21.4	21.4	78.6
	4.00	5	17.9	17.9	96.4
	5.00	1	3.6	3.6	100.0
	Total	28	100.0	100.0	

ICT KS Best practice

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	**1.00**	**5**	**22.7**	**22.7**	**22.7**
	2.00	**9**	**40.9**	**40.9**	**63.6**
	3.00	3	13.6	13.6	77.3
	4.00	5	22.7	22.7	100.0
	Total	22	100.0	100.0	

10.10.1 Synthesis of the Results of Knowledge Sharing Performance

Statistics highlighted some problems related to the activity of sharing knowledge within Elasis. The more critical aspects to solve are related to the circulation of best practices, which actually are not recorded and codified.

Best practices are a very important factor in each organization, both public and private. Elasis could improve best practice sharing through creating an electronic house organ or a section over the KMS in which for each kind of activity employees can find the 'best practice'. Today, this work is asked to employees regrouped in communities of practices.

Moreover, the firm doesn't inform his employees about the work their colleagues are doing, creating a barrier on individual capabilities' awareness. This probably explicates the high frequency of informal communication both within and across business lines. From interviews we realized that this is due mainly to frequent informal conversations and discussion during the coffee breaks or in the smoking area. This lack of information emphasized much more within the business lines Vehicle.

However, the knowledge at disposition of the employees is not sufficient for performing their work, especially within the business line Vehicle.

The two typologies of knowledge, that is who is expert on what and who is working on what could be improved by the firm simply creating a showcase over the Elasis intranet or KMS where each employee briefly describe his expertise and actual projects on which is working.

Increasingly, from interviews we found that knowledge is shared mainly with employees of the same business units or belonging to other partner of the Fiat group. Employees collaborate and share knowledge more frequently with employees of other firms of the Fiat Group than with employees of the different business lines. This conclusion is probably influenced by the strong differences existing among the activities performed by both business lines. However, it is not a useful indicator when a firm is building a complex product like a car. Probably Elasis need urgently some employees that play the role of boundary spanners.

From interviews we got that in the database and KMS of the firm a lot of knowledge about product implementation and development is archived, but this is quite unusable due to the absence, in the past, of codification rules such as templates, libraries etc. etc.

Nowadays templates are present but a large percentage of employees are not aware about it, then it should be useful to manage some meeting in order to explain the reasons and foster the utilization of the codification tools actually available.

Overall

		KS.who is working on what	KS.who is expert on what	KS.Knowledge completeness	KS.best practice	Overall Mean
N	Valid	50	50	50	50	50
	Missing	0	0	0	0	0
Mean		**2.52**	**3.20**	**2.94**	**2.42**	**2.77**
Median		2.00	3.00	3.00	2.00	
Mode		2.00	4.00	2.00	2.00	
Std. Deviation		.90891	1.04978	1.13227	1.10823	
Variance		.82612	1.10204	1.28204	1.22816	

Vehicle Statistics

		KS.who is working on what	KS.who is expert on what	KS.Knowledge completeness	KS.best practice	Overall Mean
N	Valid	28	28	28	28	28
	Missing	0	0	0	0	0
Mean		**2.39**	**3.28**	**2.64**	**2.46**	**2.69**
Median		2.00	**3.50**	**2.00**	2.00	
Mode		2.00	**4.00**	**2.00**	2.00	
Std. Deviation		.91649	1.01314	1.02611	1.13797	
Variance		.83995	1.02646	1.05291	1.29497	

ICT Statistics

		KS.who is working on what	KS.who is expert on what	Knowledge completeness	KS.best practice	Overall Mean
N	Valid	22	22	22	22	22
	Missing	0	0	0	0	0
Mean		**2.68**	**3.09**	**3.32**	**2.36**	**2.85**
Median		2.00	**3.00**	**4.00**	2.00	
Mode		2.00	**2.00**	**4.00**	2.00	
Std. Deviation		.89370	1.10880	1.17053	1.09307	
Variance		.79870	1.22944	1.37013	1.19481	

The table below resumes the mean for every variable and for the constructs considered in the present analysis:

Item Statistics

	Mean	Std. Deviation	N
Org.Factors.Knowledge Sharing Routines	**2,7200**	1,16128	50
Org.Factors.Individual_Incentives	**2,1800**	1,02400	50
Org.Factors.Group_Incentives	**3,6200**	,80534	50
Org.Factors.Fragmentation	**2,6800**	,93547	50
Org.Factors.Distance	**3,9200**	1,36785	50
Org.Factors.Employees_Mobility	**3,8600**	1,22907	50
Org.Factors.Rigid_Org_Structures	**3,8067**	,52636	50
Social.Factors.Trust	**3,6200**	,72534	50
Social.Factors.Mutual_Help	**4,1400**	,67036	50
Soc.factors.Communication effectiveness	**3,6600**	,58632	50
Org. Factors Interaction frequency	3,0200	,99980	50
Social.Factors.Socialization	**3,9000**	,67763	50
Technological.Factors.Knowledge Accessibility	**2,8600**	1,10675	50
Technological.Factors.Knowledge Format	3,0600	,97750	50
Technological.Factors.Knowledge Accuracy	**2,4800**	,86284	50
Technological.Factors.Knowledge Integration	2,9000	,88641	50
Technological.Factors.Response Time	**2,4800**	1,01499	50
Technological.Factors.Search Functionalities Efffectiveness	2,9600	1,04900	50
KS.who is working on what	**2,5200**	,90891	50
KS.who is expert on what	3,2000	1,04978	50
KS.Knowledge Completeness	2,9400	1,13227	50
KS.best practice	**2,4200**	1,10823	50
SOC	**3,8300**	,32928	50
ORG	3,2552	,46426	50
TECH	2,7900	,62616	50
Knowledge Sharing Effectiveness	2,7700	,75397	50
NPD 1	2,9800	,71400	50
NPD 2	**2,6600**	,77222	50
NPD 3	**2,7600**	,82214	50
NPD 4	**2,5800**	,75835	50
NPD	**2,7450**	,63183	50

11. Multivariate Data Analysis

It is necessary to understand the role played by each assumption for every multivariate technique. The need to test the statistical assumptions is increased in multivariate applications because of two characteristics of multivariate data analysis. First, the complexity of the relationships, owing to the typical use of a large number of variables, makes the distortion and biases more potent when the assumptions are violated, particularly when the violation compound to become even more detrimental than if considered separately. Second, the complexity of the analysis and results may mask the indicators of assumptions violations apparent in the simpler univariate analysis.

Multivariate techniques (as well as univariate) are all based on a fundamental set of assumptions representing the requirements of the underlying statistical theory.

The 'search for structure' with factor analysis can reveal substantive interrelationships among variables and provide an objective basis for both conceptual and model development and improve parsimony among the variables in a multivariate analysis.

Factor analysis tools will help in preparing data for regression analysis and in data reduction and scale construction.

11.1 Factor Analysis

By examining the data before any multivariate technique the researcher get critical insights into the characteristics of data:

1) a researcher attains a basic understanding of the data and relationships between variables. Multivariate techniques place greater demands on the researcher to understand, interpret and articulate results based on relationships. A thorough knowledge of the variables interrelationships can aid immeasurably in the specification and refinement of the multivariate model as well as provide a reasoned perspective for interpretation of the results.
2) a researcher ensures that the data underlying the data analysis meet all of the requirements for a multivariate analysis. Missing data, outliers, and the statistical characteristics of the data are much more difficult to assess in a multivariate context. Thus, the analytical sophistication needed to ensure that these requirements are met forces the researcher to use a series of data examination techniques that are as complex as the multivariate techniques themselves.

The tools generally used for factor analysis are the Histogram, the BoxPlot, the Scatterplot, the normality test (skewness and kurtosis).

11.1.2 Normality test

The most fundamental assumption is normality, referring to the shape of the data distribution for an individual metric variable and its correspondence to the normal distribution, the benchmark for statistical method. If the variation to the normal distribution is sufficiently large, all resulting statistical tests are invalid, because normality is required to use the F and t statistics.

Multivariate normality (the combination of two or more variables) means that the individual variables are normal in a univariate sense and that their combinations are also normal. Thus, if a variable is multivariate normal, it is also univarite normal. However, the reverse is not necessarily true (Hair et al.: 80). Whether the variables exhibit an univariate normality, it will help gain multivariate normality.

The researcher has to consider the shape of the offending distribution and the sample size. The researcher must not only judge the extent to which the variable's distribution is nonnormal, but also the sample size involved.

11.1.3 Impacts due to the shape of the distribution

The researcher can describe that the shape of the distribution in order to see whether it differs from the normal distribution by two measures: kurtosis and skewness.

Kurtosis refers to the 'peakedness' or 'flatness' of a distribution compared with the normal distribution. Distributions that are taller or more peaked than the normal distribution are termed leptokurtic, while a distribution that is flatter is termed playkurtic.

Whereas kurtosis refers to the height of the distribution, skewness is used to describe the balance of the distribution; that is: is it unbalanced and shifted to one side or is it centered and symmetrical with about the same shape on both sides? Skewness is in fact a measure of symmetry or more precisely, of a lack of symmetry. A distribution (or data set) is symmetric if it looks the same to the left and right of the center point.

If a distribution is unbalanced, it is skewed. A positive skew denotes a distribution shifted to the left, whereas a negative skewness reflects a shift to the right.

Summarizing, a negative kurtosis value indicate a platykurtic distribution, while positive values denote a leptokurtic distribution. Likewise positive skewness values indicate the distribution shifted to the left, and the negative values denote a rightward shift.

11.1.4 Impacts due to the sample size

Larger sample size reduces the detrimental effects of nonnormality. In a small sample of 50 or fewer observations, and especially if the sample size is less than 30 or so, significant departures from normality can have a substantial impact on the results. From sample size of 200 or more, however, these same effects may be negligible.

To assess normality, it is possible to use two methods: visual check of the histogram and statistical test. In our analysis statistical test was used. The statistic value for the skewness is calculated:

$$z_{\text{skewness}} = \frac{\text{skewness}}{\sqrt{\frac{6}{N}}}$$

Where N is the sample size (50). A z can also be calculated for the kurtosis value using the following formula.

$$z_{\text{kurtosis}} = \frac{\text{kurtosis}}{\sqrt{\frac{6}{N}}}$$

If either calculated z value exceeds the specified critical value, then the distribution is nonnormal in terms of those characteristics.

The critical value is from a z distribution, based on the significance level we desire. The most commonly used critical values are ± 2.58 (0.1 significance level) and ± 1.96, which corresponds to a 0.5 error level.

As we can see from the table, the distribution is normal as all the variables never exceed ± 2.58 or ± 1.96.

Statistics Organizational Factors

	Knowledge Sharing Routines	Individual Incentives	Group Incentives	Fragmentation	Distance	Employees Mobility	Rigid Org. Structures	ORG
N	50	50	50	50	50	50	50	50
Skewness	**.334**	**.811**	**.080**	**.384**	**-.648**	**-.891**	**-.891**	**-.683**
Std. Error of Skewness	.337	.337	.337	.337	.337	.337	.337	.337
Kurtosis	**-.984**	**.111**	**-.483**	**-1.263**	**-1.509**	**-.173**	**-1.033**	**.411**
Std. Error of Kurtosis	.662	.662	.662	.662	.662	.662	.662	.662

Kurtosis and skewness of organizational factors.

Statistics Social Factors

	Trust	Mutual Help	Socialization	Soc.factors.Communication effectiveness	Interaction Frequency	SOC
N	50	50	50	50	50	50
Skewness	**-.271**	**-.592**	**-.697**	**-.060**	**.725**	**-.192**
Std. Error of Skewness	.337	.337	.337	.337	.337	.337
Kurtosis	**-.007**	**1.043**	**1.355**	**-.932**	**-.465**	**-.545**
Std. Error of Kurtosis	.662	.662	.662	.662	.662	.662

Kurtosis and skewness of social factors

Statistics Technological Factors

		Knowledge accessibility	Knowledge accuracy	Knowledge Format	Knowledge Integration	Response Time	Search Functionalities effectiveness	TECH
N	Valid	50	50	50	50	50	50	50
	Missing	0	0	0	0	0	0	0
Skewness		**.100**	**-.533**	**.263**	**.018**	**.483**	**-.360**	**-.048**
Std. Error of Skewness		.337	.337	.337	.337	.337	.337	.337
Kurtosis		**-1.202**	**-.979**	**-.543**	**-.468**	**-.500**	**-.862**	**.306**
Std. Error of Kurtosis		.662	.662	.662	.662	.662	.662	.662

Kurtosis and skewness of technological factor variables

Statistics Knowledge Sharing Performance

		Knowledge Sharing Performance	Knowledge Sharing Performance	Knowledge Sharing Performance	Knowledge Sharing Performance
N	Valid	50	50	50	50
	Missing	0	0	0	0
Skewness		**.958**	**-.088**	**.122**	**.398**
Std. Error of Skewness		.337	.337	.337	.337
Kurtosis		**-.005**	**-1.164**	**-1.289**	**-.854**
Std. Error of Kurtosis		.662	.662	.662	.662

Kurtosis and skewness of knowledge sharing performance variables

11.2 Factor analysis decision process

A research generally contains a certain number of variables, however sometimes it is difficult whenever impossible to identify general evaluative dimensions for including such variables.
For example consumers may consider salesperson to be a more general evaluative dimension than is composed of many more specific characteristics, such as knowledge, courtesy, likeability, sensitivity, friendliness, helpfulness etc. To identify these broader dimensions the retailer could commission a survey asking for consumer evaluations on each of the 80 specified items. Factor analysis is used to identify the broader underlying evaluative dimensions.

11.2.1 Stage 1. Objective of factor analysis

The objective of factor analysis is to find a way to summarize (condense) the information contained in a number of original variables into a smaller set of new, composite dimensions or variate (factor) with a minimum loss of information.
In achieving its objective, factor analysis is keyed to 4 issues:

a. specify the unit of analysis;
b. achieving data summarization and/or data reduction;
c. variable selection;
d. using factor analysis results with other multivariate techniques.

a. Specify the unit of analysis

Thus, the researcher have to choose the unit of analysis for f.a., generally it is between respondents/cases or variables. In our case we will adopt variables.

b. Data summarization

The goal of data summarization is the definition of a structure and this is achieved only by defining a small numbers of factor that adequately represent the original set of variables. It is important to highlight that in factor analysis all variables are considered with no distinction as to dependent or independent variables.
Conversely, one can look at each factor as a dependent variable that is a function of the entire set of observed variables (Hair et al. 2006).
However, the structure is defined by the interrelatedness among variables allowing for the specification of a smaller number of dimensions representing the original set of variables.

b. Data reduction

Data reduction is an other goal of f.a. and can be achieved by:

1. identifying representative variables from a much larger set of variables for use in subsequent multivariate analyses;
2. creating an entirely new set of variables, much smaller in number, to partially or completely replace the original set of variables.

The goal is to reduce the number of variables in order to simplify the multivariate analyses.

11.2.2 Stage 2. Designing factor analyses

The first decision to take into this stage is whether calculating factor analysis with respondents or with variables. Our analysis focuses on correlation among variables, then we are going to adopt the R-Type factor analysis.

- Variable selection d measurement Issues

At this stage, we have to answer to two specific questions, such as: What type of variables can be used in factor analysis? How many variables should be included?

A correlation value can be calculated among all variables; however it is important to reduce the number of variables considering that our sample size is also limited. In our study we have three factors, such as organizational barriers, social barriers, technological barriers and one dependent variable, which is knowledge sharing performance. It is important to have a couple of variables for each factor. Literature proposes to include several variables (five or more) for each factor. Factor analysis is done in order to reduce the number of variables in order to identify a single variable for each factor. However, before doing a factor analysis it is important to identify several key variables (key indicants) that closely reflect the hypothesized underlying factor (Hair et al. 2006).

- Sample size

For what concerns the sample, generally factor analyse lose efficiency for sample lower than 50 observations, preferably the sample size should be 100 or larger. The general rule for factor analysis is to have at least five times as many observations as the number of variables to be analyzed, and the more acceptable sample size would have a 10:1 ration.

However, in our case it is impossible to obtain an adequate sample size, since our sample size is composed of 50 observations and we have 24 variables, 11 for organizational barriers, 3 for social barriers, 6 for technological barriers, and 4 for knowledge sharing performance.

In order to make factor analysis as much correct as possible we try to reduce the number of variables maintaining the variables that are more significant for our analysis.

Since our goal is to measure the barriers to knowledge transfer, we maintain the variables that better represent the factor of the analysis and that presented the lowest point in the statistical analysis made before.

Form the analysis we found that the main problems to knowledge sharing are related to the technological factor's variables. For this reason we selected the most significant variables of this factor and we made a pre-test to see whether there is a correlation among variables.

X1 Organizational factor. Knowledge Sharing Routines
X2 Organizational factor. Group Incentives
X3 Organizational factor. Individual Incentives
X4 Organizational factor. Fragmentation
X5 Organizational factor. Formal Organizational Structures
X6 Organizational factor. Distance
X7 Organizational factor. Employees' mobility

X 8 Social Factor. Trust
X 9 Social Factor. Mutual Help
X 10 Social Factor. Socialization
X11 Social Factor. Interaction Frequency
X 12 Social Factor. Communication effectiveness

X 13 Technological Factor. Knowledge Accessibility
X 14 Technological Factor. Knowledge Format
X 15 Technological Factor. Knowledge Accuracy
X16 Technological Factor. Knowledge Integration
X17 Technological Factor. Response Time
X18 Technological Factor. Search Functionalities Effectiveness

11.2.3 Stage 3. Assumptions in factor analysis

Conceptual issues

A basic assumption of factor analysis is that some underlying structure does exist in the set of selected variables.

It is not correct to mix dependent and independent variables in a single factor analysis and then using the derived factor to support dependence relationship. Moreover, the sample should be homogeneous, it is not appropriate to do factor analysis to a sample of male and females for a set of items known to differ because of gender. The combination of these data will be a poor representation of the unique structure of each group.

Some degree of multicollinearity is desirable, because the objective is to identify interrelated set of variables.

11.2.3.1 Measures of Intercorrelation

Correlations

It is important first to measure the number of correlations that exceeds .30. If there is not a substantial number of a correlation greater than .30 factor analysis is probably inappropriate.

The correlations among variables can also be analyzed by computing the partial correlations among variables.

In our case, the correlation matrix reveals that 40 of the 289 correlations are significant, which provide 13.84% of significance; tabulating the number of significant correlation per variables finds a range from 6 (Ind. Incentives) to 0 (Mutual help, Socialization, Fragmentation, Mobility).

	Org.Factors. Knowledge Sharing Routines	Org.Factors. Individual_Incentives	Org.Factors. Group_Incentives	Org.Factors. Fragmentation	Org.Factors.Employees_Mobility	Org.Factors.Rigid_Org_Structures	Org.Factors. Distance
Org.Factors.Knowledge Sharing Routines	1,000	**,421**	**-,443**	,179	,072	-,035	,243
Org.Factors.Individual_Incentives	**,421**	1,000	**-,485**	,232	,004	,255	**,375**
Org.Factors.Group_Incentives	**-,443**	**-,485**	1,000	-,029	,069	-,177	-,065
Org.Factors.Fragmentation	,179	,232	-,029	1,000	-,058	,120	,091
Org.Factors.Employees_Mobility	,072	,004	,069	-,058	1,000	,147	,054
Org.Factors. Rigid_Org_Structures	-,035	,255	-,177	,120	,147	1,000	,082
Social.Factors.Trust	-,129	-,291	,062	-,183	,191	-,143	**-,402**
Social.Factors.Soc.factors.Communication effectiveness	-,008	**,308**	-,247	,086	,074	**,637**	,061
Social Factors Interaction frequency	-,083	-,004	-,041	,072	,052	,176	-,103
Social.Factors.Mutual_Help	,182	,260	-,088	-,025	,222	**,425**	,124
Social.Factors.Socialization	,016	,056	-,034	-,212	-,042	,269	,233
Technological.Factors.Knowledge Accessibility	,271	**,383**	,054	,291	-,105	,256	,127
Technological.Factors.Knowledge Format	,105	,295	-,126	,133	,024	,023	,187
Technological.Factors.Knowledge Accuracy	,178	,247	-,055	,245	,084	,014	,172
Technological.Factors.Knowledge Integration	,250	**,313**	-,054	-,138	,043	-,086	,027
Technological.Factors.Response Time	**,515**	,072	-,272	,122	-,043	-,167	,028
Technological.Factors.Search Functionalities Effectiveness	-,043	,007	,151	,153	-,099	-,224	-,045
Org.Factors.Distance	,243	**,375**	-,065	,091	,054	,082	1,000

		Technological. Factors.Knowledge Accessibility	Technological .Factors.Knowledge Format	Technological .Factors.Knowledge Accuracy	Technological .Factors.Knowledge Integration	Technological .Factors.Response Time	Technological. Factors.Search Functionalities Efffectiveness
Correlation	Org.Factors.Knowledge Sharing Routines	,271	,105	,178	,250	**,515**	-,043
	Org.Factors.Individual_Incentives	**,383**	,295	,247	**,313**	,072	,007
	Org.Factors.Group_Incentives	,054	-,126	-,055	-,054	-,272	,151
	Org.Factors.Fragmentation	,291	,133	,245	-,138	,122	,153
	Org.Factors.Distance	,127	,187	,172	,027	,028	-,045
	Org.Factors.Employees_Mobility	-,105	,024	,084	,043	-,043	-,099
	Org.Factors.Rigid_Org_Structures	,256	,023	,014	-,086	-,167	-,224
	Social.Factors.Trust	-,271	-,313	-,029	-,219	,170	,006
	Social.Factors.Mutual_Help	,109	,049	,023	,093	-,011	-,137
	Social.Factors. Soc.factors.Communication effectiveness	-,012	-,195	-,104	,002	-,235	**-,388**
	Social.Factors.Interaction frequency	-,163	-,273	-,130	-,113	,031	-,135
	Social.Factors.Socialization	,253	,071	-,161	,051	,071	,023
	Technological.Factors.Knowledge Accessibility	1,000	**,310**	**,328**	,297	,025	**,329**
	Technological.Factors.Knowledge Format	**,310**	1,000	**,546**	**,502**	,135	**,400**
	Technological.Factors.Knowledge Accuracy	**,328**	**,546**	1,000	,278	,174	**,315**
	Technological.Factors.Knowledge Integration	,297	**,502**	,278	1,000	,077	,259
	Technological.Factors.Response Time	,025	,135	,174	,077	1,000	**,363**

	Technological.Factors.Search Functionalities Efffectiveness	**,329**	**,400**	**,315**	,259	**,363**	1,000

Bartlett test of Sphericity

A method for measuring the appropriateness of factor analysis examines the entire correlation matrix. The Bartlett test of sphericity is a test for the presence of correlations among the variables. Barlett test of sphericity, variable projected upon an n-dimensional spheroid, the significance of the relationship is then evaluated. It provides the statistical significance that the correlation matrix has significant correlations among at least some of the variables. A statistically significant Bartlett's test of sphericity (sig.<.05) indicates that sufficient correlation exist among the variables to proceed.

