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Information management and social networks in organizational innovation networks

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Dissertation submitted to the Engineering Faculty of Oporto University to obtain the Master Degree in Information Science

Dissertation realized under the orientation of PhD. Professor António Lucas Soares, of the Informatics Engineering Department, of the Engineering Faculty of Oporto University

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Abstract

Social Networks play an important role in the establishment of relationships between people and consequently organizations. In this type of platform it is possible to create and share numerous types of contents and information. When applied in organizations, these platforms enable collaboration and group problem solving. The problem adjacent to this scenario resembles the difficulty in effectively locate and use the information whenever and wherever necessary, which creates a need for the establishment of requirements to manage the information used in the problem solving situation and afterwards the sharing of results throughout the organization granting a common knowledge base.

Through methods like Social Network Analysis it is possible to represent graphically an organization's network, observing who the network *star* is, the existing sub groups and, to our purpose, how the informational flow is made, who detains control over it and act as *broker* between sub groups, having access to information exchanges and consequently a larger access to overall information assets.

Applying the previous mentioned methods to a collaborative platform and to a startup incubator, being this last scenario complemented with interviews, it was possible to assess the informational needs in a collaborative environment as well as the social informational needs verified between the actors of both networks. The main result was the specification of requirements to manage information in collaborative social networks.

Keywords: Information Management, Collaborative Platform, Social Network, Social Network Analysis, Requirements Specification, Innovation, Organizational Networks, Organizational learning, Knowledge Management

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Dissertation Structure

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Abbreviations

CMS – Content Management System

CS – Collaborative Space

EAC – Economic Activity Classification (Portuguese classification system)

ECM – Enterprise Content Management

ERP – Enterprise Resource Planning

FOAF ontology – Friend Of A Friend ontology

IM – Information Management

IR – Information Retrieval

IT – Information Technology

IS – Information System

KMS – Knowledge Management System

OMA Scheme – Opportunity, Motivation and Ability Scheme

OWL – Ontology Web Language

RDF – Resource Description Framework

SIOC – Semantically-Interlinked Online Communities

SME – Small and Medium Enterprises

SPARQL – SPARQL Protocol and RDF Query Language

UPTEC – Technological and Scientific Park of the Oporto University

URI – Uniform Resource Identifier

INTRODUCTION

Problem description and Motivation

In this past decade we have witnessed the growth of a mix of tools that enabled not only the connection among companies but also the possibility to share knowledge and to create collaborative projects. We are talking about Social Networks. Through the establishment of mutual relationships based on values and rules, organizations found a way to share their resources and perform collaborative projects which allow them to expand and measure their impact either on society as well as in the market. Through these relationships they can benefit from a common growth whether in their position on the market (competitive advantage) as in profitability and enrichment of informational assets. The fastness with which knowledge is exchanged and new knowledge emerges also emerges the need to keep this abrupt growth of knowledge under control.

Through the implementation of Knowledge Management Systems, a wide range of features can be applied to manage information. Information Management is defined by Detlor (2010) as the management of processes and systems concerning the information lifecycle (creation, maintenance, production, management, publishing and distribution of contents), being its purpose facilitate or enhance the access, processing and use of information by people and organizations making these processes effective and efficient. In his study, Detlor (2010) considers three perspectives of Information Management, the organizational, librarian or personal. In this dissertation, since we are dealing with ECM, the organizational perspective is the most relevant.

This subject has an enormous level of relevance because it addresses to areas in which little knowledge and study on Information Science impact exists. It marks also the beginning of a deeper understanding about the informational needs of collaborative platform users and their behavior towards the fulfillment of those needs. This dissertation can provide information to organizations about collaborative platforms and information management and through it, organizations can assess if collaborative networks can be a solution to their needs and problems. Due to the inexistence of prior researches, this dissertation may be the starting point for further investigations.

The study of emergent technologies and the development a new concept of information management in collaborative platforms constitutes a major factor of motivation to the realization of this dissertation project. Also the acquaintance of specific knowledge on Social Networks area and the way with which these networks can be viewed, analyzed and modified through Information Science scope has a great impact as motivational factor.