Several variables seem to be not significant, moreover the set of variables present some problems also in the MSA and in the anti-image test).

An other measure to quantify the degree of Intercorrelation among variables and the appropriateness of factor analysis is the measure of sampling adequacy (MSA).

Value of 1 relates a complete relationship, totally related, which is bad. The range which is provided as a heuristic is:

0.8 (or above) – meritorious,
0.7 (or above)- middling,
0.6 (or above)- mediocre, or
0.5 (or above)- miserable (perfectly uncorrelated).
Below 0.50 – unacceptable.

Measure of sampling adequacy values must exceed .50 for both the overall test and each individual variable; variables with values less than .50 should be omitted from the factor analysis one at a time, with the smallest one being omitted each time.

The measure of sampling adequacy with 18 variables presented a level of acceptance quite miserable.

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,510
Bartlett's Test of Sphericity	Approx. Chi-Square	313,569
	df	153
	Sig.	,000

After having performed MSA and Bartlett test we proceed to the deletion of some variables as we will see in the next paragraph.

The variables deleted are: Mutual help, Socialization, Fragmentation, Mobility, the new correlation matrix is composed of 14 variables and 41 significant correlations. As matter of fact, we did correlation again with the new set of variables. The new correlation matrix the correlation matrix reveals that 41 of the 182 correlations are significant, which provide a percentage of 22.52% of statistically significant correlations.

	Org.Factors. Knowledge Sharing Routines	Org.Factors. Individual_Incentives	Org.Factors. Group_Incentives	Org.Factors.Rigid_Org_Structures	Org.Factors.Distance
Org.Factors.Knowledge Sharing Routines	1,000	**,421**	**-,443**	-,035	,243
Org.Factors.Individual_Incentives	**,421**	1,000	**-,485**	,255	**,375**
Org.Factors.Group_Incentives	**-,443**	**-,485**	1,000	-,177	-,065
Org.Factors.Rigid_Org_Structures	-,035	,255	-,177	1,000	,082
Org.Factors.Distance	,243	**,375**	-,065	,082	1,000
Social.Factors.Trust	-,129	-,291	,062	-,143	**-,402**
Soc.factors.Soc.factors.Communication effectiveness	-,008	**,308**	-,247	,**637**	,061
Soc.factors.Interaction frequency	-,083	-,004	-,041	,176	-,103
Technological.Factors.Knowledge Accessibility	,271	**,383**	,054	,256	,127
Technological.Factors.Knowledge Format	,105	,295	-,126	,023	,187
Technological.Factors.Knowledge Accuracy	,178	,247	-,055	,014	,172
Technological.Factors.Knowledge Integration	,250	**,313**	-,054	-,086	,027
Technological.Factors.Response Time	**,515**	,072	-,272	-,167	,028

Technological.Factors.Search Functionalities Effectiveness	-,043	,007	,151	-,224	-,045

		Social.Factors.Trust	Social.Factors.Soc.factors.Communication effectiveness	Social.Factors. Org. Factors Interaction frequency
Correlation	Org.Factors.Knowledge Sharing Routines	-,129	-,008	-,083
	Org.Factors.Individual_Incentives	-,291	**,308**	-,004
	Org.Factors.Group_Incentives	,062	-,247	-,041
	Org.Factors.Rigid_Org_Structures	-,143	**,637**	,176
	Org.Factors.Distance	**-,402**	,061	-,103
	Social.Factors.Trust	1,000	-,142	-,017
	Soc.factors.Communication effectiveness	-,142	1,000	**,621**
	Org. Factors Interaction frequency	-,017	**,621**	1,000
	Technological.Factors.Knowledge Accessibility	-,271	-,012	-,163
	Technological.Factors.Knowledge Format	**-,313**	-,195	-,273
	Technological.Factors.Knowledge Accuracy	-,029	-,104	-,130
	Technological.Factors.Knowledge Integration	-,219	,002	-,113
	Technological.Factors.Response Time	,170	-,235	,031
	Technological.Factors.Search Functionalities Efffectiveness	,006	**-,388**	-,135

		Technological. Factors.Knowledge Accessibility	Technological .Factors.Knowledge Format	Technological .Factors.Knowledge Accuracy	Technological .Factors.Knowledge Integration	Technological .Factors.Response Time	Technological. Factors.Search Functionalities Efffectiveness
Correlation	Org.Factors.Knowledge Sharing Routines	,271	,105	,178	,250	**,515**	-,043
	Org.Factors.Individual_Incentives	**,383**	,295	,247	**,313**	,072	,007
	Org.Factors.Group_Incentives	,054	-,126	-,055	-,054	-,272	,151
	Org.Factors.Rigid_Org_Structures	,256	,023	,014	-,086	-,167	-,224
	Social.Factors.Trust	-,271	**-,313**	-,029	-,219	,170	,006
	Soc.factors.Communication effectiveness	-,012	-,195	-,104	,002	-,235	**-,388**
	Org. Factors Interaction frequency	-,163	-,273	-,130	-,113	,031	-,135
	Technological.Factors.Knowledge Accessibility	1,000	**,310**	**,328**	,297	,025	**,329**
	Technological.Factors.Knowledge Format	**,310**	1,000	**,546**	**,502**	,135	**,400**
	Technological.Factors.Knowledge Accuracy	**,328**	**,546**	1,000	,278	,174	,315
	Technological.Factors.Knowledge Integration	,297	,**502**	,278	1,000	,077	,259
	Technological.Factors.Response Time	,025	,135	,174	,077	1,000	**,363**
	Technological.Factors.Search Functionalities Efffectiveness	**,329**	**,400**	**,315**	,259	**,363**	1,000
	Org.Factors.Distance	,127	,187	,172	,027	,028	-,045

Since the there was some problems with the number of factors and Bartlett test, we deleted some variables, which presented a MSA values under .50, and we did the Kaiser-Meyer-Olkin Measure of sampling adequacy again. We decided to perform again the Bartlett' test with the new set of variables. The Kaiser-Meyer-Olkin Measure of sampling adequacy score is higher but still miserable (0.546).

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		,546
Bartlett's Test of Sphericity	Approx. Chi-Square	248,969
	Df	91
	Sig.	,000

Anti-Image correlation

A high partial correlation is one with practical and statistical significance, and a rule of thumb is would be to consider partial correlations above .7 as high. Anti-Image correlation matrix is just the negative value of the partial correlation. In each case, larger partial or anti-image correlations are indicative of data matrix perhaps not suited to factor analysis. Here we propose the anti-image correlation with 14 variables.

Anti-image Matrices

	Org.Factors. Knowledge Sharing Routines	Org.Factors.In dividual_Incent ives	Org.Factors.Pr oximity	Org.Factors.Gr oup_Incentive s	Social.Factors. Trust	Communicatio n effectiveness	Soc. factors Interaction frequency	Technological. Factors.Knowl edge Accessibility	Technological. Factors.Knowl edge Format	Technological. Factors.Knowl edge Accuracy	Technological. Factors.Knowl dge Integration	Technologic al.Factors.R esponse Time	Technological.Factors.S earch Functionaliti es Efffectivene ss
Org.Factors.Knowledge Sharing Routines	,392	-,050	-,071	,120	,057	,047	,022	-,146	,093	-,048	-,141	-,231	,161
Org.Factors.Individual_In centives	-,050	,436	-,171	,198	-,014	-,090	,022	-,141	-,023	-,016	-,081	,043	-,028
Org.Factors.Group_Ince ntives	,120	,198	-,143	,510	-,018	,097	-,070	-,162	,088	-,029	-,115	,078	-,029
Social.Factors.Trust	,057	-,014	,229	-,018	,622	-,004	,087	,107	,160	-,161	,029	-,121	,000
Communication effectiveness	,047	-,090	-,034	,097	-,004	,366	-,274	-,069	,035	-,006	-,065	,071	,124
Org. Factors Interaction frequency	,022	,022	,081	-,070	,087	-,274	,464	,087	,066	-,034	,031	-,116	-,066
Technological.Factors.K nowledge Accessibility	-,146	-,141	,109	-,162	,107	-,069	,087	,555	-,001	-,090	,036	,075	-,176
Technological.Factors.K nowledge Format	,093	-,023	-,020	,088	,160	,035	,066	-,001	,414	-,230	-,193	-,040	-,060
Technological.Factors.K nowledge Accuracy	-,048	-,016	-,081	-,029	-,161	-,006	-,034	-,090	-,230	,606	,027	,011	-,037
Technological.Factors.K nowldge Integration	-,141	-,081	,138	-,115	,029	-,065	,031	,036	-,193	,027	,611	,052	-,088
Technological.Factors.R esponse Time	-,231	,043	-,033	,078	-,121	,071	-,116	,075	-,040	,011	,052	,427	-,193
Technological.Factors.S earch Functionalities Efffectiveness	,161	-,028	,016	-,029	,000	,124	-,066	-,176	-,060	-,037	-,088	-,193	,477
Org.Factors.Proximity	-,071	-,171	,652	-,143	,229	-,034	,081	,109	-,020	-,081	,138	-,033	,016
Org.Factors.Knowledge Sharing Routines	**,518(a)**	-,122	-,140	,270	,115	,125	,050	-,314	,230	-,098	-,288	-,564	,372
Org.Factors.Individual_In centives	-,122	**,705(a)**	-,321	,419	-,027	-,225	,049	-,287	-,054	-,030	-,158	,100	-,062
Org.Factors.Group_Ince ntives	,270	,419	-,249	**,515(a)**	-,033	,224	-,143	-,304	,191	-,051	-,205	,166	-,058
Social.Factors.Trust	,115	-,027	,360	-,033	**,555(a)**	-,008	,161	,182	,315	-,262	,047	-,235	-,001
Communication effectiveness	,125	-,225	-,070	,224	-,008	**,527(a)**	-,664	-,153	,091	-,013	-,138	,180	,298
Org. Factors Interaction frequency	,050	,049	,147	-,143	,161	-,664	**,456(a)**	,171	,149	-,064	,059	-,260	-,141
Technological.Factors.K nowledge Accessibility	-,314	-,287	,181	-,304	,182	-,153	,171	**,569(a)**	-,003	-,155	,062	,155	-,341
Technological.Factors.K nowledge Format	,230	-,054	-,038	,191	,315	,091	,149	-,003	**,660(a)**	-,459	-,384	-,096	-,135
Technological.Factors.K nowledge Accuracy	-,098	-,030	-,128	-,051	-,262	-,013	-,064	-,155	-,459	**,690(a)**	,044	,021	-,068
Technological.Factors.K nowldge Integration	-,288	-,158	,219	-,205	,047	-,138	,059	,062	-,384	,044	**,634(a)**	,103	-,162
Technological.Factors.R esponse Time	-,564	,100	-,063	,166	-,235	,180	-,260	,155	-,096	,021	,103	**,453(a)**	-,428
Technological.Factors.S earch Functionalities Efffectiveness	,372	-,062	,029	-,058	-,001	,298	-,141	-,341	-,135	-,068	-,162	-,428	**,558(a)**

11.2.4 Stage 4: Partitioning the variance of a variable

We used component analysis as our objective was to summarize most of the original information (variance) in a minimum number of factors for prediction purposes.
Component analysis considers the total variance and derives factor that contain small proportions of unique variance and, in some instances, error variance.
In factor analysis we group variables by their correlations, such that variables in a group (factor) have high correlation with each other. Thus, for the purpose of factor analysis, it is important to understand how much of a variables' variance is shared with other variables in that factor versus what cannot be shared. The total variance of any variable can be divided into three types of variance:

- Common variance, is defined as that variance in a variable that is shared with all other variables in the analysis. This variance is accounted for (shared) based on variable's correlations with all other variables in the analysis. A variable's communality is the estimate of its shared, or common, variance among the variables as represented by the derived factor.
- Specific variance. Is associated with only a specific variable. This variance cannot be explained by the correlations to the other variables but is still associated uniquely with a single variable.
- Error variance. Is also variance that cannot be explained by correlations with other variables, but it is due to unreliability in the data-gathering process, measurement error, or a random component in the measured problem.

Thus, the total variance of any variable is composed of its common, unique, and error variances.

Criteria for the number of factor to extract

We have different criteria for the number to extract to adopt, these are:

1) Root criterion (or eigenvalues)

With component analysis each variable contributes a value of 1 to the total eigenvalue.
Researchers seldom use a criterion such as the latent root as a guideline for the first attempt at interpretation.
Thus, only the factor with latent roots or eigenvalues greater than 1 are considered significant; all factor with latent roots less than 1 are considered insignificant and are disregarded. Using the eigenvalue for establishing a cutoff is most reliable when the number of variables is between 20 and 50.
As it is possible to note from the table below in our case, we have 7 components that present an eigenvalue higher or equal to 1.

2) Percentage of variance criterion

The percentage of variance criterion is an approach based on achieving a specified cumulative percentage of total variance extracted by successive factor. The purpose is to ensure practical significance for the derived factor by ensuring that they explain at least a specified amount of variance. In social sciences, it is not common to consider solution that accounts for 60 % of the total variance as satisfactory.

The table below shows the result of our analysis with 18 variables, we account for seven factors that cumulatively explain 72.69% of the variance, which is sufficient in terms of total variance explained, even if the fifth factor do not reach precisely eigenvalue 1.0. However when eigenvalue is quite close to 1., then it might be considered for inclusion as well. The first component explains 18.93% of variance, the second explains the 15.05% of variance, and the third 9.62% of variance and so on.

Total Variance Explained (18 variables)

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3,408**	**18,935**	**18,935**	3,408	18,935	18,935
2	**2,709**	**15,052**	**33,988**	2,709	15,052	33,988
3	**1,732**	**9,624**	**43,612**	1,732	9,624	43,612
4	**1,579**	**8,775**	**52,387**	1,579	8,775	52,387
5	**1,320**	**7,334**	**59,720**	1,320	7,334	59,720
6	**1,197**	**6,649**	**66,369**	1,197	6,649	66,369
7	**1,138**	**6,321**	**72,691**	1,138	6,321	72,691
8	,917	5,096	77,786			
9	,832	4,625	82,411			
10	,730	4,057	86,467			
11	,556	3,087	89,555			
12	,519	2,881	92,436			
13	,403	2,241	94,677			
14	,266	1,477	96,155			
15	,245	1,363	97,518			
16	,186	1,033	98,551			
17	,153	,850	99,401			
18	,108	,599	100,000			

Extraction Method: Principal Component Analysis.

We performed variance test also with the 14 variables excluding the ones identified by the correlation matrix, barlettt test and anti-image. The following table shows that for explaining a 62.73% cumulative percentage, 4 factors are necessary. Our reduced number of variables and factor on the contrary explains about the same percentage of variance with 4 factors less.

Total Variance Explained (14 variables)

Total Variance Explained

Component	Initial Eigenvalues	Extraction Sums of Squared Loadings

	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	**3,242**	**23,154**	**23,154**	3,242	23,154	23,154
2	**2,579**	**18,418**	**41,572**	2,579	18,418	41,572
3	**1,686**	**12,040**	**53,612**	1,686	12,040	53,612
4	**1,277**	**9,120**	**62,732**	1,277	9,120	62,732
5	,946	6,757	69,489			
6	,918	6,556	76,046			
7	,843	6,024	82,069			
8	,666	4,757	86,827			
9	,545	3,892	90,719			
10	,491	3,511	94,229			
11	,265	1,892	96,121			
12	,238	1,702	97,823			
13	,187	1,333	99,157			
14	,118	,843	100,000			

Extraction Method: Principal Component Analysis.

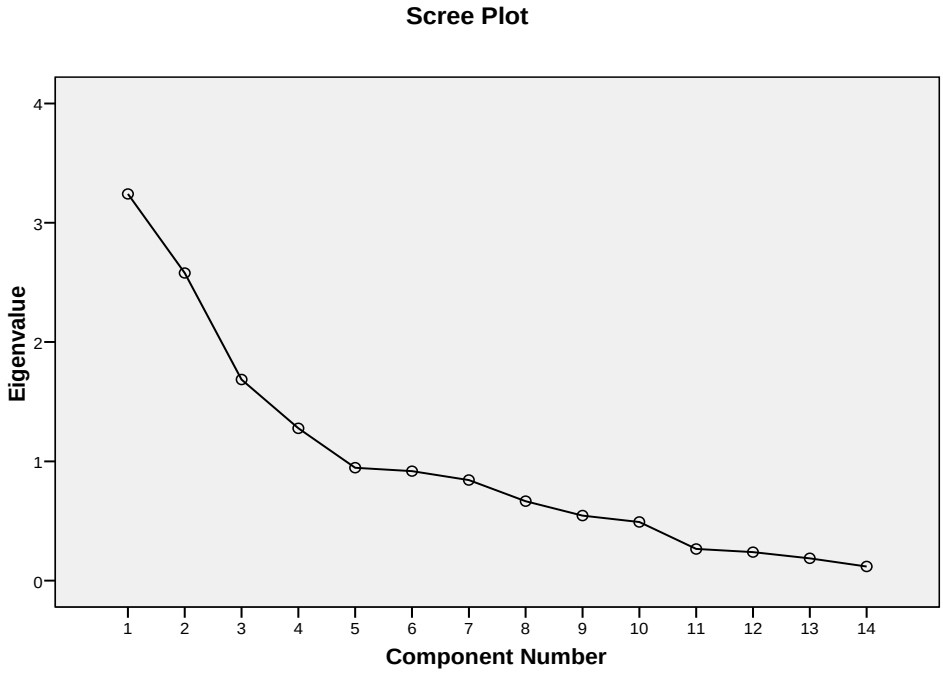
Component Matrix(a)

	Component			
	1	**2**	**3**	**4**
Org.Factors.Knowledge Sharing Routines	,566	,157	**-,600**	-,186
Org.Factors.Individual_Incentives	**,663**	,481	-,086	-,085
Org.Factors.Group_Incentives	-,341	-,427	**,574**	,057
Org.Factors.Distance	,414	,239	,109	**-,569**
Org.Factors.Org.Factors.Rigid_Org_Structures	,078	**,690**	,247	,248
Social.Factors.Trust	**-,413**	-,305	-,406	,363
Soc.factors.Communication effectiveness	-,092	**,889**	,078	,311
Org. Factors Interaction frequency	-,270	**,513**	-,113	,502
Technological.Factors.Knowledge Accessibility	**,611**	,037	,318	,172
Technological.Factors.Knowledge Format	**,730**	-,211	,269	,106
Technological.Factors.Knowledge Accuracy	**,611**	-,176	,114	,272
Technological.Factors.Knowledge Integration	**,600**	-,087	,153	,196
Technological.Factors.Response Time	,353	-,248	**-,717**	,213
Technological.Factors.Search Functionalities Efffectiveness	,415	**-,563**	,090	,409

Extraction Method: Principal Component Analysis.
a 4 components extracted.