Research Question and Objectives

Following are the research question for this dissertation, the hypothesis formulated according to the research question and the required objectives to accomplish.

How do organizational social networks use Information and Knowledge Management methods, techniques and IT systems in innovation related activities?

Following this research question, three hypotheses can be formulated:

- Hypothesis 1: Knowledge/Information Management Systems when applied to social networks affect collaboration between network users'.

- Hypothesis 2: Collaborative Network users' positions affect knowledge/Information flow and consequent knowledge/Information Management activities.

- Hypothesis 3: Information Management activities represent an important (or a major) part of collaboration and innovation activities.

The main objective (shown below) can be defined and then decomposed into specific sub objectives in order to establish and provide a specific line of action towards the tasks that will be performed to their achievement.

Main objective: Adapt and apply information management models, techniques and methods in a collaborative platform under the social network paradigm to support innovation networks and projects.

1 Characterize in detail organizational social networks platforms in their features towards information management.

2 Assess two networks in their networking, information management and collaboration potentialities, features and needs.

3 Develop a collaborative platform concept centered around a strong integration of social networks with information and knowledge management, to a specific application on innovation networks and projects.

4 Specify the implementation of the concept through requirements to change and evolve a collaborative platform.

Theoretical and Methodological approach

The main objective of this dissertation is to create a concept of Information Management centered in a Social Network paradigm. This concept must be then translated into requirements that can be implemented in an innovation and collaboration platform, H-KNOW. This specific line of research, according to literature review, has not been addressed from a pragmatical point of view. Thus it was followed an approach considering the mentioned concept by its constituting parts, i.e., innovation platforms, collaborative platforms, social networks and information and knowledge management. Accordingly, it was surveyed a threesome approach: i) the execution of observation methods in the *Collaborative Platform Z*; ii) the processing of the gathered data and; iii) posterior analysis by the Social Network Analysis lens. This method revealed that network users have influence in the information flow. Through the performed study at UPTEC, the interviews allowed the verification of the importance of KMS in collaboration and innovation activities. The concept design was guided by the assessed needs of finding suited information, contents and contacts to satisfy a variety of problems. Following the Information Lifecycle and the developed concept, a set of requirements was created in order to, through its implementation, provide collaborative platforms with social network features while applying information management processes.

Given the research focus of this dissertation, the methodologies applied allow the investigator a study of his subject through the search and reading of scientific and academic papers to acquire a basic knowledge on the subject at hand. The search was lead through search expressions based on innovation networks, collaborative platforms, social networks, knowledge management systems, information architecture and content management systems. The scientific areas studied to the given purpose were mainly information science and communication technologies, knowledge management and computer mediated collaborative systems. The literature review allowed the gathering of technics, such Social Network Analysis that was used to study the *Collaborative Platform Z.*

The data gathering in the empirical studies was performed differently according to the considered study. In the *Collaborative Platform Z* study, data was gathered through the observation of activity in the platform. It allowed an

initial assessment of the platform regarding its capabilities towards Information and Knowledge Management. Applying the technics surveyed in the literature review, the gathered data was processed in order to investigate the role of users in the network and their relation with the information. From this study, relevant results were obtained and then confronted with the previous established hypothesis.

In the UPTEC study, interviews were performed to managers, technical staff and to enterprises in order to assess the collaboration and informational needs. This was the main way of data gathering, however, the observation of training and social events was also performed to collect more data so that, collaboration needs could be better perceived. The obtained results provided clear insights about the main concerns and needs that enterprises face when talking about collaboration and information management.

Dissertation Structure

This dissertation is structured in three parts. The first part is dedicated to the literature review. In the literature review there are three chapters in which the first one focuses innovation networks, what must be perceived with this concept and how it manifests in the world more precisely in the corporate world. The following chapter approaches social networks aiming to its technological and social aspects that enable and lead to the nowadays information society that create and communicate knowledge instantaneously. The motivational factors and barriers towards knowledge sharing are also verified in this chapter. Following there's a study of classification, organization and retrieval processes in Social Networks that contributed to the observation and design of a framework to assess the previous activities through the study of four Social Networks. The following part is dedicated to empirical studies. In the first chapter of this part, such purpose was investigated through the study of two collaborative networks in order to obtain a practical perception of real networking activities, collaboration aspects, platforms that enable the previous aspects and features that allow the management of the information that is created and also how it flows in these activities. The next chapter centers itself in the achieved results from of the previous study emphasizing the Information

Management aspects and how these affect the performance of networking and consequently collaboration activities. These results lead us to the final part of this dissertation where the main purpose is, to start “preparing grounds” to design a concept of collaborative platform centered on Social Network capabilities and also the necessary requirement specification to guide and implement the created concept. The last chapter is reserved for final considerations and conclusions of this dissertation, mentioning the main results achieved confronting these with the expected results and suggestions for future studies and researches.

PART I: LITERATURE REVIEW

This dissertation begins with the literature review. It starts by approaching the concept of innovation, how it occurs within organization and its view through an informational scope in order to provide insights about what we intend to achieve. Social Networks follows and some approaches and technics to study them are explained in order to provide a knowledge basis about the technical and social aspects, how can we measure them and how the obtained measure can be used in the established purpose and be combined to grant the success that these networks have nowadays. The final chapter of this part is reserved for information management in these platforms. Through a set of processes towards knowledge and information management, a comparative analysis provides insights about the efforts and capabilities that nowadays popular social networks possess towards this purpose.

1 Innovation Networks

This first chapter intends to approach the concept of innovation network, observing what can be considered an innovation network, what benefits arise from it, how its establishment in the organizational world affects it in terms of performance and, for the purpose of this dissertation, assess its impact in information related issues that arise from collaboration activities between organizations in platforms designed for such purpose.

Innovation Networks are established with the purpose of improving organizations performance and allow the achievement a solid market position. When looking for the reasons that lead to the establishment of interorganizational networks, Rycroft and Kash (2004) point to globalization as a major factor, stating that *"Globalization makes cooperation more attractive in many "exogenous" ways, including: (1) by intensifying competition, shortening product and process life cycles, and increasing the risks and benefits of complex innovation; (2) by encouraging innovation using the largely codified knowledge (e.g., patents, standards, data bases) made available on a worldwide basis—much of which is facilitated by innovations in information and communication technologies; (3) by adding to the value of*

accessing unique, often local, mostly tacit, knowledge-based assets (e.g., know-how, skills) residing in different national innovation systems around the world; (4) by focusing innovations on satisfying increasingly diverse and customized global markets; and (5) by changing (e.g., through market liberalization and deregulation) the relationships among corporate shareholders and stakeholders (e.g., financial institutions), leading toward more flexibility in organizational governance".

Innovation must be seen as way through which organizations may improve their performance in the market and towards their competitors. According to Tomaél et al. (2005) *"The continuous quest to achieve innovation through creation or development of new products and processes, diversification, quality and advanced technology absorption, it's indispensable to ensure high levels of efficiency, productivity and competitiveness."* Another view of the innovation concept is given by Williams (1999) who states that, *"Innovation can be described as the implementation of both discoveries and inventions and the process by which new outcomes, whether products, systems or processes come into being"*, both authors go further on their definition and connect, through the reasoning of Tidd et al. (2005), the concept of innovation with knowledge stating, *"that innovation essentially is "about knowledge – creating new possibilities through combining new knowledge sets"* (quoted in Andreeva and Kianto 2011), this vision is also shared by Rycroft and Kash (2004) when they say, due to the globalization factor, that innovation consists of the use of, as the author says, "codified knowledge", referring to the own particular language that characterizes each organizational environment.