3) Scree test Criterion

The scree test is used to identify the optimum number of factor that can be extracted before before the amount of unique variance begins to dominate the common variance structure.
The scree test is derived by plotting the roots against the number of factor in the order of extraction, and the shape of the resulting curve is used to evaluate the cutoff point. In our case the picture with the 5 factors extracted. Starting with the first factor, the plot steeply downward initially and then slowly. The point at with the curve first begins to straighten out is considered to indicate the maximum number of factor to extract, in the first case (14 variables considered) this point coincides with variables 4-5. Consequently, our choice to delete the other 9 variables would result appropriate from the scree plot test, as it is possible to see from the second scree plot test with 6 variables:



However, the scree plot together with the eigenvalue criterion (or latent root) and the percentage of variance criterion help us to identify three factors that are more suited for continuing the statistical analysis, viewing the high value relative (0.946) to the latent root criterion the fifth factor can be also included.

11.2.5 Stage 5 interpreting the factors

Identify the significant loadings in the unrotated factor matrix

Rotated and unrotated factor matrices for significant factor loadings and adequate commonalities were examined without finding any deficiencies.

By examining the loadings we have a clear understanding of the each factor and the structure in the set of variables. The first factor accounts for the largest amount of variance with 4 variables having high loading (higher than .40). The second and the third factors have each one variable with high loading.

	Component					
	1	2	3	4	**Communalities**	**Extraction**
Org.Factors.Knowledge Sharing Routines	,566	,157	**-,600**	-,186	1,000	,740
Org.Factors.Individual_Incentives	**,663**	,481	-,086	-,085	1,000	,685
Org.Factors.Group_Incentives	-,341	-,427	**,574**	,057	1,000	,631
Org.Factors.Distance	,414	,239	,109	**-,569**	1,000	**,564**
Org.Factors.Org.Factors.Rigid_Org_Structures	,078	**,690**	,247	,248	1,000	,605
Social.Factors.Trust	**-,413**	-,305	-,406	,363	1,000	**,560**
Soc.factors.Communication effectiveness	-,092	**,889**	,078	,311	1,000	,901
Org. Factors Interaction frequency	-,270	**,513**	-,113	,502	1,000	,601
Technological.Factors.Knowledge Accessibility	**,611**	,037	,318	,172	1,000	**,506**
Technological.Factors.Knowledge Format	**,730**	-,211	,269	,106	1,000	,660
Technological.Factors.Knowledge Accuracy	**,611**	-,176	,114	,272	1,000	**,491**
Technological.Factors.Knowledge Integration	**,600**	-,087	,153	,196	1,000	**,429**
Technological.Factors.Response Time	,353	-,248	**-,717**	,213	1,000	,745
Technological.Factors.Search Functionalities Efffectiveness	,415	**-,563**	,090	,409	1,000	,665
Eigenvalue	**3,242**	**2,579**	**1,686**	**1,277**	***Total***	**8784**
Percentage of trace	***23,154***	***18,418***	***12.040***	***9.120***	***Total***	**62.73%**

Extraction Method: Principal Component Analysis.
a 4 components extracted.

Communalities of the variables in the unrotated factor matrix

The row sum of squared factor loadings, known as communalities, show the amount of variance in a variable that is accounted for the by the two variables taken together. The size of the communality is a useful index for assessing how much variance in a particular variable is accounted for by the factor

solution. Higher communalities value indicates that a large amount of the variance in a variable has been extracted by the factor solution. Small communalities show that a substantial portion of the variables' variance is not accounted for by the factors. Practical consideration of what is small and high dictate that a lower level of .50.

Finally, considering all the tests done with 14 variables we decided to delete also the variable: knowledge integration.

Rotation of factor

The goal of each rotation is to simplify the rows and column of the factor matrix to facilitate interpretation. In a factor matrix, column represent factor, with each row corresponding to the variable loads across the factor.

VARIMAX ROTATION

The varimax criterion centers on simplifying the columns of the factor matrix. With the varimax rotation approach, the maximum possible simplification is reached if there are only 1s and 0s in a column. The varimax method maximizes the sum of variance of required loadings of the factor matrix. In quartimax approach many variables cal load high or near high on the same factor because the technique centers on simplifying the rows.

With the varimax approach, some high loadings (close to +1 or -1) are likely, as are some loadings near 0 in each column of the matrix. The interpretation is easier when the variables correlations are close to either +1 or -1, thus indicating a positive or negative association between the variable and the factor, or close to 0, indicating a clear lack of association. In our case, all the factors considered for the multiple regression analysis present a high correlation.

Rotated Component Matrix(a)

	Component			
	1	2	3	4
Org.Factors.Knowledge Sharing Routines	,085	-,086	**,828**	,191
Org.Factors.Individual_Incentives	,281	,310	**,507**	,499
Org.Factors.Group_Incentives	,080	-,224	**-,750**	-,121
Org.Factors.Distance	,050	-,078	,196	**,708**
Org.Factors.Org.Factors.Rigid_Org_Structures	,112	,**760**	-,041	,214
Social.Factors.Trust	-,153	-,102	,045	**-,726**
Social.Factors.Soc.factors. Communication effectiveness	-,179	**,922**	,066	,113
Social.Factors.Interaction frequency	-,160	**,682**	,045	-,318
Technological.Factors.Knowledge Accessibility	**,670**	,142	,020	,283
Technological.Factors.Knowledge Format	**,725**	-,136	,075	,279
Technological.Factors.Knowledge Accuracy	**,723**	-,018	,138	,050
Technological.Factors.Response Time	,251	-,218	**,702**	-,389
Technological.Factors.Search Functionalities Effectiveness	**,734**	-,274	-,030	-,286

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Component Transformation Matrix

Component	1	2	3	4
1	**,690**	-,001	,543	,478
2	-,358	**,856**	,161	,336
3	,331	,114	**-,820**	,454
4	,535	,504	-,086	**-,673**

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

QUARTIMAX ROTATION

We decided to perform also the Quartimax Rotation as our goal is to simplify the rows of a factor matrix. Quartimax focuses on rotating the initial factor so that a variable loads high on one factor and as low as possible on all other factor. In these rotations, many variables can load high or near high on the same factor because the technique centers on simplifying the rows. The Quartimax method has not proved especially successful in producing simpler structures.

Factor loadings in the range of ± .30 to ± .40 are considered to meet the minimal level for interpretation of structure; whereas loadings ± .50 or greater are considered practically significant. Loadings exceeding ± .70 are considered indicative of a well-defined structure and are the goal of any factor analysis. In our case, only the factors related to the technological dimension. The only variable that presents loading ± .50 is Individual Incentives, while the all the others are equal or higher than ± .70. In a sample of 100 respondents, factor loadings of .55 and above are significant, whereas in a sample of 50, a factor loading of .75 is required for significance.

Rotated Component Matrix(a)

	Component			
	1	2	3	4
Knowledge Sharing Routines	,097	-,084	**,827**	,190
Individual Incentives	,293	,312	**,504**	,494
Group Incentives	,071	-,225	**-,751**	-,123
Distance	,065	-,077	,195	**,708**
Org.Factors.Rigid_Org_Structures	,111	,**761**	-,042	,211
Trust	-,165	-,103	,048	**-,723**
Soc.factors.Communication effectiveness	-,181	**,921**	,067	,115
Interaction frequency	-,168	**,681**	,047	-,316
Knowledge Accessibility	**,674**	,146	,013	,271
Knowledge Format	**,731**	-,132	,068	,267
Knowledge Accuracy	**,725**	-,014	,132	,038
Response Time	,252	-,217	**,700**	-,392
Search Functionalities Effectiveness	**,730**	-,270	-,037	-,299

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.
a Rotation converged in 5 iterations.

Component Transformation Matrix

Component	1	2	3	4
1	,704	,004	,536	,466
2	-,355	,855	,163	,341
3	,330	,116	-,823	,447
4	,520	,506	-,091	-,683

Extraction Method: Principal Component Analysis.
Rotation Method: Quartimax with Kaiser Normalization.

11.2.6 Stage 6: Additional Uses of Factor Analysis Results

Now the objective is to identify appropriate variables for subsequent application to other statistical techniques, then some form of data reduction is needed.

Literature suggest that at this point we have the option of examining the factor matrix and selecting the variable with the highest factor loading on each factor to act as a surrogate variable that is representative of that factor. In our case this approach is more appropriate, as we have only one variable with a factor loading substantially higher than all other factor loadings. Factor analysis provided four components that could be considered for the present analysis. From the beginning we considered three orders of factors that could impact on knowledge sharing effectiveness and these are technological factors, social factors and organizational factors. Factor analysis confirmed the presence of the impact of these three factors. For each of them, we reduced the variables to consider for the analysis, and we select the more appropriate items for each component/factor. The items deleted are the following:

- ***Component 1*** *(Org. factors): Fragmentation, Employees' mobility*
- ***Component 2*** *(Social Factor): Socialization, Mutual help*

The resulting set of variables per component will be the following:

- ***Component 1*** *(Knowledge Accessibility; Knowledge Format; Knowledge Accuracy; Response Time; Search Functionalities Effectiveness);*
- ***Component 2*** *(Communication effectiveness; Interaction frequency);*
- ***Component 3*** *(Knowledge Sharing Routines; Individual Incentives; Group Incentives; Rigid Org. Structures);*
- ***Component 4*** *(Trust; Distance).*

However this method has some disadvantages, that is prone to measurement errors and it doesn't represent all 'facets' of a factor. An alternative method should be the one of the 'summated scales' but it will not be taken into consideration in the present analysis.

12. Multiple regression analysis

Regression analyses are a set of statistical techniques which allow one to assess the relationship between one dependent variable (DV) and several independent variables (IVs).
However, in multiple regressions it is required to use the mean for the dependent variable, which has several desirable properties.
We created a composite item also for the independent variables: social factors, technological factors and organizational factors. Then, this was our regression model.
Our multiple regression equation was the following:

$$Y = \alpha + b_1X_1 + b_2X_2 + b_3X_3$$

$\mathbf{X_{1,2...N}}$ Independent variables of the model that is explaining the variance in Y

$\mathbf{B_{1,2,..N}}$ is the Slope (Beta coefficient) for X_1

12.1 Stage 1: Research Problem

The application of multiple regression falls into two broad classes of research problems: prediction and explanation. Prediction involves the extent to which the regression variate (one or more independent variables) can predict the dependent variable.
Explanation examines the regression coefficients for each independent variable and attempts to develop a substantive or theoretical reason for the effects of the independent variables. These research problems are not mutually exclusive, and an application of multiple regression analysis can address either or both types of research problem.
In our case, the multiple regression analysis will have a predictive purpose.

12.2 Stage 2. Research Design

Sample size

The effects of sample size are seen most directly in the statistical power of the significance testing and the generalizability of the results. Small sample usually have fewer than 30 observations and are appropriate only when we have a single independent variable in simple regression. Likewise, large samples of 1000 observations or more make statistical significance tests overly sensitive often indicating that almost any relationship is statistically significant.
Our sample is composed of 50 respondents and all provided a complete response, resulting in 50 observations available for analysis.

Power levels and generalizability

In multiple regressions, power refers to the probability of detecting as statistically significant a specific level of R^2 or a regression coefficient at a specified significance level for a specific sample size.

The significance level implies a relation 5:1, that is 5 observations every independent variable in the variate. Although the minimum level is 5:1, the desired level is between 15 to 20 observations for each independent variable, which should increase when stepwise estimation is used.

As we are adopting 4 independent variables, the desired number of observations should be between 60 and 80; as such our sample of 50 observations presents an actual ratio of 12:1.

In fact, the sample size affects also the generalizability of the results by the ratio of observations to independent variables. As the ratio falls below 5:1 the researcher encounters the risk of overfitting the variate to the sample, making the results too specific to the sample and thus lacking generalizability.

Degree of freedom is a statistical measure that contains the degree of generalizability calculated as:

Degrees of freedom (*df*) = sample size (50) - number of estimated parameters (5) = 45

Or

Degrees of freedom (*df)* =N (50) – (Number of independent variables +1) (4+1) = 45

The larger degree of freedom the more generalizable are the results. Maximizing the degrees of freedom improves generalizability and addresses both model parsimony and sample size concerns. In our research, degree of freedom is 45.

12.3 Stage 3. Assumptions in multiple regression analysis

Nonnormality tests were performed during the factor analysis and confirmed the robustness of the model.

12.4 Stage 4. Estimating the regression model

In order to choose the set of independent variables for the regression model, the researcher may choose between a sequential or a combinatorial process.

Sequential Search methods

The researcher has a total control over variables selection, he decides to add or delete among these variables until some overall criterion measure is achieved. This approach is an objective method for selecting among variables and it has an other advantage that is to maximize the prediction while employing the smallest number of variables.

There are two types of sequential approaches: 1) stepwise estimation and 2) forward addition and backward elimination.

In each approach variables are individually assessed for their contribution to prediction of the dependent variable and added to or deleted from the regression model based on their relative contribution.

1. Stepwise estimation

This method implies the consideration of each independent variable at a time to the regression model. The independent variable with the greatest contribution is added first. Independent variables are then selected for inclusion based on their incremental contribution over the variables already in the equation. It is important to follow the following steps:

Starts with a simple regression model selecting the one independent variable that is the most highly correlated with the dependent variable. Then, examine the partial correlation coefficient to find an additional independent variable that explains the largest statistically significant portion of the unexplained variance remaining from the first regression equation.

Recomputed the regression equation using the two independent variables and examine the partial F value for the original variable in the model to see whether it still makes significant contribution, given the presence of the new independent variable.

In our research, we will adopt the stepwise method in order to delete those variables that minimize the predictive accuracy. Stepwise method was adopted for identifying the highest bivariate correlation and to remove the lowest ones. After having run stepwise method, the indicator social factor was removed automatically.

2. Forward addition and backward elimination method

It is mainly a trial and error process for finding the best regression estimates. It is similar to the stepwise as it starts with a single independent variable, but it starts with a regression equation including all the independent variables, and then deletes the independent variables that not contribute significantly.

12.5 Stage 5: Estimating the statistical significance of the model

We compute all the items related to the 4 components/factors identified through the factor analysis. To test the hypotheses that the amount of variation explained by the regression model is more than the baseline prediction we have to calculate the F ratio.

$$F \text{ ration} = \frac{\text{Sum of Squares}}{\text{Degrees of Freedom}} = \frac{\text{SS regression}}{df \text{ regression}} = 8{,}777$$

$$\frac{\text{Sum of Squares}}{\text{Degrees of Freedom}} \quad \frac{\text{SS residual}}{df \text{ residual}}$$

Variables Entered/Removed(b)

Model	Variables Entered	Variables Removed	Method
1	TECH, component_4, component_2, component_3(a)	.	**Enter**

a All requested variables entered.
b Dependent Variable: Knowledge Sharing Effectiveness

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,662(a)	**,438**	**,388**	,58967

a Predictors: (Constant), TECH, component_4, component_2, component_3

ANOVA(b)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12,208	4	3,052	8,777	,000(a)
	Residual	15,647	45	,348		
	Total	27,855	49			

a Predictors: (Constant), TECH, component_4, component_2, component_3
b Dependent Variable: Knowledge Sharing Effectiveness

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	-1,095	,905		-1,210	,233
	component_2	,320	,153	,242	2,091	,042
	component_3	**,478**	,190	**,329**	2,513	,016
	component_4	-,027	,140	-,022	-,191	,849
	TECH	**,534**	,155	**,444**	3,448	,001

a Dependent Variable: Knowledge Sharing Effectiveness

As the value 8,777 is too low, we decide to perform stepwise method in order to identify the components with higher predictive power.

Variables Entered/Removed(a)

Model	Variables Entered	Variables Removed	Method
1	TECH	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
2	component_3	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
3	component_2	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

a Dependent Variable: Knowledge Sharing Effectiveness

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,533(a)	,284	,269	,64445
2	**,618(b)**	**,382**	**,355**	,60537
3	**,662(c)**	**,438**	**,401**	**,58346**

a Predictors: (Constant), TECH
b Predictors: (Constant), TECH, component_3
c Predictors: (Constant), TECH, component_3, component_2

ANOVA(d)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	7,920	1	7,920	**19,069**	,000(a)
	Residual	19,935	48	,415		
	Total	27,855	49			

2	Regression	**10,630**	2	5,315	**14,504**	,000(b)
	Residual	**17,225**	47	,366		
	Total	**27,855**	49			
3	Regression	12,195	3	4,065	**11,941**	,000(c)
	Residual	15,660	46	,340		
	Total	27,855	49			

a Predictors: (Constant), TECH
b Predictors: (Constant), TECH, component_3
c Predictors: (Constant), TECH, component_3, component_2
d Dependent Variable: Knowledge Sharing Effectiveness

a Predictors: (Constant), component_3, TECH
b Dependent Variable: Knowledge Sharing Effectiveness

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	,979	,420		2,329	,024
	TECH	,642	,147	**,533**	4,367	**,000**
2	(Constant)	,054	,521		,104	,917
	TECH	,460	,153	**,382**	2,999	**,004**
	component_3	,504	,185	**,347**	2,720	**,009**
3	(Constant)	-1,185	,766		-1,548	,129
	TECH	,538	,152	**,447**	3,532	**,001**
	component_3	,467	,180	**,321**	2,602	**,012**
	component_2	,323	,150	**,244**	2,144	**,037**

a Dependent Variable: Knowledge Sharing Effectiveness

Excluded Variables(d)

Model		Beta In	T	Sig.	Partial Correlation	Collinearity Statistics
		Tolerance	Tolerance	Tolerance	Tolerance	Tolerance
1	component_2	,273(a)	2,270	,028	,314	,952
	component_3	,347(a)	2,720	,009	,369	,810
	component_4	,048(a)	,390	,698	,057	,998
2	component_2	,244(b)	2,144	,037	,301	,943
	component_4	-,047(b)	-,389	,699	-,057	,913
3	component_4	-,022(c)	-,191	,849	-,028	,904

a Predictors in the Model: (Constant), TECH
b Predictors in the Model: (Constant), TECH, component_3
c Predictors in the Model: (Constant), TECH, component_3, component_2
d Dependent Variable: Knowledge Sharing Effectiveness

$$\frac{\text{Sum of Squares}}{\text{Degrees of Freedom}} = \frac{SS_{\text{regression}}}{df_{\text{regression}}} = \mathbf{14{,}504}$$

$$F \text{ ration} = \frac{\text{Sum of Squares}}{\text{Degrees of Freedom}} \quad \frac{SS_{\text{residual}}}{df_{\text{residual}}}$$

As we can see the Stepwise method created three models, excluding the components that are less significant for predictive purpose. The variable excluded is the component 4, as it is not included in the model summary.

Among the three model proposed we decide to select the second one, then excluding also the component 2. Our decision was taken considering that the adjusted R square of the model 2 and 3 is not very different (**Model 3 = .401; Model =, 355**), while the F ratio decrease from **14.504** of the model 2 to **11,941** of the model 3.

ANOVA and F Ratio

This table reports an ANOVA, which assesses the overall significance of our model. The ANOVA analysis provides the statistical test for the overall model fit in terms of the F ratio. The total sum of squares (10630 + 17255 = 27855) is the squared error that would occur if we used only the mean of Y to predict the dependent variable.

All the models sorted from the stepwise estimation are significant, in fact $p < 0.05$ (Sig.) for the all the components considered.

Significance tests of regression coefficients. Establishing a confidence interval

Significance test is a appropriate when we use a sample of the population rather than a census. Significance testing of regression coefficient is a statistically based probability to estimate whether the estimated coefficients across a large number of samples of a certain size will indeed be different from zero.

To make this judgement, a confidence interval must be established around the estimated coefficient.

In our case, the coefficient is different from zero (technological factors= .151, component_3= .131), then we can assume that the coefficient's difference from zero is statistically significant.

We established the significance level at .05 (as used frequently from researchers); this level denotes the chance the researcher is willing to take of being wrong about whether the estimated coefficient is different from zero.

Coefficients(a)

Model		T	Sig.	95% Confidence Interval for B	
		Lower Bound	Upper Bound	B	Std. Error
1	(Constant)	,104	,917	-,994	1,102
	TECH	2,999	,004	,151	,769
	component_3	2,720	,009	,131	,877

a Dependent Variable: Knowledge Sharing Effectiveness

B, and (Standardized) Beta and the measurement of the relationship

The beta value allows for a direct comparison between coefficients as to their relative explanatory power of the dependent variable. The beta is measured in units of standard deviation. The regression coefficient (b) and the standardized coefficient reflect the change in the dependent measure for each unit change in the independent variable.

Thus, the higher the beta value the greater the impact of the predictor variable on the criterion variable.

In our sample, technological factors present a (standardized) beta value of .382, indicating that a change of one standard deviation in this variable will result a change of .38 standard deviations in the knowledge sharing effectiveness. While the component 3 has a (standardized) beta value of .347, indicating that a change of one standard deviation in this variable will result a change of .34 standard deviations in the knowledge sharing effectiveness.

Model		Unstandardized Coefficients		Standardized Coefficients
		B	Std. Error	Beta
1	(Constant)	,054	,521	
	TECH	**,460**	,153	**,382**
	component_3	**,504**	,185	**,347**

a Dependent Variable: Knowledge Sharing Effectiveness

Finally, the beta regression coefficient allows us to compare and to assess the strength of the relationship between each predictor variable to the dependent variable. In this case, the relationship between technological factors and knowledge sharing effectiveness is the strongest relationship (.382).

The Standardized Beta Coefficients give a measure of the contribution of each variable to the model. A large value indicates that a unit change in this predictor variable has a large effect on the dependent variable.