In a network perspective, new knowledge creation depends of the organization's learning capabilities. Organizations committed with innovation must have a set of resources, Inkpen (1996) identified these resources as *"existing core capabilities (or competencies); already internalized complementary assets; and completed organizational learning"*. In an interorganizational network environment, *"Learning (…) requires that networks have a "window" on their partners' capabilities and assets"* (quoted in Rycroft and Kash 2004), the sharing of resources, competences and abilities, will allow the recognition of core capabilities, strengths and weaknesses enabling a learning process of each organization in the network. This process,

according to Rycroft and Kash (2004), *"... involves at least three collaborative activities: (1) searching for new problem solving knowledge and procedures (e.g. heuristics); (2) experimenting with and redefining the problems; and (3) modifying the technological pathway, or trajectory."* These activities allow organizations to build networks based on transparency, trust and collaborative values from which they can collect benefits. On the other hand, Florén and Tell (2004), completes the definition previously presented by stating that, learning *"... is based on trust and requires much reciprocity between firms, receptive and confrontational capacity, and network transparency. Trust results in honest giving and taking, openness about how others can contribute, knowledge of when to confront members, and honest sharing among members."* (quoted in Thorgren et al. 2009)

The innovation process can be defined trough the model proposed by Taatila et al. (2006). This model (Fig. 1) consists of four stages and in each stage

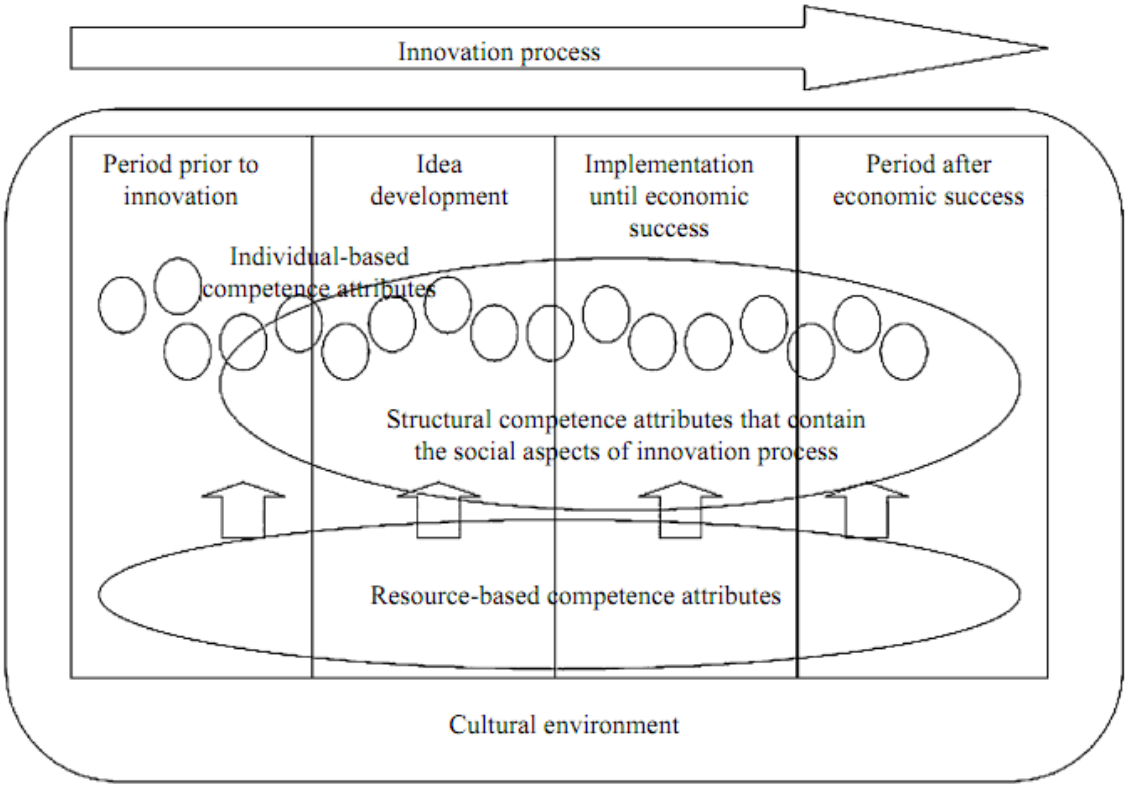


Fig. 1 - Social view of Innovation Process (Taatila et al., 2006)

there is the use and combination of resources, these resources, according to the authors can be defined as *inner* and *outer* resources where *"... inner resources are the accumulated and structured knowledge that humans have and the outer resources are the physical and social environments in which humans*

live." Shirouzu et al. (2002) (quoted in Taatila et al. 2006) when referring to individual-based competence attributes, it addresses the period before the innovation process when individuals are moving between groups exchanging knowledge, acting like a dynamic brainstorming process. The idea development stage occurs when there is a consensus on a specific product or service idea channelizing all resources into the idea. During this stage, feedback provided by customers through a social network can be given. This is essential because it allows organization to assess the impact of the product and also to check if there are changes to be done. The implementation stage marks the transition of an idea into a material object, in this stage organizations must apply their most effective marketing strategies in order to the developed product make a great impact and, according to the economic view of innovation, pay off the costs that its creation generated. In the final stage when the product was developed and achieved its success, the development team can be dismembered and start working on another projects or it can remain together and start a new development cycle to innovate the developed product or create products that derive from the first one. One final, but crucial, aspect is the cultural context, according to the author, *"The cultural environment does not refer only to the geographical cultures, but the term may refer, for example, to knowledge domain – specific cultures or any other external cultural structures that the innovation process is related to."* (Taatila et al. 2006)

In spite of different naming, collaborative networks have similar purposes of innovation networks but the main goal is to resolve collaborative projects and enable resource sharing among organizations. The following section will address collaborative networks properly.

1.1 Collaborative Networks of Organizations

Collaborative Networks, as said before, intend to enhance communications within organizations (Andreeva and Kianto, 2011; Wilkesmann and Wilkesmann, 2011) and among organizations (Mariotti, 2011; Bhandar; Zyl, 2008; Rycroft and Kash, 2004) so that organizational knowledge can be shared and or created. This subchapter purpose is to approach collaborative networks through their potentialities to manage information and knowledge, so that it may be available throughout organizations in the network. To accomplish such purpose, it was assessed what can be considered as organizational knowledge,

how it is processed and transferred, in an immediate level, inside organizations and, posteriorly, among organizations through the collaborative platform. Organizational knowledge consists of knowledge that resides not only in physical (reports or policies) or digital (workflows, email or web pages) supports but also on organizations employees (know how, procedures and behaviors developed during time). Organizational knowledge encompasses all kinds of knowledge an organization possesses and defines the way it develops its activities.

Nonaka (1994) proposed a model (Fig. 2) to explain organizational knowledge creation, through this model he affirms that the process starts at an