The t and Sig (p) values give a rough indication of the impact of each predictor variable – a big absolute t value and small p value ($p < 0.05$) suggests that a predictor variable is having a large impact on the criterion variable.

R squared and Adjusted R Square

In essence, R Square is the measure of the level of accuracy of the prediction of the predictor variable, briefly the strength of the relationship. If the regression is = 1.0, the regression model perfectly predict the dependent variable. The R squared is the correlation coefficient squared, also referred to as

coefficient of determination and it is a measure of the prediction of the combined effect of the entire variate in the prediction, even when the regression equation contains more than one independent variable. The sign of the correlation coefficient (+ or -) denotes the slope of the regression line.
As we can see from the table of our regression model, the R square is .382, meaning that it explains 38% of the possible variation in the dependent variable. The R square in fact indicates the percentage of variation of Y (dependent variable, in this case knowledge sharing effectiveness) explained by the regression model consisting of the two independent variables considered in the analysis (technological and organizational factors).

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,618(a)	,382	**,355**	,60537

a Predictors: (Constant), component_3, TECH

However, R square tends to somewhat over-estimate the success of the model when applied to the real world,
so an Adjusted R Square value is calculated which takes into account the number of variables in the model and the number of observations (participants) our model is based on. This Adjusted R Square value gives the most useful measure of the success of our model. In our model, we have an Adjusted R Square value of 0.355, so that we can say our model has accounted for 35 % of the variance in the criterion variable.

Stage 6 Validation of the results

A more appropriate empirical validation approach is to test the regression model on a new sample drawn from the general population. A new sample will ensure representativeness and can be used in several ways.
The original model can predict values in the new sample, and predictive fit can be calculated.
However, this requirement was limited in the present research due to time pressures and more importantly availability of respondents. As we have seen at the beginning of our research, the most difficult task has been the capability to involve firms' employees in order to get the questionnaire correctly filled.
The scarce willingness of respondents to participate to the survey was confirmed also by the internal responsible of our analysis.

Regression model synthesis

Finally, our model with a sample of 50 observations, with 2 components (independent variables) and one dependent variable (knowledge sharing effectiveness) is able to detect relationships with R^2 values of approximately 38% at a power of .382 (component 1_technological factors) and .347 (component_3) (B value) with the significance level set at 0.05.

12.7 Stepwise method with the most significant independent variables

In order to evaluate the predictive of each single independent variable among the ones that resulted to be more significant, we run stepwise method with all independent variables.

Variables Entered/Removed(a)

Model	Variables Entered	Variables Removed	Method
1	Org.Factors .Individual_I ncentives	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
2	Technologic al.Factors.K nowledge Accuracy	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
3	Org.Factors .Group_Ince ntives	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).
4	Technologic al.Factors.K nowledge Accessibility	.	Stepwise (Criteria: Probability-of-F-to-enter <= ,050, Probability-of-F-to-remove >= ,100).

a Dependent Variable: Knowledge Sharing Effectiveness

Stepwise method sorted 4 models, as it is possible to see from the table the fourth model has a strongest predictive power. The models are composed as follows:

a Predictors: (Constant), Org.Factors.Individual_Incentives

b Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy

c Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives

d Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives, Technological.Factors.Knowledge Accessibility

As it is possible to notice, individual (and group) incentives are very predictive of knowledge sharing performance (Beta=.616; F=29417).
The second model comprises also knowledge accuracy, which is the second important predictor of knowledge sharing (Beta=.290; F=19922).

In the third model we have also the group incentives (B= -.311; F=17.453). Finally, in the fourth model we find knowledge accessibility (B= .329; F=17.682). Then we have two aspects related to organizational factors and tow related to technological factors.
These four factors present an adjusted R Square of .577

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	,616(a)	**,380**	**,367**	,59984
2	,677(b)	**,459**	**,436**	,56635
3	,730(c)	**,532**	**,502**	,53216
4	,782(d)	**,611**	**,577**	,49061

ANOVA(e)

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10,584	1	10,584	**29,417**	,000(a)
	Residual	17,271	48	,360		
	Total	27,855	49			
2	Regression	12,780	2	6,390	**19,922**	,000(b)
	Residual	15,075	47	,321		
	Total	27,855	49			
3	Regression	14,828	3	4,943	**17,453**	,000(c)
	Residual	13,027	46	,283		
	Total	27,855	49			
4	Regression	17,024	4	4,256	**17,682**	,000(d)
	Residual	10,831	45	,241		
	Total	27,855	49			

a Predictors: (Constant), Org.Factors.Individual_Incentives
b Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy
c Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives
d Predictors: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives, Technological.Factors.Knowledge Accessibility
e Dependent Variable: Knowledge Sharing Effectiveness

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
1	(Constant)	1,781	,201		8,850	,000
	Org.Factors.Individual_Incentives	,454	,084	**,616**	5,424	,000
2	(Constant)	1,267	,273		4,642	,000
	Org.Factors.Individual_Incentives	,401	,082	**,545**	4,922	,000
	Technological.Factors.Knowledge Accuracy	,253	,097	**,290**	2,616	,012
3	(Constant)	2,525	,533		4,734	,000
	Org.Factors.Individual_Incentives	,286	,088	**,389**	3,267	,002
	Technological.Factors.Knowledge Accuracy	,272	,091	**,311**	2,980	,005
	Org.Factors.Group_Incentives	-,291	,108	**-,311**	-2,689	,010
4	(Constant)	2,622	,493		5,320	,000
	Org.Factors.Individual_Incentives	,173	,089	**,235**	1,942	,058
	Technological.Factors.Knowledge Accuracy	,206	,087	**,236**	2,373	,022
	Org.Factors.Group_Incentives	-,381	,104	**-,407**	-3,661	,001
	Technological.Factors.Knowledge Accessibility	,224	,074	**,329**	3,020	,004

a Dependent Variable: Knowledge Sharing Effectiveness

Excluded Variables(e)

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics
		Tolerance	Tolerance	Tolerance	Tolerance	Tolerance
1	Org.Factors.Knowledge Sharing Routines	,295(a)	2,474	,017	,339	,823
	Org.Factors.Group_Incentives	-,285(a)	-2,286	,027	-,316	,765
	Org.Factors.Proximity	-,100(a)	-,813	,420	-,118	,860
	Rigid_Org_Structures	,012(a)	,101	,920	,015	,935
	Social.Factors.Trust	,028(a)	,232	,818	,034	,915
	Communication effectiveness	,059(a)	,494	,624	,072	,905
	Org. Factors Interaction frequency	,015(a)	,132	,895	,019	1,000
	Technological.Factors.Knowledge Accessibility	,279(a)	2,376	,022	,327	,853
	Technological.Factors.Knowledge Format	,209(a)	1,793	,079	,253	,913
	Technological.Factors.Knowledge Accuracy	,290(a)	2,616	,012	,357	,939
	Technological.Factors.Knowldge Integration	,162(a)	1,367	,178	,196	,902
	Technological.Factors.Response Time	,244(a)	2,227	,031	,309	,995
	Technological.Factors.Search Functionalities Efffectiveness	,145(a)	1,286	,205	,184	1,000
2	Org.Factors.Knowledge Sharing Routines	,271(b)	2,390	,021	,332	,817
	Org.Factors.Group_Incentives	-,311(b)	-2,689	,010	-,369	,761
	Org.Factors.Proximity	-,128(b)	-1,101	,277	-,160	,853
	Rigid_Org_Structures	,027(b)	,243	,809	,036	,932
	Social.Factors.Trust	,014(b)	,125	,901	,018	,914
	Communication effectiveness	,122(b)	1,061	,294	,155	,870
	Org. Factors Interaction frequency	,053(b)	,490	,627	,072	,982
	Technological.Factors.Knowledge Accessibility	,214(b)	1,825	,074	,260	,795
	Technological.Factors.Knowledge Format	,079(b)	,601	,551	,088	,675
	Technological.Factors.Knowldge Integration	,103(b)	,885	,381	,129	,860
	Technological.Factors.Response Time	,204(b)	1,921	,061	,273	,969
	Technological.Factors.Search Functionalities Efffectiveness	,061(b)	,532	,597	,078	,896
3	Org.Factors.Knowledge Sharing Routines	,196(c)	1,708	,094	,247	,739
	Org.Factors.Proximity	-,089(c)	-,803	,426	-,119	,837
	Rigid_Org_Structures	,011(c)	,101	,920	,015	,929

	Social.Factors.Trust	-,014(c)	-,128	,899	-,019	,905
	Communication effectiveness	,092(c)	,848	,401	,125	,861
	Org. Factors Interaction frequency	,043(c)	,416	,679	,062	,981
	Technological.Factors.Knowledge Accessibility	,329(c)	3,020	,004	,411	,730
	Technological.Factors.Knowledge Format	,072(c)	,582	,564	,086	,674
	Technological.Factors.Knowldge Integration	,134(c)	1,235	,223	,181	,850
	Technological.Factors.Response Time	,136(c)	1,276	,209	,187	,888
	Technological.Factors.Search Functionalities Efffectiveness	,110(c)	1,017	,315	,150	,872
4	Org.Factors.Knowledge Sharing Routines	,130(d)	1,180	,244	,175	,702
	Org.Factors.Proximity	-,062(d)	-,608	,546	-,091	,830
	Rigid_Org_Structures	-,058(d)	-,580	,565	-,087	,882
	Social.Factors.Trust	,041(d)	,407	,686	,061	,875
	Communication effectiveness	,116(d)	1,159	,253	,172	,856
	Org. Factors Interaction frequency	,085(d)	,891	,378	,133	,961
	Technological.Factors.Knowledge Format	,032(d)	,275	,785	,041	,665
	Technological.Factors.Knowldge Integration	,096(d)	,942	,351	,141	,836
	Technological.Factors.Response Time	,124(d)	1,269	,211	,188	,887
	Technological.Factors.Search Functionalities Efffectiveness	,033(d)	,317	,753	,048	,812

a Predictors in the Model: (Constant), Org.Factors.Individual_Incentives

b Predictors in the Model: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy

c Predictors in the Model: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives

d Predictors in the Model: (Constant), Org.Factors.Individual_Incentives, Technological.Factors.Knowledge Accuracy, Org.Factors.Group_Incentives, Technological.Factors.Knowledge Accessibility

e Dependent Variable: Knowledge Sharing Effectiveness

12.8 Reliability Measures

Cronbach's alpha was used as a measure of reliability because it provides a lower bound for the reliability of a scale and is the most widely used measure (Nunnally, 1978).

Reliability Statistics

Cronbach's Alpha	N of Items
,752	19

Item-Total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Knowledge Sharing Effectiveness	54,3667	52,422	,849	**,709**
Knowledge Sharing Routines	54,4167	53,128	,460	**,729**
Individual Incentives	54,9567	52,371	,597	**,718**
Group Incentives	53,5167	67,346	-,434	**,787**
Distance	53,2167	56,777	,175	**,760**
Rigid Org. Structures	53,3300	60,817	,142	**,752**
Trust	53,5167	65,141	-,291	**,776**
Soc.factors.Communication effectiveness	53,4767	60,716	,132	**,752**
Interaction frequency	54,1167	62,366	-,070	**,772**
Knowledge Accessibility	54,2767	52,849	,509	**,725**
Knowledge Format	54,0767	55,061	,431	**,733**
Knowledge Accuracy	54,6567	55,144	,497	**,729**
Knowledge Integration	54,2367	56,204	,397	**,736**
Response Time	54,6567	56,640	,301	**,743**
Search Functionalities Effectiveness	54,1767	57,532	,228	**,749**
Who is working on what	54,6167	52,233	,700	**,712**
Who is expert on what	53,9367	53,202	,520	**,724**
Knowledge Completeness	54,1967	52,864	,493	**,726**
Best Practice Sharing	54,7167	53,553	,461	**,729**

Nunnally (1978) suggest that a value of 0.70 indicated good reliability for items. The lower limits of acceptability are comprised according to Nunnally between 0.5-0.6.

All items have Cronbach alpha greater comprised between .702 and .787, providing an adequate level of reliability for predictor tests and hypothesized measures of a construct (Nunnally, 1978: 245–246).

All variables and construct accounted a Cronbach alpha of 0.752.

12.9 Conclusion and to-be scenario of the knowledge sharing within Elasis

From the stepwise method, we got five models, the constant and strongest predictor has resulted to be individual incentives.

Before starting the analysis, we consider that the index for the knowledge sharing performance is negative, any variable that is positively related to it, constitute a factor blocking or relenting the knowledge sharing process.

If we would have had a positive performance and we would have found items with a negative relationship, we would have identified some barriers to knowledge sharing performance. On the contrary, when the dependent variable, that in this case is knowledge sharing performance, is negative all variables positively related to it amplify its negative performance being the relationship positive.

On the contrary, all the factors linked negatively with knowledge sharing performance represent a factor enabling and accelerating knowledge sharing. Thus, factors with a positive relationship are considered as barriers and factors with a negative relationship are considered enablers.

Individual incentives represent the strongest predictor of the negative performance of the firm in the activity of knowledge sharing.

We have underlined during the first part of our analysis the scarce use of individual incentives probably elicit some contrast or conflict. However, it can be also that employees expect some individual recognition for their activity that is not always evaluated as it should be. Certainly, individual incentives represent the strongest barrier to knowledge sharing and it should be useful to investigate whether this scarce use is a source of conflicts or is the source of the lack of willingness in sharing knowledge.

Elasis seem to prefer group incentives as we have understood, however this scarce use of individual incentives seem to influence more strongly than other factors the activity of knowledge sharing (4^{th} Model: R Square= ,611; Adjusted R Square= ,577; F= 19.682; Sig. = .000).

The relationship is positive, meaning that the presence of individual incentives undermines the performance of knowledge sharing.

Then, the more individual incentives will be used the more it will influence negatively knowledge sharing.

Together with individual incentives the other important factor to consider is the subjectivity of historical knowledge. In fact, in Elasis employees have never used a particular terminology or a code to recover knowledge. This has caused the proliferation of knowledge codified subjectively by each employee, which have made difficult knowledge understanding and application to new projects.

The difficulty in retrieving knowledge due to ambiguous directories, multi-disciplinary of the knowledge and its belonging to different categories, and to lack of its update have lead to blocking the transfer of knowledge to other projects.

This last factor is very important if we consider that employees have declared to have strong difficulties in retrieving past knowledge in the repositories of the KM platform (R square = .661; Adj. R Square = .623; F = 17.194; Beta = .283; Sig. = .009.

Finally, we can see a predominance of organizational factors affecting knowledge sharing performance such as individual incentives, employee's mobility frequency, and group incentives. However, it is important to consider that the last two factors have a negative relationship, meaning that they represent a strong predictor knowledge sharing effectiveness in Elasis.

Then, these two factors more than others represent what Elasis have to improve and iterate in the future. In fact, both factors facilitate employees to know other employees and their specialization, contributing to the diffusion of the knowledge of the other's and of the other's knowledge and capabilities. Group work is very important for improving the quality of work and incentives strongly promote this way of working in EIasis.

On the contrary, the factor individual incentives have a positive relationship, meaning that individual incentives affect the low performance of knowledge sharing effectiveness.

Technological factors both represent a barrier to knowledge sharing. In particular these two factors are related to the lack of shared frames, ontology and terminology among the different business units. The lack of a shared system of terms, codes, repositories have made knowledge accessibility impossible.

Actually, knowledge is shared mainly by telephone or face-to-face meetings and group discussions, it is urgent to adequate the platform to the standard of a modern knowledge management platform.

This intervention will significantly improve knowledge sharing performance.

13. Case Study: the process of Target setting

The process of new product development in a big automotive supplier as Elasis requires the work of people and other suppliers located in different geographical areas and with different specialization and professionals.

In the Fiat terminology this organization is defined ‘platform’ and it is replicated for the development of every new product in order to reduce time and costs.

In order to analyze in detail the presence of barriers related to knowledge sharing identified through the multiple regression analysis (knowledge accuracy and knowledge accessibility). The difficulty in retrieving knowledge and apply it to other projects or programs inevitably impact on the new product development process quality.

We chose to identify an appropriate process in order to evaluate the presence of these problems in Elasis. The process selected for our analysis is the ‘Target Setting’ or ‘Management of product requirements’, a process in which Elasis transform Fiat needs into technique goals for the building of the Vehicle. In this process a fundamental task is the management of the irregularities/errors occurring during the development process of a new vehicle.

The execution of this process is partly automatized, but this is limited to the workflow being absent the functionality enabling the search and recognition of analogies between irregularities/errors within the same platforms of between different platforms.

Being absent this functionality, Elasis have to dedicate employees’ time in the solution of irregularities that has to be made by retrieving analogies between irregularities and their solutions. Thus, this solution relent considerably production time and affect the whole group performance, since all other platforms are blocked until the irregularity is identified and solved. The scenario of irregularities identification and solution in the Fiat group terminology is said ‘Issue Management’.

13.1 As-Is of the Issue Management: The Digital Mock-up

Mainly due to the fragmentation of the new product development process and the continuous updates made by single employees, the activity of irregularities' identification is not systematic and it is not configured as a routine. During new product development every single employee does his own task, then only through the integration of these single activities the irregularities can emerge. Evidence of irregularities are a component going through an other component, accessibility problems (some element such as batteries, candles should be always easily reachable), development problems (such as logistics, costs, productivity, supplying, reliability) and so on.

For this reason, in Elasis plenary assembly are frequent and aimed at checking the situation in a certain moment and for verifying all these aspects.

In the past these assemblies were organized at the end of the production process, when the prototype was already developed.

Today, these activities are anticipated at the first stages of product development, which is in the phase of product design, in which the single Computer Aided Designs are integrated in one single numeric model (the DMU, or Digital Mock Up).

The Digital Mock Up, is a virtual dispaly of the product/component, it is organized and aggregated according to project and process' rules in order to support the product development process.

The DMU simulate the form and the disposition of the systems of the Vehicle, assembled in order to produce a final product. The DMU is obtained by assembling the single components of the system to represent, taken by the enterprise's PDM as independent CAD 3 D models. This assembly enables engineers to see how the different systems interact. It is not possible through the DMU to evaluate product functionalities such as performance, position and so on in the space.

The DMU permits:

- To design and take under control vehicle packaging;
- To make simulation of the physical product;
- To identify errors and irregularities of the product;
- To design and simulate the different phases of the manufacturing process

The DMU enables to verify:

- visual analysis;
- interferences/contact analysis;
- distance between components analysis;
- distance/assembly/disassembly of components;
- ergonomics analysis (e.g. visibility, habitability, distance from the devices)
- connections and fixing analysis;

- wiring analysis;
- profiles and games analysis;
- analysis of kinematic mechanisms

At this stage engineers can make controls, analysis, and can simulate realistically operations of assembling, disassembling, and production and so on…

Today, it is important to segment the car according to the specific needs of an increased number of new segments.

Then, it is important for all automakers to start to consider a full range of options for enabling the personalization of the car, provided that the models are still produced on a large scale.

This motivation has pushed all OEM (Original Equipment Manufacturers) to develop complex and high technical products that satisfy the increasing customers' requirements on style, quality, safety, comfort and environmental protection.

OEM have tried to shorten the time-to-market of new products in order to better interpret the voice of the customer and implement these needs in the new product. They have also redefined their Vehicle Development Process (VDP), based on the use of a digital approach in the product development.

CAE (Computer Aided Engineering) engineers use DMU Data to create their simulation models in order to analyse and monitor the performances of the new Product.

Another important technology is Virtual Reality (VR) that today seems to be very integrated in the VDP. In fact, VR is used in the field of Styling, DMU and Physical Mock Up (PMU), Design, Ergonomics, Simulation, Digital Plant, Marketing and Sales. The VR Centre is becoming the place where the designer chooses the car style model, where the car development team executes DMU design reviews, analyses alternative solutions and deliberates product and process validation.

VR represents an user interface technology that enables the interaction of the engineer with the virtual models of the car, thanks also to the immersion feature. VR allows, in fact, intuitive analysis and simple presentation of complex three-dimensional systems. Furthermore, with immersive virtual environment, ergonomist can study the "man-car-environment" interaction and evaluate the comfort of a new car.

The expected benefits of using Virtual Technologies are, therefore, the reduction of development time (it enables the concurrent engineering), the reduction of development costs (better design through virtual pre-checks, less modifications and less PMUs) and increasing quality.

13.2 Vehicle's packaging

This process of integration of the single CAD is called 'vehicles' packaging'. This integration is completely virtual and it is aimed at integrating the sub-components of each Vehicle by defining the configuration, the position, the links and the fixing of the components related to:

- Functional specifications related to the interfaces;
- Reliability;
- Security;
- Aesthetics;
- ergonomics;
- Assembly.

This methodology is very useful also for monitoring the ergonomics of the vehicle and for measuring the ease of use such as reflection, display and readability of the equipment, habitability, style, such as colours, interiors, pleasantness…
The check of irregularities is done through specific check-list, where it is specified the controls to execute, some are manual some others are automatized.
Together with the DMU, one other interesting methodology used is the Computer Aided Engineering (CAE), that thanks to particular software enabling the technological problem solving of

- Aerodynamics;
- The flowing of fluids in the hydraulic circuit;
- Analogic or digital simulations of electric circuits;
- Measure of electromagnetic areas for the study of interfences;
- Evaluation of static and dynamic charges, of the vibrations….

An irregularity is indicated in Fiat as an issue and for its solution, taking into consideration the effects of each modification on the final product, has been defined an articulated process.

13.3 Roles and responsibilities

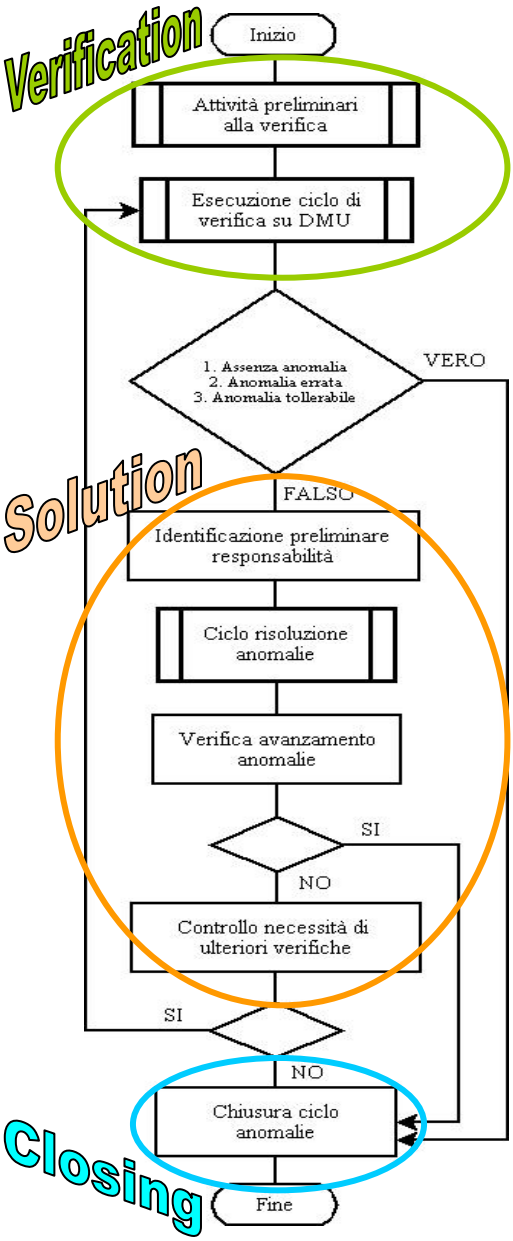
People that have to face irregularities have different roles and responsibilities; we have investigated which are these actors:

RU	The responsible of the business unit have to : 1. develop and/or experiment a system or more systems and modules; 2. activities/processes/designs of the engineering; 3. develop and manage the materials of the Vehicle.
RSS	The Responsible for the development of the system is charged of the development of the whole system: he coordinates and manages time and costs (development and costs / investments of product), performance and details of the system, of its personalization for the application to the Vehicle and its adaptability. He is the responsible for the development of the needed Know-How, of the system in the short-mid and long term, and of the technical decisions taken in the innovation projects shared with the Innovation Organ.
TL Pack	Team Leader of the Packaging is responsible of the physical integration of the systems of his competence; he guarantees the optimization of the different systems to the Vehicle by respecting functional goals, security, reliability, assembly, assistance, aesthetics with the necessity of interface, share and solve conflicts with Team Leader of the other enterprise's function involved in the process. He worries about monitoring the process through indicators and highlights any violation and shifting from the specifications defined in the planning phase. The TL Pack assigns tasks and defines priorities to CPA, to RPM and to representatives of the organs of the Team. He can delegate responsibilities to the components of the Team for the solution of the problems. If the CPA doesn't get to a common decision, he gets all the relevant information and proposes a solution and/or takes a decision. He contributes to the evaluation of the results of work of the CPA and of the members of the Team.
CPA (Project Chief)	The project Chief , is the responsible of the whole project, collaborating also with other organs (such as designers), systems and components, and monitor: ▪ quality/performance ▪ time ▪ costs The definition of the goals and responsibilities of the business unit, and in particular of the RSS (Responsabile Sviluppo Sistema), whether the CPA highlights criticalities or violations. The responsibilities of the CPA concern: ▪ delivers of the technical specifications of the product, ▪ choices of the technical solutions, ▪ coordination of the activity of technological feasibility done in the business unit Design ▪ verifies the time of the project ▪ verifies coherence of the costs of the project ▪ activates of modifications and management of the ODM, ▪ contribution to the elaboration of a plan of vehicle's reliability and design release; ▪ supports in the development/ production phase; ▪ manages the indicator of product/process development; ▪ determines the costs of the system with the support of Cost Engineering

RPM	The Responsabile Model Design is charged of the technological management of the model under development, of the sharing of the technical specification with the Project Chief (CPA), he monitors the reach of the technical goals of systems/components by taking into consideration the costs and investments given from the CPA and he is responsible of the coherence of the designs projected.
RVP (Responsabile verifiche Progetto)	The Responsabile Verifiche Progetto coordinates the activities of the TVP (Tecnico verifica Progetto) and is charged of: 1. Systemic verification through norms and check list, both in the virtual and physical phase in order to guarantee the correspondence to the goals (quality, reliability, serviceability, etc.). 2. signalling of irregularities of Verifica Progetto. 3. management of the advancement, signaling and solution of anomalies during all the phase of Verifica Progetto. Moreover, he proposes possible solutions for the solution of irregularities identified and contributes to the refinement of the project.
TVP	The Tecnico Verifica Progetto systematically verifies the conformity on DMU trough norms, check list/ test plans at disposition by the different organs. He manages the documentation of the irregularities signalling.
TLPE	Il Team Leader of Engineering Performance defines, for each phase, the plan f the functional tests needed impacting on the packaging. He supports the Performance Engineering with a particular focus on the integration with CPA and RPM. He is responsible of the update of the prototypes for the audit/verification of the dynamic/thermal aspects of the choices operated for the packaging.
VPM	Il Verificatore Progetto Meccanica belongs to the Packaging organism and manages all activities linked to systematic research and to the management of the irregularities of the project present in the interfaces between the different systems of the Vehicle (excluded auto body and the completions).
VPC	Il Verificatore Progetto Carrozzeria belongs to the Packaging organism and manage the activities of research and management of the projects' irregularities present within the components/systems of auto body and completions, and their interfaces towards the other systems of the Vehicle.

13.4 The Process of Issue management

In Fiat the Issue management is the process in which irregularities emerging during the product development are identified and solved. This process is defined in three distinct phases:



1. Audit/verification, in which systems and subsystems of a Vehicle are analyzed on order to check the presence of potential irregularities

2. **Solution,** in which irregularities found are solved, eventually also through the activation of the cycle of ODM (Orders Of Modification);

3. **Closing** in which it is declared which are the irregularities solved and the ones which have not yet been solved.

The phase of audit/verification is particularly interesting for our analysis, especially considering that it has a number of sub-activities to be researched for each irregularity identified and it is in this phase that the responsible for its solution can recycle a solution previously adopted, whether the irregularity is not new.

13.5 The audit/verification process

13.5.1 Preliminary activities

The preliminary activity to the audit/verification is composed of the following sub-activities:

i. *Definition of the Team of Audit/verification* in order to involve the professionals and competences needed

ii. Definition of the modality of execution of the process of audit/verification for identifying norms and procedures of reference or justify potential exceptions

iii. Definition of a calendar of the audit/verifications according to the plan of release of the project

iv. *Definition of the domain of the audit/verifications,* that is which audit/verification to do and on which component

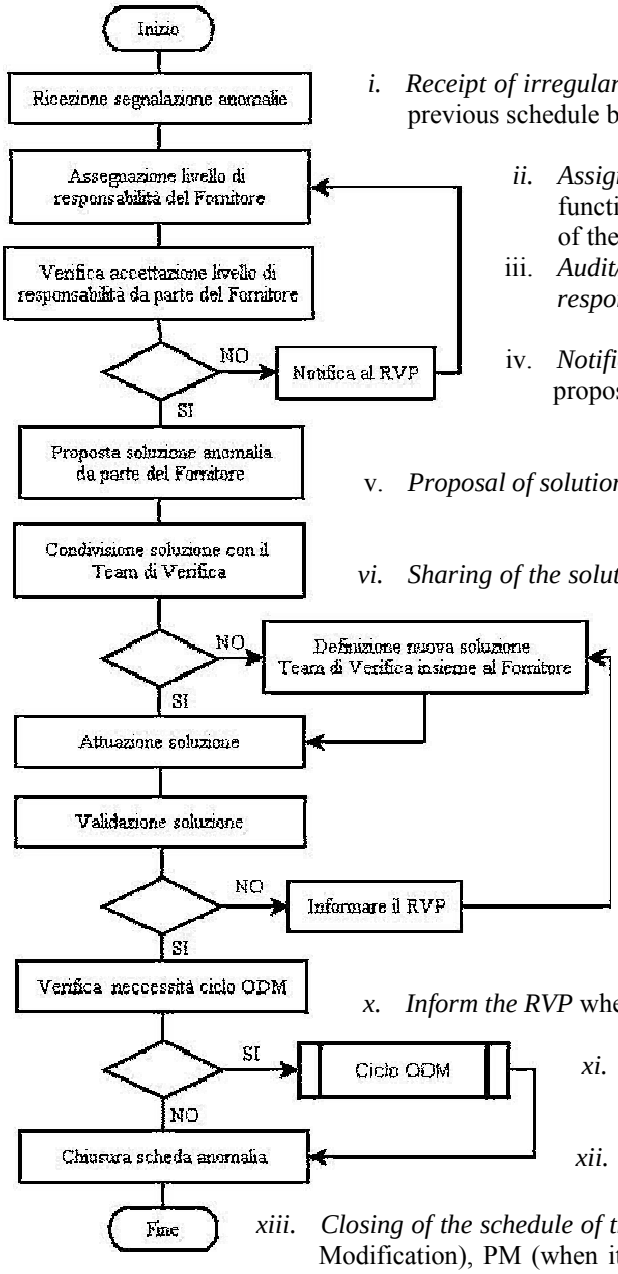
v. Communication of the audit/verification plan in order to share the modality of execution, the calendar and the dominion

vi. Previous Activities to the audit/verification in order to define the way of execution of the audit/verification on the specific project

13.5.2 Preliminary identification of responsibilities

In this phase, preliminary responsibilities are identified, that is all actors that have any link with the system in which the irregularity has been identified during the audit/verification cycle on DMU:

- they identify the supplier that has realized the system on which the irregularity have been found
- whether the irregularity involve more systems, all suppliers involved are identified, and in a second phase, also the firm's organisms involved in the development of those systems to define and share the responsibilities among different subjects.



i. *Receipt of irregularity signalling with* irregularity schedule or retrieval of a previous schedule by the RVP.

ii. *Assignment the level of responsibility of the supplier* in function of the gravity of the irregularity and of the typology of the relationship with the supplier.

iii. *Audit/verification of the acceptance of the level of responsibility by the supplier.*

iv. *Notification to the RVP*, when the supplier doesn't accept the proposal in order to redefine the collaboration.

v. *Proposal of solution of the irregularity by the supplier.*

vi. Sharing of the solution with the audit Team which, after having analyzed it, can refuse or accept it.

vii. Definition of a new solution by the audit Team together with the supplier

viii. Implementation of a solution through the modification of the CAD *mathematics*

ix. Validation of the solution by one specialist of the audit team

x. Inform the RVP whether the solution is different from what was established

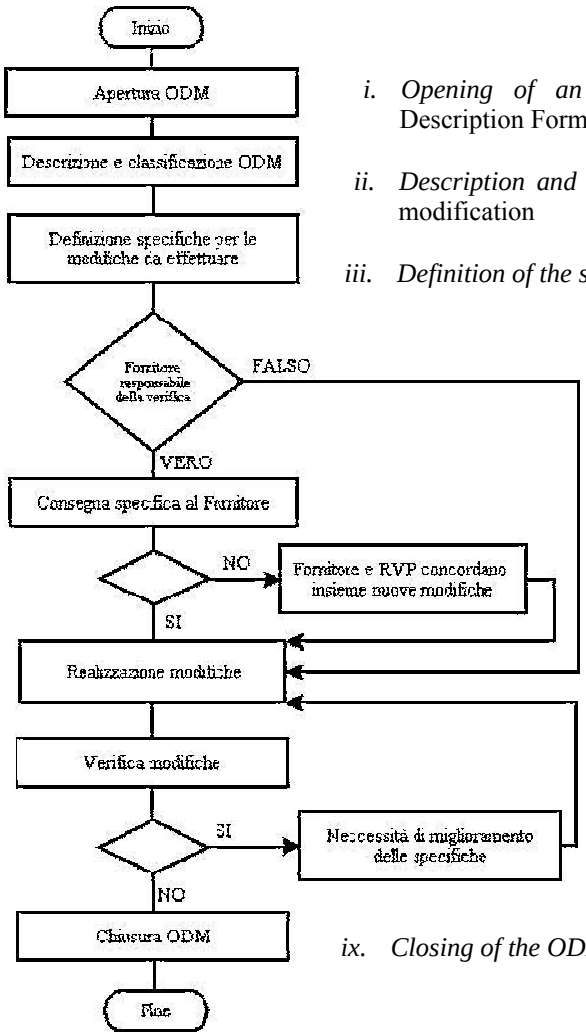
xi. Verification of the necessity of an ODM cycle whether the irregularity is solved

xii. ODM cycle has been started.

xiii. Closing of the schedule of the irregularity like: OD (whether it requires an Order of Modification), PM (when it requires the process) or NI when it requires an ODM but it is not approved and the irregularity is accepted.

13.5.3 ODM Cycle (Order of Modification)

An ODM cycle (Ordine di Modifica) is the flux of activities for the management of the necessitated modifications for the solution of an irregularity through an ODM. It is carried on by the actor to whom it has been previously given the responsibility for the solution of the irregularity: MC, supplier or MC and supplier together.



i. *Opening of an ODM* described by the CTDF (Change Technical Description Form)

ii. *Description and classification of an ODM* as technical or organizational modification

iii. *Definition of the specifications for the modifications to execute*

iv. *Delivery of the specifications to the supplier*

v. *Supplier and RVP agree upon new modifications whether* he doesn't accept the proposal of modification

vi. *Realization of the shared modifications*

vii. *Audit of the modifications to ascertain* the effective solution and the introduction of new irregularities

viii. *Necessity of improvement* to correct irregularities identified by an expert.

ix. *Closing of the ODM* when the irregularity is solved.

13.5.4 Schedule of an Irregularity

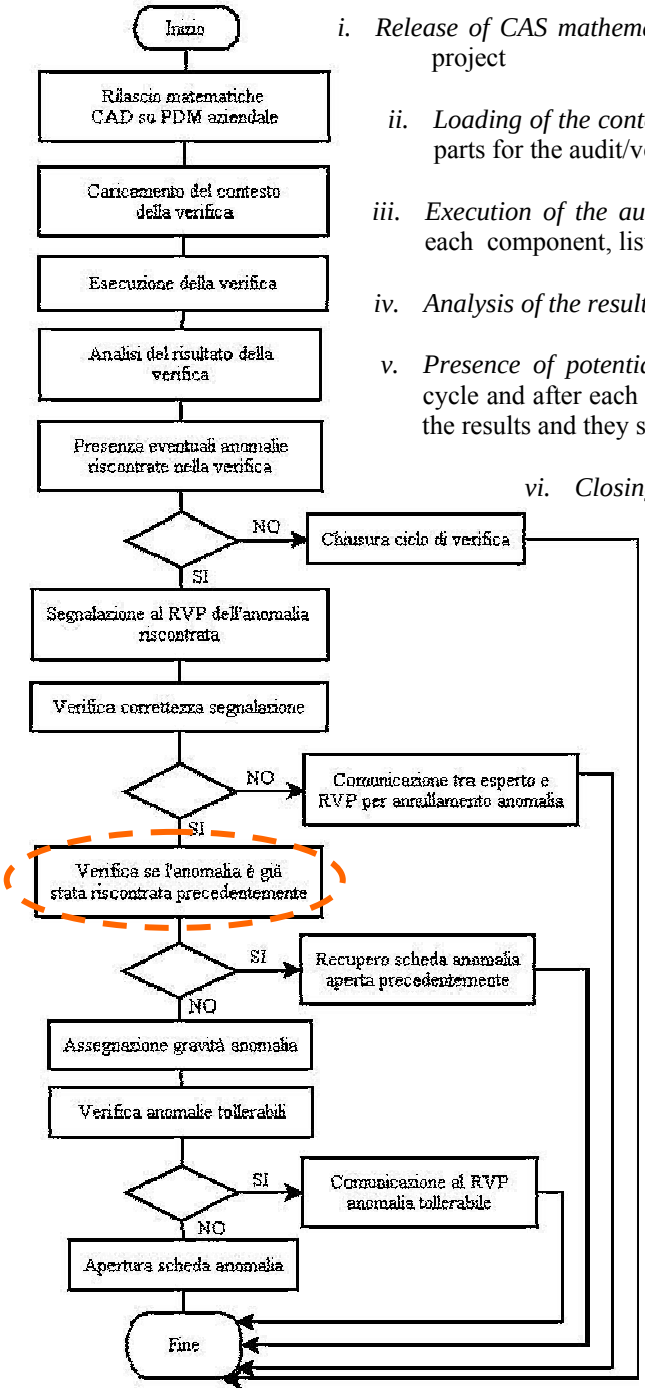
The irregularity schedule, common to all processes of audit, is a standardized template containing numerous areas:

SCHEDA ANOMALIA	
Codice anomalia	
Tipo di verifica	
Disegno	
Id. PDM	
Data segnalazione	
Data apertura	
Segnalata da	
TL Pack	
Descrizione anomalia	
Stato anomalia	¤ Open Issue ¤ Red Issue
	¤ Closed Issue
Storico stato anomalia	
Diagnosi	
Stato scheda	¤ IV In Valutazione
	¤ ST Soluzione Tecnica
	¤ STV Soluzione Tecnica Verificata
	¤ OD ODM Approvvata
	¤ PM Piano Metodi
	¤ NI Nessun Intervento
	¤ AN Annullata
Demerito	¤ 0
	¤ 10
	¤ 40
	¤ 100
Demerito residuo	¤ 0
	¤ 10
	¤ 40
	¤ 100
Numero ODM	
Data approvazione ODM	
Data chiusura	

- *univocal irregularity code*: like KKK.XXX.YYY.ZZZZZZ, where:
  - KKK = surveyor
  - XXX = project
  - ZZZZZZ = progressive number
- *Typology of audit* (Virtual/physical)
- *Design* Number of the design of the component to whom the irregularity is attributed.
- *Id. PDM*: id of the component to whom the irregularity has been attributed.
- *Date of signalling of the irregularity to the* responsible to whom it has been attributed
- *Date of opening*.
- *Name of the surveyor*.
- *TL Pack*: name of the TL Pack to whom the irregularity has been attributed.
- *Description of the irregularity*
- *State of the irregularity:*
  - OPEN ISSUE: in solution
  - CLOSED ISSUE: solved
  - RED ISSUE: high priority
- *Storicizzazione degli stati di un anomalia*
- *Diagnosis*: description of the irregularity which specifies the audit cycle in which it has been identified.
- *Corrective actions*: description of the solution.
- *State of the schedule*:
  - IV = IN VALUTAZIONE: open schedule with a technical solution without the mathematics;
  - ST = TECHNICAL SOLUTION: identified and published on the PDM;
  - STV = TECHNICAL SOLUTION VERIFIED: the RVP has ascertained the solution with a new release on PDM;
  - OD = ODM APPROVED: closing of the signalling of the irregularity. When the mathematics has not yet sent to the PDM it is sufficient the revision PDI released on PDM;
  - PM = PLAN METHOD: the schedule of the irregularity is solved by the Plan Methods (eg.: new utensil for the assembly) and it is not necessary to modify the mathematic.
  - NI = NO INTERVENTION: the irregularity exists but nobody intervenes accepting the fault
  - AN = CANCELED: because it has been already signalled and/or fault interpretation of the RDV.
- *Fault identified*: evaluation of the fault at the moment of the identification of the irregularity.
- *Residual fault*: indicates, after the application of corrective measures, the new fault.
- *Number ODM*: associated to the irregularity
- *Date of approval ODM*:
- *Closing date*

13.5.5 Execution audit/verification cycle on the DMU

The execution of the audit/verification cycle on DMU is composed of the following sub-activities:



i. *Release of CAS mathematics on firm's PDM for sharing the advancement* of the project

ii. *Loading of the context of audit/verification*, that is the *ensemble* of the needed parts for the audit/verification through DMU

iii. *Execution of the audit/verification* through the help of check list which, for each component, list the controls to execute

iv. *Analysis of the result of audit/verification*

v. *Presence of potential irregularities found in the audit/verification*, at each cycle and after each audit/verification executed, they proceed to the analysis of the results and they signal potential irregularities

vi. *Closing of the audit/verification* whether anomalies are not found

vii. *Signalling to the RVP about the irregularity found*

viii. *Audit/verification of the correctness of the signalling from an expert* in order to confirm it

ix. *Communication of the expert with RVP for cancellation of the irregularity*, in case of false signalling

x. Audit/verification whether the irregularity has been previously found in the same project or in others

xi. Retrieval of the irregularity schedule

xii. Allocation of a degree of gravity to the irregularity according to a predefined scale

xiii. Audit/verification of the degree of tolerability of the irregularities found in order to under stand whether the intervention is necessary or not.

xiv. Whether it is tolerable, communication to the RVP for the closing of the audit/verification phase

xv. Opening of a schedule of irregularities whether, on the contrary, the irregularity has to be solved.

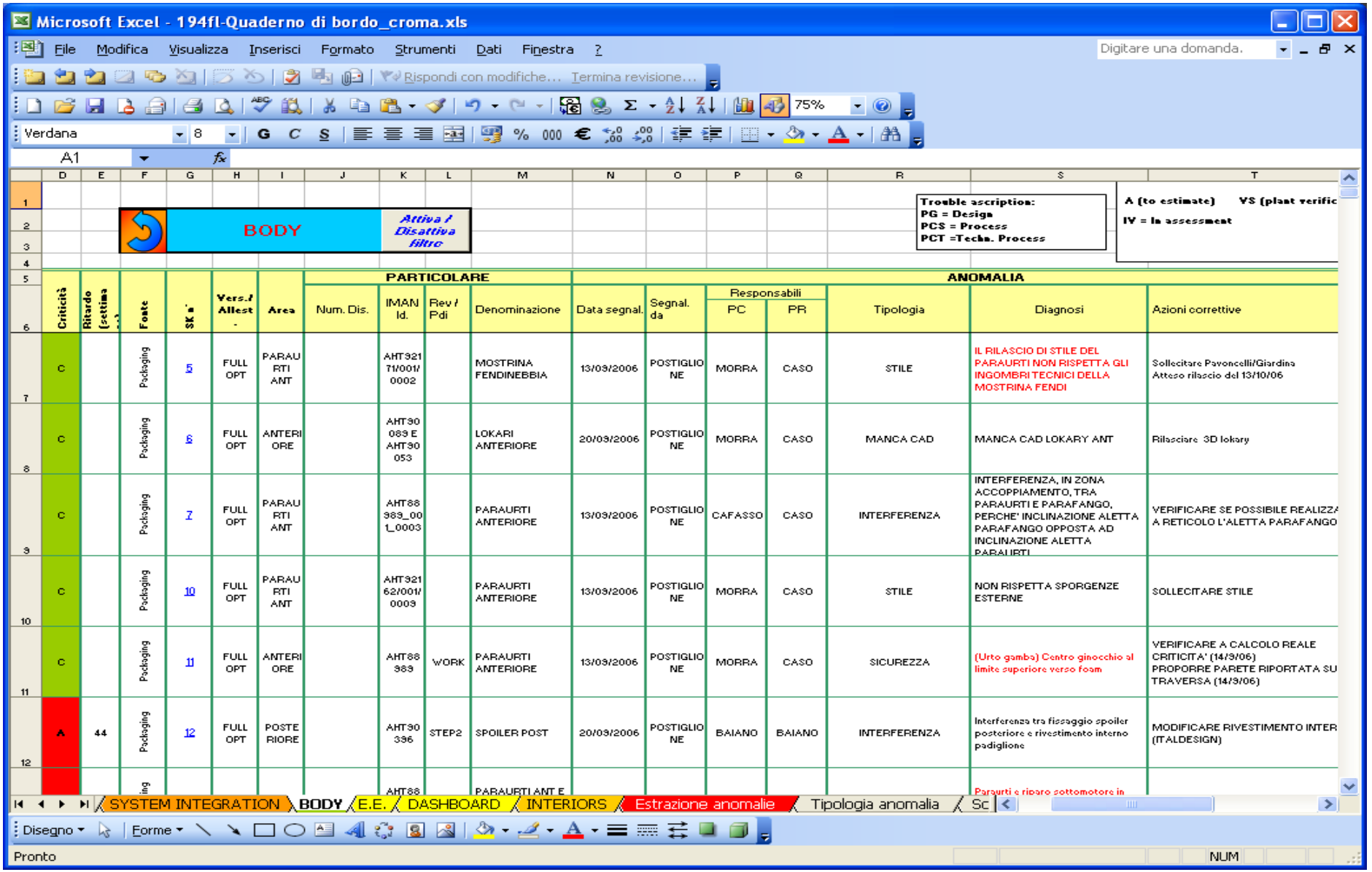
13.5.6 The Ship's Log

To support the process of irregularity solution a ship's loag has been created. The Ship's loag is an excel paper that registers chronologically the irregularities, with information like the components involved, the typology, the refinement of the irregularity schedule and every other document produced in the process of audit/solution of the anomalies. A ship's loag presents always two typologies of content:

1. ***statistical information***, such as tables, graphs defining the progress of the project (mainly number and typology of the irregularities found).
2. ***details on the single issues*** that, during the packaging, include:
   - **generic information**: function involved (integration of the system, electric-electronic system, bridge and interiors), model/ preparation of the Vehicle (FULL OPT), area (front), reference to the irregularity schedule.
   - **particular involved**: denomination and identity of the part CAD on PDM (Radiator oil motor 2.4 JTD, AHT92171/001/0002)
   - **irregularity**: date, "signalled by", person responsible for its solution, typology (stile, interference, security,…), diagnosis (fog light at 7.4 mm from the radiator oil motor), corrective actions (repositioning of the radiator oil to reach the light of 19 mm)
   - **state of the irregularity**: date of the solution, forecast date for the solution, value of fault, residual fault and reference at the Order of Modification.

The actors involved in this process are:

Actor	Description
manager of the Ship's loag	Define new irregularities Define the list of the responsible of the irregularity Can manage the anomalies of the "ship's loag Operator"
Operator of the ship's loag	Define new irregularities Define the list of the responsible of the irregularity Can manage only the irregularities he defines.
Responsible anomaly	Define the solution paths. Identify the users involved in the solution and the user for the verification. Specify the actions to do in every step. He is the user to whom it is possible to assign an anomaly.
User of reference	It doesn't exist a predefined list of users, but these are identified in the phase of activity assignment by the "Responsible anomaly".
Consultant	He is qualified in searching for information available on anomalies


Microsoft Excel - 194fl-Quaderno di bordo_croma.xls
BODY
Attiva / Disattiva filtro
Trouble ascription:
PG = Design
PCS = Process
PCT =Techn. Process
A (to estimate)
VS (plant verific
IV = In assessment
PARTICOLARE
ANOMALIA
Criticità
Ritardo (settima
Fonte
SK a
Vers./ Allest.
Area
Num. Dis.
IMAN Id.
Rev / Pdi
Denominazione
Data segnal.
Segnal. da
Responsabili
PC
PR
Tipologia
Diagnosi
Azioni correttive
C
Packaging
5
FULL OPT
PARAURTI ANT
AHT32171/001/0002
MOSTRINA FENDINEBBIA
13/03/2006
POSTIGLIONE
MORRA
CASO
STILE
IL RILASCIO DI STILE DEL PARAURTI NON RISPETTA GLI INGOMBRI TECNICI DELLA MOSTRINA FENDI
Sollecitare Pavoncelli/Giardina Atteso rilascio del 13/10/06
C
Packaging
6
FULL OPT
ANTERIORE
AHT30089 E AHT30053
LOKARI ANTERIORE
20/03/2006
POSTIGLIONE
MORRA
CASO
MANCA CAD
MANCA CAD LOKARY ANT
Rilasciare 3D lokary
C
Packaging
7
FULL OPT
PARAURTI ANT
AHT88383_001_0003
PARAURTI ANTERIORE
13/03/2006
POSTIGLIONE
CAFASSO
CASO
INTERFERENZA
INTERFERENZA, IN ZONA ACCOPPIAMENTO, TRA PARAURTI E PARAFANGO, PERCHE' INCLINAZIONE ALETTA PARAFANGO OPPOSTA AD INCLINAZIONE ALETTA PARAURTI
VERIFICARE SE POSSIBILE REALIZZA A RETICOLO L'ALETTA PARAFANGO
C
Packaging
10
FULL OPT
PARAURTI ANT
AHT32162/001/0009
PARAURTI ANTERIORE
13/03/2006
POSTIGLIONE
MORRA
CASO
STILE
NON RISPETTA SPORGENZE ESTERNE
SOLLECITARE STILE
C
Packaging
11
FULL OPT
ANTERIORE
AHT88383
WORK
PARAURTI ANTERIORE
13/03/2006
POSTIGLIONE
MORRA
CASO
SICUREZZA
(Urto gamba) Centro ginocchio al limite superiore verso foam
VERIFICARE A CALCOLO REALE CRITICITA' (14/3/06)
PROPORRE PARETE RIPORTATA SU TRAVERSA (14/3/06)
A
44
Packaging
12
FULL OPT
POSTERIORE
AHT30336
STEP2
SPOILER POST
20/03/2006
POSTIGLIONE
BAIANO
BAIANO
INTERFERENZA
Interferenza tra fissaggio spoiler posteriore e rivestimento interno padiglione
MODIFICARE RIVESTIMENTO INTER (ITALDESIGN)
AHT88
PARAURTI ANT E
Paraurti e ripara sottomotore in
SYSTEM INTEGRATION
BODY
E.E.
DASHBOARD
INTERIORS
Estrazione anomalie
Tipologia anomalia
Sc
Pronto
NUM

13.6 Conclusion and to be scenario of the Issue management Process

This process of anomalies' audit/solution doesn't support the search and identification of analogies and similarities between a new and an old anomaly found previously, neither between platforms, nor while they increase on the same platform, blocking the "verification whether the irregularity has been already found previously" process prescribed in the "execution verification cycle on the DMU".
Thus, the search for similar irregularities relent the solution process and affect the whole progress of the project.
Actually, knowledge management systems used in the automotive sector enable to monitor the progress of the project in single platforms, tracing only the number and the typology.
A solution to the current problem can be identified in the:

1. identification of the potential community of practices to be involved in the issue management;
2. Representing the information related to anomalies through the methodology of semantic web.

The creation of communities of practice can certainly be a valid solution for Elasis, considering the results obtained highlighted previously. Social dynamics within the firm tell us that every solution concerning the creation of work groups will be welcome. An important task of these communities in this case will be the creation of rules of thumb and intuition, which is flexible guides to action developed through trial and error and over the long experience and observation, for example related to the Issue management process (irregularity audit/solution). These are heuristics that contain solution to new problems that resemble problems previously solved by experienced workers. So they don't have to build an answer from scratch every time. Sometimes we arrive to solve problems very quickly by intuition, but intuition is not mystical; it means that we have thoroughly learned the steps that they happen automatically without conscious thought, and therefore at great speed. Karl Weick named it 'compressed experience'. In the first part of the thesis, we have already extensively approached the organizational model of the communities of practice and theirs functions. Then, we will briefly highlight what are CoP and what is their role. A CoP is a social group composed by employees that is charged of searching and organizing the tacit knowledge produced within and across the firm so it is not lost and everyone can have access to it. In this context a CoP should be composed by all employees that work on similar subjects related to the irregularity audit/solution process beyond the groups constituted every time for this purpose. Communities of practice are groups of people who share ideas and insights, help each other solve problems and develop a common practice or approach to the field (McDermott, 1999). They focus on learning within functions or disciplines, sharing information and insight, collaborating on common problems, stimulating new ideas (Wenger, 1998; McDermott, 1998).

14. Identifying CoPs through Social Network Analysis

In order to identify the potential memebers of a community of practicefor solving the problems highlighted previously in this research; it is useful to view the business unit's knowledge sharing network.

Social network analysis (SNA) has been demonstrated of being a valid tool in recognizing communities of practice (Cross et al., 2006). SNA enables to uncover the key members of the community as well as assess overall wealth in terms of connectivity.

This technique is useful for different purposes, especially for determining the most central people within a unit or a group and by identifying the ego-centric network of every worker. This information will result help in the mapping of the actual network of relationship present within and across the platforms.

For this purpose the selection of the employees belonging to the two different business considered in the present analysis is particularly well-suited because these units are more frequently than others involved in the process of irregularities audit/solution.

As complementary methodology in the present study we decided to adopt social network analysis. This technique will complement and enrich the results coming from interviews and questionnaires with top manager and other employees.

14.1 Social Network Analysis (SNA)

Network analysis is derived from graph theory and attempts to describe the structure of relations (displayed by links) between given entities (displayed by nodes), and applies quantitative techniques to produce relevant indicators and results for studying the characteristics of a whole network and the position of individuals in the network structure. The first application of this technique remind to Mitchell, Barnes, Watson and to the School of Manchester, where they studied the dynamics and the distribution of power in social groups. Sociometric matrices were built to analyse the influence of individuals in groups. The sociometric representation of *N* actors network is a matrix (NxN) whose generic element aij=1, means that between actor *i* and actor *j* there is a relationship, otherwise aij=0. Then Nadel (1957) introduced the concept of role, and mathematical methods were needed to study the interaction of agent's role in a network of relationship. Through this technique researcher have started to analyze the structure of networks such as: egocentrism (centrality), the intensity, the duration, the density (which indicates the connectivity, frequency and extension of relationships) and the mutuality of networks.

The main data to collect in SNA are relational data, which are contacts, links, connecting an agent to one another.

This approach has to deal with interconnected world ontology rather than with a deterministic model of explaining phenomena.

It has been widely proved by several researchers that organizational boundaries, such as formal structure, work processes, geographic dispersion, leadership style and culture are inhibitors of knowledge sharing and inter-functional integration. However, intra and inter-functional collaboration within a firm is often associated with superior firms' performance.

During the last decade, among researcher, an increasing interest in considering the social aspects of collaboration has emerged. Sometimes managers believe that by introducing collaboration technologies or communities of practice, firm's performance would have increased. Accordingly, cause-effect mechanisms and mechanicistic approach have often showed their limitations for an effective solution of the problems.

Coordination and work increasingly occur through informal networks of relationships rather than through channels tightly prescribed by formal reporting structures (Cross, Borgatti, Parker, 2002). 'People rely very heavily on their network of relationships to find information and solve problems—one of the most consistent findings in the social science literature is that who you know often has a great deal to do with what you come to know' (Cross, Borgatti, Parker, 2002:26).

Managers often are not aware of these informal processes of knowledge/information exchange and the 'movement towards de-layered, flexible organizations and emphasis on supporting collaboration in knowledge-intensive work has made it increasingly important for executives and managers to attend to informal networks within their organizations (ibidem).

The understanding of informal relationships has become increasingly recognized as a useful tool for managers, the need to map and a document informal network precisely has become paramount. A growing interest towards social network analaysis is showed by researchers in the area of knowledge management community (Tichy et al., 1979; Georghiou et al., 1988; Cross and Parker, 2004; Dahl and Pedersen, 2005; Mote, 2005) that have already used 'social network analysis'.

Although managers may be able to diagram accurately the social links of the five or six people closest to them, their assumptions about employees outside their immediate circle are usually off the mark."(Krackhardt and Hansen, 1993). Social network analysis can be an invaluable tool for systematically assessing and then intervening at critical points within an informal network. The idea of drawing a picture (called a "sociogram") in sociology is an old idea and is credited to J.L. Moreno (1934), an early social psychologist who envisioned mapping the entire population of New York City2.

Today researcher in the field of management have started to invest their efforts in recognizing informal networks and their effect on work performance (J. Lincoln, "Intra- and Interorganizational Networks," in Samuel B. Bacharach, ed., Perspectives in Organizational Sociology (Greenwich, CT: JAI Press, 1982), pp. 1-38; B. Wellman and S.D. Berkowitz, Social Structures: A Network Approach (Greenwich, CT: JAI Press, 1997); N. Nohria and R.G. Eccles, eds., Networks in Organizations:

[2] J.L. Moreno, *Who Shall Survive?* Washington D.C: Nervous and Mental Disease Publishing Company, 1934.

Structure, Form, and Action (Boston: MA, Harvard Business School Press, 1992); S. Andrews and D. Knoke, eds., Networks In and Around Organizations, Research in the Sociology of Organizations, 16 (Stamford, CT: JAI Press, 1999).

As we have previously said, in social network analysis there are two different approaches, a 'structuralist' approach and a content approach. The first one is aimed at studying the structure of a given network, it relates to the relationship level, such as the presence of strong a weak ties.

On the contrary the content approach is aimed at investigating the resource flowing through social networks such as information, knowledge, comments, and informal communications and the influence played by the position of the actors.

We thus do not only apply the 'structuralist' approach of social networks to the front-end, but also include the role of network content.

Social Network analysis can be particularly useful for (Cross, Borgatti and Parker, 2002):

1. *mapping informal knowledge sharing flows*

Social Network analysis helps in visualizing the pattern of knowledge/information sharing in strategically important groups. In practice it provides is a means to make 'visible' the 'invisible' patterns of interaction/collaboration occurring in important networks within an organization.

2. *identifying highly central people and bottlenecks*

For identifying people that are highly central in networks (and so disproportionately impact a group by controlling information or decision making), it can help a manager consider how to reallocate informational domains or decision-making rights so that the group as a whole is more effective.

By the investigation of informal networks it is possible to identify critical personnel who may otherwise go unrecognized. This includes both technology gatekeepers and boundary-spanning individuals, but may also include staff who may be acting as bottlenecks to knowledge transfer (Anklam, 2005).

3. *Understanding who is peripheral*

Alternatively, understanding who is peripheral in a network and crafting ways to engage these people is also an important means of ensuring that expertise resident in a given network is being effectively utilized.

4. *Getting people connected quickly in high turnover situations*

Particularly in high turnover situations, it is increasingly important to get people connected more and more quickly so that they are productive for an organization.

5. *discovering excessive relationships*

Assessing SNA can help managers in identifying over –burdened people and alleviate or decrease time consuming connections. Sometimes employees overloaded with email, requests, calls are stressed to a point that they endanger their health.

6. *Help in identifying fragmented networks or groups*

Furthermore, assessing junctures in networks that are fragmented across geographic, functional, hierarchical or organizational boundaries (or detecting sub-groups) can be particularly informative for social or technical interventions that help to integrate disparate groups. Network analysis provides us with the means to understand where collaboration is and is not occurring.

14.2 Goal of the study

Following Krackhardt and Hanson (1993), we want to show that network analysis can help Elasis' managers in identifying three types of relationship networks of fundamental importance for solving organizational problems, such as:
1) **the advise network**, identify who in the organization provide more often technical information and help in problem solving. They are useful to examine when a company want to change its routines.
2) **the trust network**, tells which employees share delicate political information and back one another in a crisis. This network should be examined when an organization is implementing a major change or a experiencing a crisis.
3) **the communication network**, reveals the employees who talk about work-related matters on a regular basis. They should be examined when productivity is low, because they can help in identifying gaps in the flow of information that is often associated with an inefficient use of resources and lack of new ideas.

Our work was initially aimed at detecting these three typologies of network, however since our goal was to detect the most central players in the knowledge sharing flows of the firm, we decided to focus only on the communication (of knowledge) network.
Mainly the goal of this work is to detect the presence of communities or the potential members that can give shape to a dynamic and flexible community of practice.
Moreover, for understanding potential problems related to knowledge sharing, we are going to conduct a SNA also for:
- detecting breakdowns in collaboration occurring across functional lines, or due to misuse of power, lack of forums and well intentioned leaders;
- ensuring integration post-merger and large scale change. In fact, very often, large-scale change (Pre and post- merger) initiatives impair the effectiveness of established networks while at the same time doing little to help development of new relationships;

- promoting innovation. SNA reveals how a team is integrating its expertise and the effectiveness with which it is drawing on the expertise of others within the organization;
- assessing strategy execution. Core capabilities or competencies in a knowledge intensive work are usually a product of collaboration across functional or divisional boundaries. SNA allows executives to determine whether the appropriate cross-functional or departmental collaboration are occurring to support strategic objectives.

14.3 Methodology

Social Network Analysis is composed of several phases, in our study we follow the six phases identified by Cross Borgatti and Parker (2002), which are:

1. Identify a strategically important group
2. Assessing meaningful and actionable relationships
3. Visual analysis of the results
4. Quantitative analysis of the results
5. Meaningful feedback sessions
6. Assessing progress and effectiveness

In identifying the strategic group that is more interesting for our purposes we select the persons more involved in the process of audit/solution of irregularities. This process presents some problems and lowers considerably time efficiency in product development. In order to solve these problems we have to identify the persons that can create a community of practice. The first step is to identify an informal network where effective collaboration and knowledge sharing has a significant impact on the organization's process. Often, these groups do not appear on a formal organizational chart.
Then, as two functions were identified as the core function within new product development process, group-level approach was selected. In fact, in SNA two different approaches are available, a personal network approach and a group-level approach.
Personal level approach requires a person to identify other people who are important for a given function or task and then asking question regarding each of these people; eg.: employees in the same SBU, in other SBU, people in different organization, friends, family members. An advantage of this approach is that it covers all relationships that are important to a person.
Group level approach requires that the researcher first define a network of interest, like core function or group of people who are integral to a core process. Then the researcher surveys each person in the group about his or her relationship with every other member of that group, and from this survey it is possible to extract a list of names from the group chosen.
The sample frame consisted of R&D personnel belonging to the two business units considered in the present analysis: Vehicle and ICT.

Each respondent was asked to nominate up to five people with whom he shares more frequently knowledge during their work, indicating whether they were colleagues located in the same office, division/department, colleagues belonging to other firms of the Fiat group, academicians or researchers, suppliers or partners' firms. The rest of the survey then asked questions about the five people/organization chosen such as distance, frequency of interaction, level of trust, frequency of relocation and movement, medium used, resource shared, frequency of many-to-many (forum, brainstorming) interactions. This followed the methodology for co-nomination set out in Nedeva et al. (1996). Conducting a social network survey is a straightforward process of obtaining a list of all people in the defined network and simply asking all members of the group to characterize their relationship with each other.

These kind of questions were inserted in the questionnaire that we used for the first part of our study. The questions related to social network were positioned in the middle of the questionnaire. The questionnaire was administered via e-mail as a Word attachment, which took 5-10 minutes to complete.

Of the targeted 62 individuals, 50 responses were received, representing a response rate of 88%. Each respondent reported an average of five relationships, thereby generating an initial total sample of 254 observations (Sample information is the same that we have described at the beginning of the statistical analysis).

In order to elicit honest answer from employees, we assured that their answer will not damage them or other employees and that their immediate colleagues will not access to the responses. Moreover, anonymous responses were guaranteed nominating an external responsible for questionnaires collections.

Further, all surveys were returned directly to the researchers to reduce the likelihood of biased answers.

14.3.1 Constructs of the study

The goal of the present study was to map the intra and the inter-firm knowledge sharing network in the two business units of Elasis.

For this purpose in the questionnaire we asked to participants to name the persons with whom more frequently they shared knowledge. We adopted the ego-centric network approach, which consists in asking to participants to name till a certain number of collaborators with whom they work. The network is built according to the responses provided by the participants, avoiding the investigation of the network of the persons named.

Finally, the questionnaire asked participants to name at least the 5 persons belonging to their internal and external network of collaborators with whom they shared knowledge more frequently. With internal and external network we mean people belonging to the same firm (Elasis) or to other firms of the Fiat group or other kind of partners such as strategic alliances, research centres and universities,

and suppliers. Through this information we can understand how extended is the network of everyone, how it is composed, the degree of heterogeneity, the extension of the external network and so on. After having named the persons composing their knowledge sharing network, these employees have to determine for each of them the frequency of interaction, of movement, the level of trust, the medium used. Then, they have also to specify what typology of knowledge information they shared and with what result.

Finally, we followed a bit the Lasswell Formula (1948) in order to get information on:

- Who: the communicator
- Says What: the content
- In What Channel: the medium used
- To Whom: the audience
- With what effect: opinion change…

We adapted this model according to our goals and we got information on:

- Who share with whom: the persons that more frequently share knowledge with our sample
- What: ideas, technical knowledge and best practice, market knowledge…
- Where: information on the location of the communicators
- When: how frequently: rarely, sometimes, frequently…
- In What Channel: the medium used: e-mail, telephone, face-to-face…
- With what effect: accelerating, reducing costs, increasing rate in NPD process.

Definitely for each questions we graduate the response following the 5 Likert scale model and we specify

for every single the meaning of the number.

So the questions interesting for social network analysis in the questionnaire were:

1) name up to five persons/organizations (belonging to the firm, to the Fiat Group or external partners such suppliers, research centres …) with whom you share more frequently knowledge during your work;

1. …..
2. ….
3. …. (and so on)

2) Where is located this persons/organization?

1- in an other country;
2- in an other region of Italy;
3- in the same region but in an other industrial establishment;
4- in an other department/unit but in the same industrial establishment
5- in the same unit/department and in the same industrial establishment

3) With what frequency you move/travel for sharing knowledge with him?

1- very frequently (once a week)
2- frequently (once a month)
3- sometimes (once every 2/3 months)
4- rarely (once every 5/6 months)
5- never

4) How frequently you interact with this person/organization to share knowledge?

1- very frequently (more times day)
2- frequently (once a day)
3- sometimes (once every week)
4- rarely (once a month)
5- never

5) How much you trust this person/organization

1. I trust him very much
2. I trust him
3. Sincerely, it depends from the situations (not so much)
4. Low trust
5. I don't trust him

6) Which is the medium used more frequently for sharing knowledge with him?

1. forums, blogs
2. km portal, intranet, extranet
3. e-mail
4. video-conference
5. telephone
6. face-to-face
7. conference, plenary sessions, seminars

7) Which is the resource more frequently shared with him?

1. ideas
2. technical knowledge and problem solving
3. best practices

4. market knowledge
5. procedural and service information
6. information about the strategy of the group

8) During the activity of sharing knowledge, which is the channel more frequently used?

1. always Computer-Mediated-Communication
2. more frequently Computer-Mediated-Communication
3. balance of Face-to-Face and Computer-Mediated-Communication
4. more frequently Face-to-Face
5. always Face-to-Face

9) Which is the frequency of many-to-many communication, such as forums, plenary sessions…?

1. very frequently (weekly)
2. frequently (once a month)
3. sometimes (every 5/6 months)
4. rarely (once a year)
5. never

We adapted most of the survey items from pre-existing scales in the literature. All multi-item constructs—including trust, interaction frequency, distance…— showed good discriminant validity based on factor analysis, using Correlations, Anti-Image, Bartlett test of Sphericity, Measure of sampling adequacy, scree plots of eigenvalues, and all expected factor loadings above 0.4. Constructs had good convergent validity as well, with all Cronbach's alphas above 0.70.

14.3.2 Visual analysis of the results

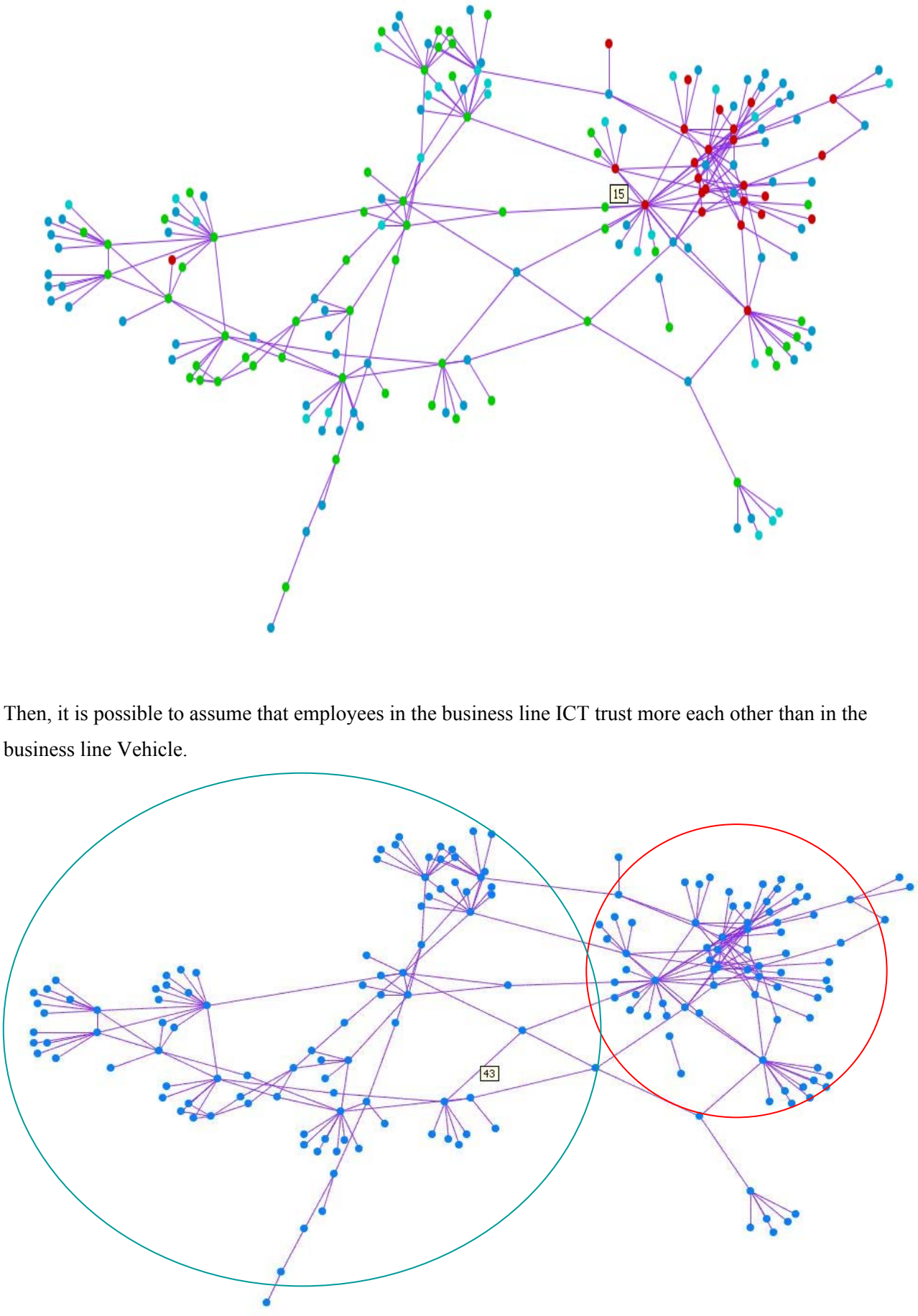
There are different software used for conducting social network analysis, the most popular are Pajek, Ucinet, Techflow and others. In our study we adopted Techflow, because it seemed easier to use and the only one available in the research center. Sociograms represent the network as a series of nodes, which represents individuals connected to other individual (nodes) through a line.
After having set the attributes of the individuals of the sample, we created a *fileloader* for communication frequency within Elasis. Then we charged the data and the software displayed a static picture of the communication occurring within the two business lines.
Through SNA we can get three different typologies of results: visual results and quantitative results (individual and group measures).
Visual results include:

- *Length of a line* : you can vary to illustrate the strength and the frequency of a relationship;
- *Sub-group formation*, when there are impediments in the relationships between people;
- *Reciprocity* of information/knowledge exchange, when the lines point both actors (not considered);
- *Centrality degree*, people with most ties (relationships) are positioned at the center, with the fewest outside (often underutilized resources).

First, we want to see through the length of the line the strength of relationship between groups and individuals.

As we can see from the first sociogram, there is a clear separation between two groups, which are the two business units considered for the analysis. At the right side of the picture there are mainly workers belonging to the ICT business unit, and on the left side there are the participants to the sample of the vehicle business unit. From this first simple visualization, we can immediately see that the two business lines are very far, whilst communication are not so frequent. Employees belonging to these business lines are more used to communicate with external actors. Then, the two business lines considered for the present analysis don't communicate, inter-functional collaboration is quite inexistent.

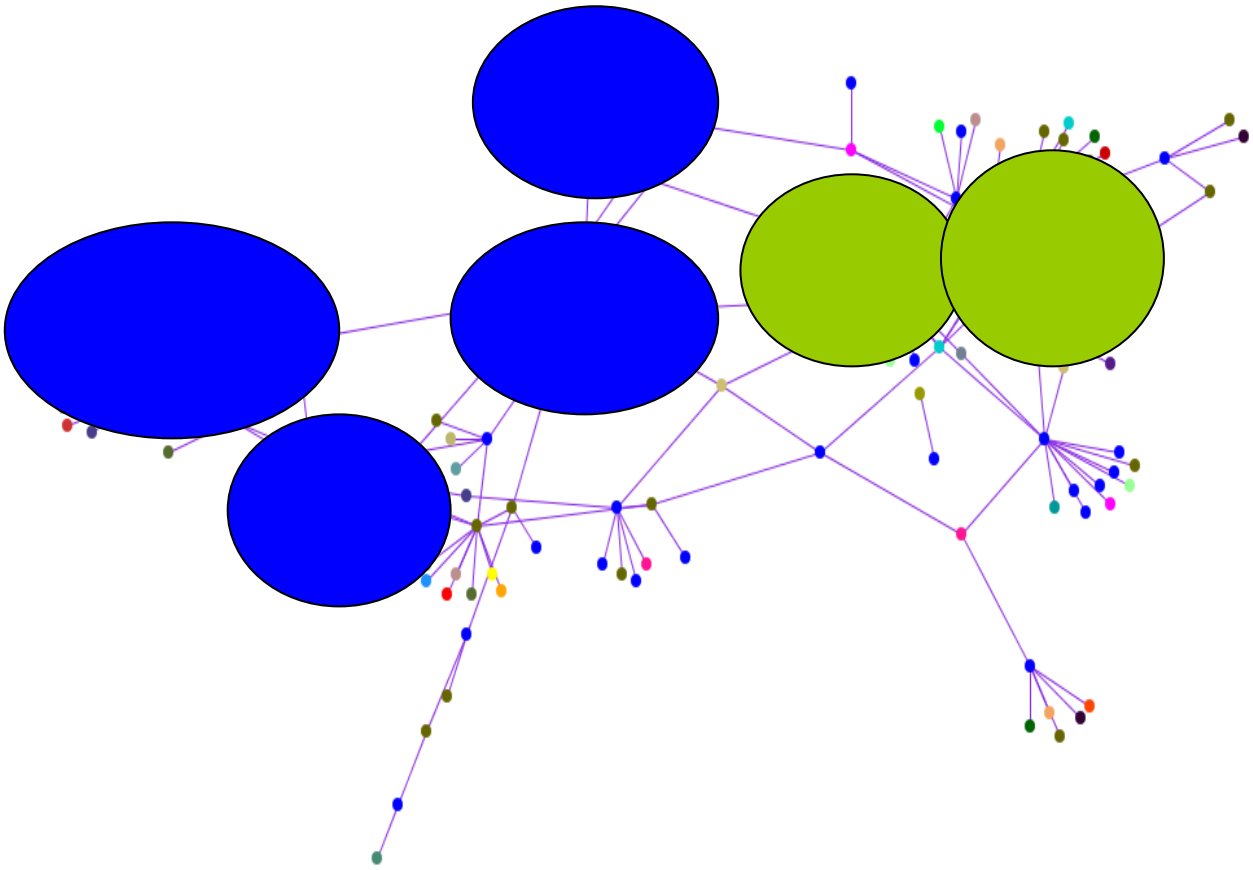
Moreover, it is possible to see that the intensity of communication within both business lines is not the same, employees of the ICT business line communicate more frequently with each other than employees of the business line Vehicle. This result was also highlighted during statistical analysis. Since, business units are quite separate it is useful to identify some worker that act as a boundary spanner or bottleneck.



Then, it is possible to assume that employees in the business line ICT trust more each other than in the business line Vehicle.

Figure 1. Social network analysis of the two business units

Moreover, we noticed that there are couples of actors interacting very frequently between each other. This is evident by looking at the Distance between the nodes in the sociogram. These couple:
4-12, 7-8, 58-12, 2-54
The fact that employees of the business line Vehicle communicate less frequently and consistently the network seem to be more dispersed than the one of ICT, is probably due to a different organization of the establishments in which they are locate. In fact, employees working within Vehicle are more numerous and they are located on different levels, where there are different sub-units that work on different part of the Vehicle, such as ergonomics, interiors design, materials, components…and so on.
Visual analysis enables also the identification of sub-groups. As we can see from the picture below, the business line vehicle is fragmented in 4 sub-groups, while in the business line ICT it is possible to identify two subgroups.



An other important measure in social network analysis is the degree centrality. Degree centrality is simply the number of direct relationships that an entity has. An entity with high degree centrality:

- Is generally an active player in the network.
- Is often a connector or hub in the network.
- is not necessarily the most connected entity in the network (an entity may have a large number of relationships, the majority of which point to low-level entities).
- May be in an advantaged position in the network.
- May have alternative avenues to satisfy organizational needs, and consequently may be less dependent on other individuals.
- Can often be identified as third parties or deal makers.

The actors with most of ties and that are more central are:

ID 13, Russo Antonio, Elasis (**19 ties**), sede di Pomigliano, edificio E1, piano 1, settore ICT.

ID 11, Ferro Catello (**16 ties**), sede di Pomigliano, edificio E1, piano 1, settore ICT.

ID 10 Atripaldi Aniello (**14 ties**), sede di Pomigliano, edificio E1, piano 1, settore ICT.

ID 7, Paduano Ciro (**13 ties**), sede di Pomigliano, edificio E1, piano 1, settore ICT.

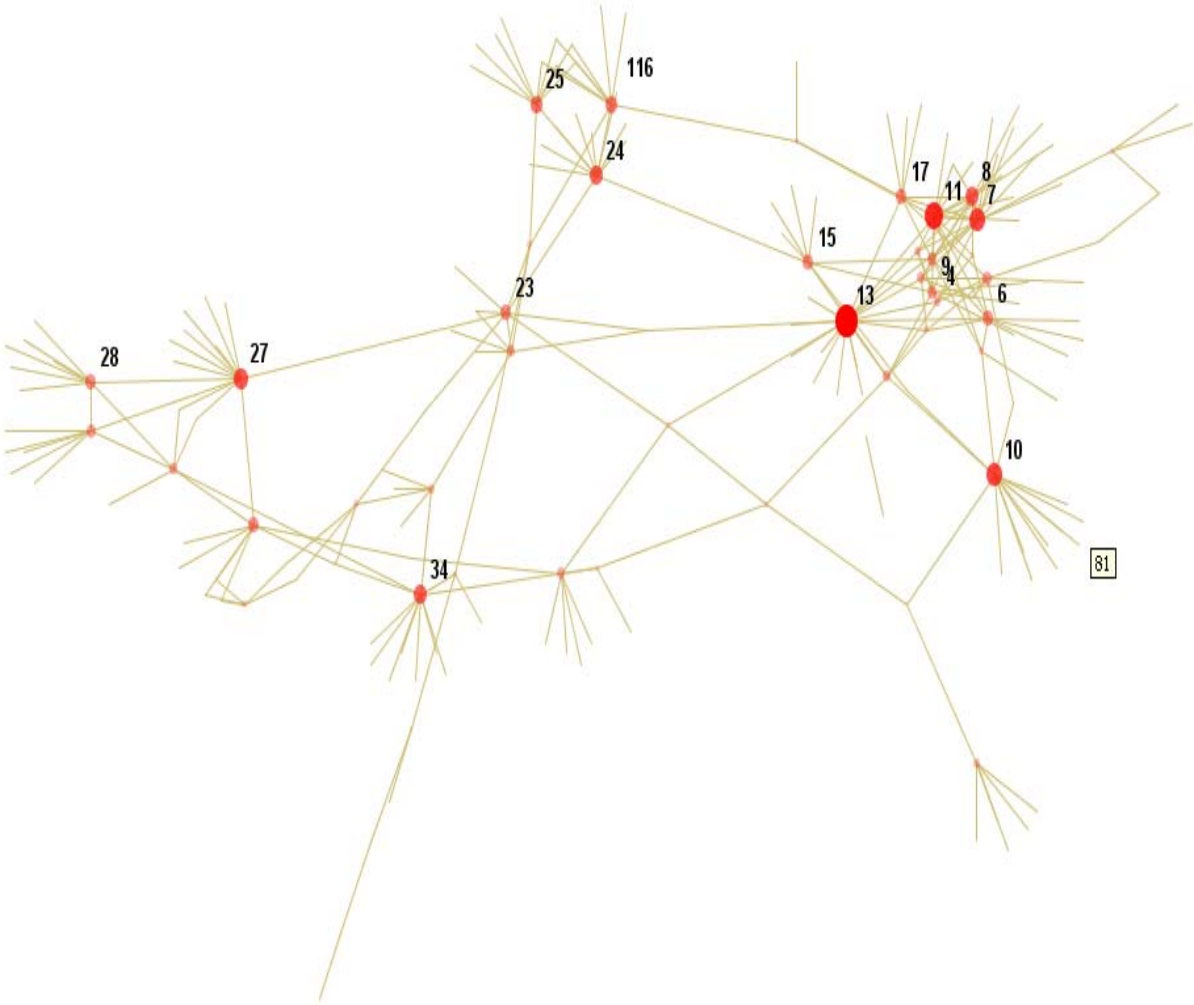
ID 24, De Angelis Coccanari Marco (**12 ties**), Elasis, sede di Pomigliano, edificio E 27, piano 1, settore: Veicolo.

ID 27 Oliviero Giuseppe, Elasis, Pomigliano, anonimo, veicolo

ID 28 Esposito Luigi, Elasis Pomigliano, E27, piano 2, settore Veicolo

ID 8, Carcavallo Ferinando (**12 ties**) sede di Pomigliano, edificio E1, piano 1, settore ICT.

ID 34, Scantamburlo Giuseppe, (**12 ties**), Fiat Auto, Torino, CRF Vehicle integration


25
116
24
17
8
11
7
15
9
4
23
13
6
28
27
10
34
81

14.3.3 Quantitative Individual Results

Individual quantitative results include:

- Betweeness centrality, extent to which a person lie between other important connectors in the network
- In-degree centrality, number of incoming ties
- Out-degree centrality, number of outgoing ties
- Closeness centrality, the extent to which a person lies at short distances to many other persons in the network
- Brokerage measures, people who broker connections within the same group (coordinators), between their own group and another (representatives and gatekeepers), between two different groups (liaisons).

Whereas quantitative group results include:

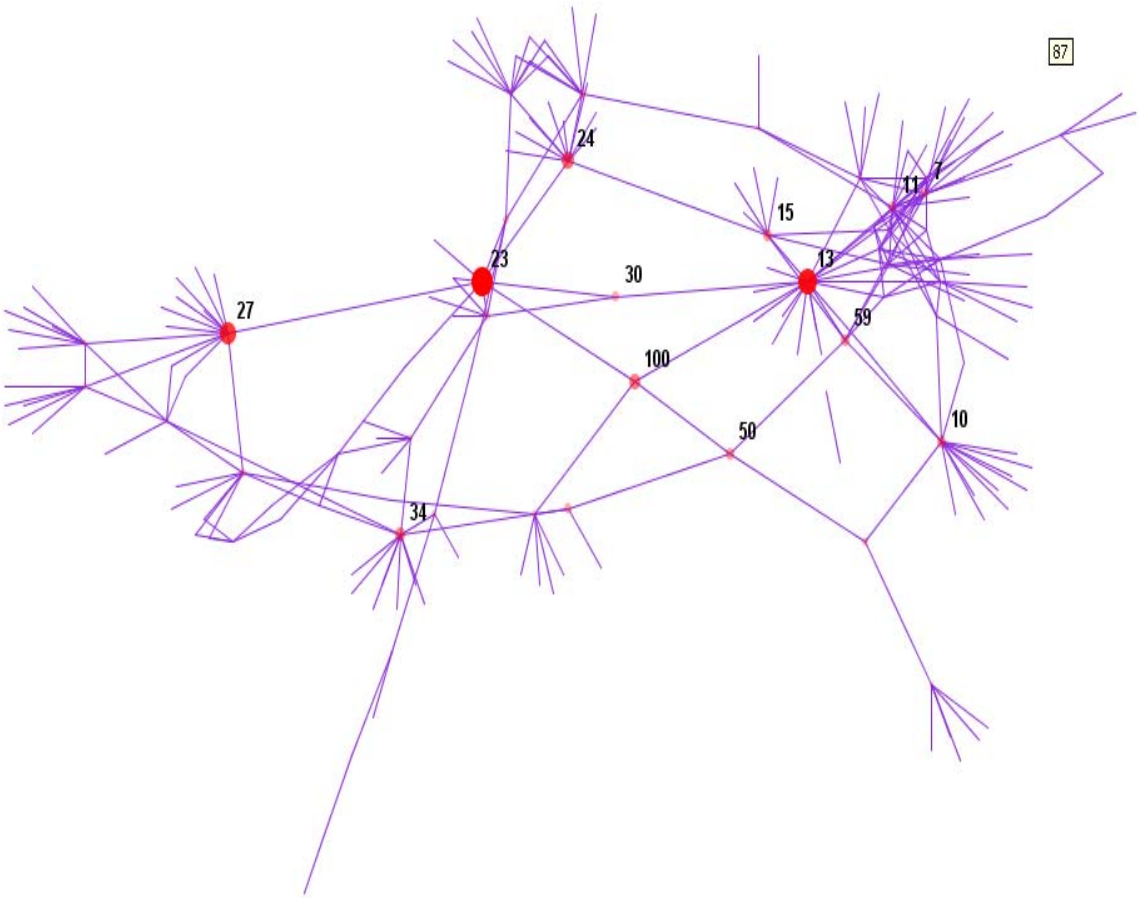
- Density, the percentage of ties on the total possible. For example you can divide people into subgroups (for example function or location) and calculate network density between and within subgroups.
- Cohesion, the average of the shortest paths between every pair of people in the network

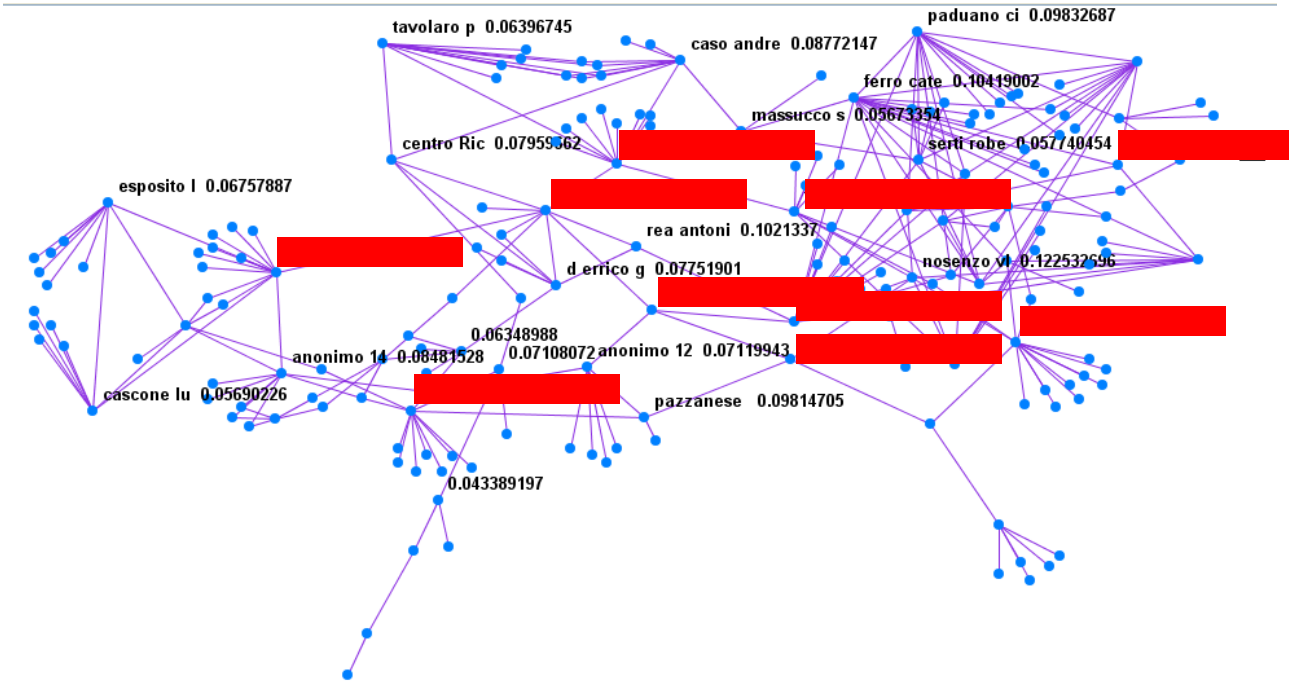
Betweenness centrality is the extent to which a person lies between other people in the network and identifies an entity's position within a network in terms of its ability to make connections to other pairs or groups of influent actors in the network. An entity with a high betweenness centrality generally:

- Holds a privileged or powerful position in the network.
- Represents a single point of failure—take the single betweenness spanner out of a network and you sever ties between cliques.
- Has a greater amount of influence over what happens in a network.

In our case the **ID 60** has the highest betweeness centrality (Ippolito Gaetano, 8.28) since it is between actors with a lot of connections such as the ID 6 (Lando Simone), the ID 8 (Carcavallo Ferdinando) and the ID 4 (Fecondo Giacomo) and the ID 11 (Ferro Catello).
An other actor presenting a high betweeness centrality is the **ID 23** (Morra Carlo, 0.30), which connects two actors that own multiple links in the network; these are the ID 24 (De Angelis Marco) and the ID 27 (Giuseppe Oliviero).
Thus, we have:

ID 13 (Russo Antonio, 0.27) which is among ID 11 (Ferro Catello), ID 6 (Lando Simone), ID 7 (Paduano Ciro), ID 59 (Nosenzo Vladi); ID 27 (Oliviero Giuseppe, 0.24) which is between the ID 23 (Morra Carlo) and the ID 28 (Esposito Luigi);
ID 24 (De Angelis, 0.18) which is between ID 26 (Caso Andrea) and ID 25 (Tavolaro Pietro).
ID 100 (University Federico II di Napoli, 0.16) which is between the ID 13 (Russo Antonio) the ID 23 (Morra Carlo).
ID 34 (Scantamburlo Giuseppe, 0.14) which is between the ID 163 (Strippoli Dino) and the ID 33 (Palumbo Ciro);
ID 10 (Atripaldi Aniello, 0.13) which is between the ID 59 (Nosenzo Vladi) and the ID 3 (Lacchè Ida),
ID 59 (Nosenzo Vladi, 0.12) which lies between actors such as the ID 10 (Atripaldi Aniello), ID 13 (Russo Anotonio), ID 15 (Truppa Arcangelo), ID 9 (Langella Aniello).





Finally, by aggregating quantitative and qualitative results (visual results) we identified the potential components of the CoP to be constituted in Elasis. These are:

- Ippolito Gaetano Iveco Italia, Torino, Information Systems
- Morra Carlo Elasis, Pomigliano, E 27, piano 1, Veicolo.
- Russo Antonio, Elasis, sede di Pomigliano, edificio E1, piano 1, settore ICT.
- De Angelis Marco, Elasis, sede di Pomigliano, edificio E 27, piano 1, settore: Veicolo.
- Nosenzo Vladi Iveco Italia, Torino, Information Systems
- Scantamburlo Giuseppe Fiat Auto, Torino, CRF Vehicle integration
- Atripaldi Aniello Elasis, Pomigliano, E1, piano 1, ICT.
- Ferro Catello Elasis, sede di Pomigliano, edificio E1, piano 1, settore ICT.
- Paduano Ciro Elasis, sede di Pomigliano, edificio E1, piano 1, settore ICT.

14.3.4 Conclusions and implications

This research was designed to identify the main barriers to knowledge sharing previously identified by other authors. An actor of the automotive sector was selected, Elasis s.c.p.a., a Fiat's first tier supplier. Through the analysis of the literature we identified several factors that were grouped into three typologies:
social factors; organizational (and cultural) factors; and technological factors (KMS effectiveness and knowledge quality).
The research was conducted through a questionnaire, but the factors and the constructs chosen for the research were identified through previous interviews with the manager of the firm.
The statistical analysis anticipated that the social factors had the highest point, highlighting high level of trust, frequent interactions and informal communication, mutual help and friendship nurtured within the work environment.
Then, the environmental condition seemed to be very good, working probably as an enabler of knowledge sharing.
On the contrary, technological factors showed the lowest point, highlighting a negative situation for what concerns the capability to store and codify correctly the knowledge and the easiness of its retrieval. Knowledge management systems did not satisfy the needs of the worker, as we found that the satisfaction level was low.
Before multiple regression, we performed factor analysis, through which we reduced the number of constructs from 18 to 14, deleting mutual help, socialization, employee's mobility and fragmentation and we create the 4 factors for the multiple regression analysis.
Multiple regression was performed for answering to the main question of the research, aimed at identifying the strongest influencer of knowledge sharing effectiveness (among the three dimensions identified before and the constructs that composed each dimension).
The result of multiple regression showed that knowledge management systems appear to be the strongest predictor of knowledge sharing performance. And as knowledge sharing performance was negative, the main responsibility is attributable to knowledge management systems.
The main problematic related to knowledge management systems were knowledge accuracy and knowledge accessibility. In fact, a great part of the knowledge archived in these systems is not reused in other projects, due to the difficulty in retrieving each time the needed knowledge or to problems related to lack of a homogeneous terminology and format for knowledge archival.
Also organizational factors play a strong role in influencing the performance of knowledge sharing in Elasis, the strongest factors are individual and group incentives. Individual incentives are scarcely used and group incentives are low and distributed too late. Knowledge Sharing Routines and Rigid Org. Structures were also compound in the same item and demonstrated a certain influence.
Social factors in this context are not a predictor of knowledge sharing, since every factor related to this dimension performed very well and in this research we are looking for barriers to knowledge sharing.

In an organization located in south Italy, informality, face-to-face communication and frequent interactions are not infrequent, and certainly this represents an important competitive asset for getting round out of the lack of effective knowledge management systems.
In order to analyze the problem related to knowledge storage, retrieval and application, we decided to analyze an important process in which these activities are very frequent and of capital importance for the success of the process.
The process identified was the 'Issue Management', a process formalized for the audit/solution of anomalies during product development. The difficulty in retrieving knowledge was confirmed also in this process. In fact, it was found the employees have difficulties in retrieving knowledge of how in the past other employees have solved the same irregularities.
This process impacted strongly on product development time, as the identification of anomalies relent the process considerably, according to managers the process could be 20% more rapid if KMS supported the process of identification of past anomalies in new projects.
Briefly, Elasis possess a huge quantity of knowledge archived in KMS that is useless as it is quite never used because it is difficult to retrieve and to understand. Knowledge in the past was archived roughly; probably they did not imagine that knowledge is path-dependent. In fact, today employees have difficulty in retrieving and utilize past knowledge blocking the transmission of the historical knowledge to newcomers and to the same employees.
Increasingly, knowledge management systems don't support this activity, and the knowledge retrieval is left to people with good memory. This problem affects strongly product development and in particular time performance.
This research had only a proposal stage. In fact, after having detected such problems we started to think to an appropriate and costly solution.
The intent was to build up a community of practice that would have achieved the goal of systematize and codify the huge quantity of knowledge dispersed in the knowledge management systems used by the firm. Moreover, this activity was necessary since Elasis was planning to buy a new KMS.
Then, in order to identify the members that would have composed the CoP we adopted social network analysis (Cross et al., 2006).
The visual results of social network (sociograms) enabled the mapping of knowledge transfer in the two business lines considered as case study for the present research (ICT and Vehicle).
Visual and quantitative results were analyzed.
Visual results included the mapping of sub-group formation, the identification of boundary spanners and the interaction frequency within units and between them.
The visual results showed two business units that don't communicate/collaborate between them. Inter-fuctional collaboration was quite inexistent and some boundary spanners were identified in order to improve this lack of knowledge transfer and coordination.
Moreover, though SNA we identified the actors that are more central in the knowledge sharing network and the ones that were connected between influent actors in the same network.

Quantitative results concerned centrality and betweeness centrality. Finally, visual and quantitative results enabled the composition of a CoP, with the preliminary goals of systematize and codify historical knowledge and of favoring inter-functional communications.

Finally, this research highlighted the adequacy of the multidisciplinary approach by identifying social, organizational and technological factors blocking or enabling the transfer of knowledge within the same firm and between firms.

Moreover, the presence of a phase in which a practical solution to the problems identified is presented. The appropriateness of the use of triangulation, adopting quantitative and quantitative methods was also highlighted.

Bibliography

Carrington P., Scott J., Wasserman S., Models and Methods in Social Network Analysis, Cambridge (MA), Cambridge University Press, 2005.

Dahl, M. and Pedersen, C. (2005) "Social networks in the R&D process: the case of the wireless communication industry around Aalborg, Denmark". *Journal of Engineering and Technology Management*, 22, 75–92.

Freeman, L. C.: "A set of measures of centrality based on betweenness"; *Sociometry*, 40, 1 (1977), 35-40.

Freeman, L. C.: "Centrality in social networks: Conceptual clarification", *Social Networks*, 1, 3 (1979), 215-239.

Georghiou, L., Giusti, W.L., Cameron, H.M. and Gibbons, M. (1988) The use of co-nomination analysis in the evaluation of collaborative research. In Van Raan, A.F.J. (ed.), Handbook of Quantitative Studies of Science and Technology. Amsterdam: Publisher: Elsevier Science Publishers B.V., pp. 275–290.

Hair J.F., Tatham R., Anderson R.E., Black W., Multivariate Data Analysis, Prentice Hall, 6th edition, 2005

Mote, J.E. (2005) R&D ecology: using 2-mode network analysis to explore complexity in R&D environments. *Journal of Engineering and Technology Management*, 22, 93–111.

Nedeva, M., Georghiou, L., Loveridge, D. and Cameron, H. (1996) "The use of co-nomination to identify expert participants for technology foresight." *R&D Management*, 26, 155–168.

Nunnally, J. and Bernstein, I. (1994). Psychomteric Theory. New York: McGraw Hill.

Scott, J. (1991) Social Network Analysis. A Handbook, Sage, London.

Stone, E. F. Research Methods in Organizational Behavior, Scott, Foresman Company, Glenview, IL, 1978.

Tichy, N.M., Tushman, M.L. and Fombrun, C. (1979) Social network analysis for organizations. *Academy of Management Review*, 4, 4, 507–519.

Wasserman, S., Faust, K., (1994). Social Network Analysis: Methods and Applications, Cambridge University Press, Cambridge/MA (1994).

Wellman, B., Berkowitz, S. D.: "Social Structures", Cambridge University Press, Cambridge/MA (1988)

Wellman, B. (1982). Studying personal communities. In P. Marsden & N. Lin (Eds.), Social Structure and network analysis: 61-80. Beverly Hills, CA: Sage.

Wellman, B., & Frank, K. 2001. Network capital in a multilevel world: Getting support from personal communities. In N. Lin, K. Cook, & R. Burt's (Eds.), Social capital: Theory and research: 233-273. New York: Aldine De Gruyter.

Yin, R. (1984). Case study research: Design and methods (1st ed.). Beverly Hills, CA: Sage Publishing.

Appendix

List of Items used in the questionnaire

Organizational Factor

Learning Routines

1. Elasis has provided routines for knowledge sharing and feedback (routines for KS and feedback)

2. Employees participate frequently to learning activities such as workshops, conferences, meetings (frequency of learning activities)

Incentives (Individual and Group)

3. The enterprise provides incentives for people undertaking knowledge sharing (Individual Incentives;

4. Presence of group incentives for knowledge sharing (group incentives)

Fragmentation

5. The work is strongly fragmented and I don't have the cognition of the whole picture

Bureaucracy degree

7. Frequency of interaction (Both face-to-face and CMC) (interaction frequency for knowledge sharing);

8. Informality of the communication process with these actors (informality of the communication process);

9. Frequency of forum, collective brainstorming or problem solving (one-to-many and many-to-many);

10. Employees interact frequently with their superiors (frequency of bottom-up communications flows)

Proximity

11. Location of the person with which knowledge is more often shared

Employees' mobility

12. Frequency of employee's rotation, movement for sharing knowledge

Social Factors

Trust

13. How much do you trust your colleagues with whom you share knowledge more frequently?

Mutual Help

14. People ask very frequently help to colleagues informally

Socialization

15. Employees in Elasis easily and frequently socialize with other employees and manage for meetings, social activities outside their work

KMS effectiveness

26. Knowledge in Information Management System is organized in a way that facilitates its retrieval (knowledge accessibility);

27. People often use templates in order to codify the knowledge so that everybody can use it (knowledge format);

28. Knowledge present in KMS is explicated clearly in a way that facilitates its application to new projects (knowledge accuracy and reuse);

29. KMS effectively integrate knowledge of different parts of the firm (knowledge integration);

30. Through KMS, knowledge is retrieved rapidly (response time)

31. Search functionalities are effective (search functionalities effectiveness).

Knowledge Sharing Performance Factors

31. The enterprise adopt mechanisms for making everybody aware on what project others are working on (knowing who is working on what);

32. People within the firm always know where to find the most competent person in a certain domain (knowledge of who is expert on what);

33. I have at disposition all the knowledge I need for my work (completeness of knowledge at disposition);

34. KMS and people provide me information on best practice (knowledge on best practices).

Questions used for Social Netork Analysis

5) name up to five persons/organizations (belonging to the firm, to the Fiat Group or external partners such suppliers, research centres …) with whom you share more frequently knowledge during your work;

1…..

2….

3…. (and so on)

6) Where is located this persons/organization?

1. in an other country;
2. in an other region of Italy;
3. in the same region but in an other industrial establishment;
4. in an other department/unit but in the same industrial establishment
5. in the same unit/department and in the same industrial establishment

7) With what frequency you move/travel for sharing knowledge with him?

1. very frequently (once a week)
2. frequently (once a month)
3. sometimes (once every 2/3 months)
4. rarely (once every 5/6 months)
5. never

8) How frequently you interact with this person/organization to share knowledge?

1- very frequently (more times day)
2- frequently (once a day)
3- sometimes (once every week)
4- rarely (once a month)
5- never

10) How much you trust this person/organization

1. I trust him very much
2. I trust him
3. Sincerely, it depends from the situations

4. Low trust
5. I don’t trust him

11) Which is the medium used more frequently for sharing knowledge with him?

1. forums, blogs
2. km portal, intranet, extranet
3. e-mail
4. video-conference
5. telephone
6. face-to-face
7. conference, plenary sessions, seminars

12) Which is the resource more frequently shared with him?

1. ideas
2. technical knowledge and problem solving
3. best practices
4. market knowledge
5. procedural and service information
6. information about the strategy of the group

13) During the activity of sharing knowledge, which is the channel more frequently used?

1. always Computer-Mediated-Communication
2. more frequently Computer-Mediated-Communication
3. balance of Face-to-Face and Computer-Mediated-Communication
4. more frequently Face-to-Face
5. always Face-to-Face

14) Which is the frequency of many-to-many communication, such as forums, plenary sessions…?

1. very frequently (weekly)
2. frequently (once a month)
3. sometimes (every 5/6 months)
4. rarely (once a year)
5. never