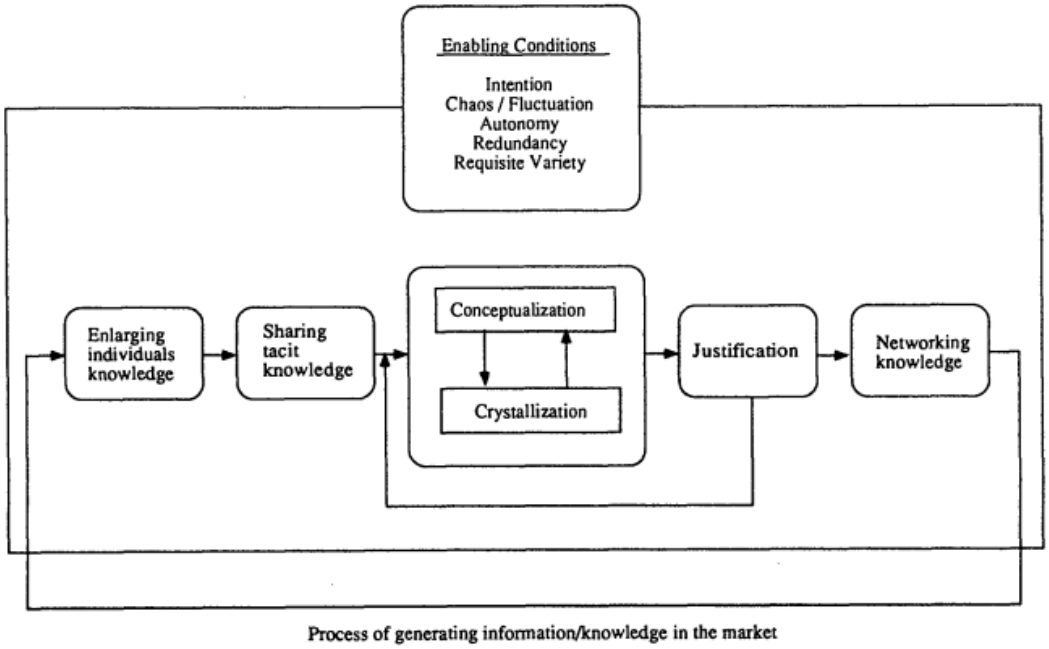


Fig. 2 - Model of Organizational Knowledge creation (Nonaka, 1994)

individual level and it can reach interorganizational levels. In the individual level, there's an accumulation of implicit knowledge (this subject will be addressed properly after) obtained by performing several tasks. The sharing of tacit knowledge is done through acts of socialization with other individuals and consequently occurs a combination (conceptualization and crystallization) of the exchanged knowledge with the existing knowledge in order to create new knowledge. The justification stage takes place to validate the truthfulness of the obtained knowledge and finally, in network knowledge stage the created knowledge flows through the organizations' network (workers, customers, suppliers and other network elements) leading to the beginning of a new cycle of

knowledge creation. Knowledge creation can also be seen through the perspective of competitiveness; the competitiveness of an organization is connected to the capacity to create new knowledge from the available resources. Janhonen and Johanson (2011) define the organization creation of knowledge as *"the process of making available and amplifying knowledge created by individuals as well as crystallizing and connecting with an organizations' knowledge system. In this sense, knowledge creation and codification is an important part of a firm's strategy"*. This process, in an organizational perspective, leads us to the next subject, organizational learning, in order to observe how all the created and shared knowledge may leverage organizations.

1.2 Organizational learning and learning organization

Organizational learning intents to make organizations "live and dynamic" organisms in order to seek ways to anticipate customers' needs and have products and services that, when such needs manifest, are readily available. Organizational learning has its foundations through values like understanding, learning and debating the past in order to guide and take actions in the future (Tomaél et al., 2005). The same author defines the purpose of organizational learning bridging concepts like knowledge (assuming it as crucial stage of the learning process), learning and innovation, stating that *"Organizational learning main objective is innovation, in which people refine continuously their skills, working together in investigation or in subjects with a higher complexity level, aiming consciously to deeper personal modifications, where they can constantly question their mental models and create safe environments so that other people do the same"*. Argyris and Schön (1996) also share a similar opinion of the previous authors, quoting, *"Organizational learning occurs when individuals within an organization experience a problematic situation and inquire into it on the organization's behalf. They experience a surprising mismatch between expected and actual results of action and respond to that mismatch through a process of thought and further action [...]"* (Wilkesmann and Wilkesmann, 2011). In their assumption of organizational learning, Mishra and Bhaskar (2010) narrow the borders between knowledge and organizational learning stating that the process of organizational learning encompasses the capability of transfer and use

knowledge to solve problems leading to the creation of new knowledge and potential innovations that will provide a competitive advantage and it increases the knowledge base of organization as well as its knowledge management skills (Mishra and Bhaskar, 2010).

The fact that organizations may create a learning environment can make these organizations turn themselves into learning organizations (Tomaél et al., 2005) and leads us to conclude that the state of learning organization is inseparable of organizational learning capabilities.

Wilkesmann and Wilkesmann (2011) presented a model (Fig. 3) in which knowledge transfer may occur. According to the Parcel model of knowledge transfer, *subject A* shares knowledge about a specific subject that is perceived by *subject B* the same way. The Interaction model of knowledge transfer, *subject A* transmits knowledge about a specific subject to *subject B*, which in turn, through the combination of the received knowledge with the possessed knowledge about the subject, creates new knowledge and transmits it back to *subject A* which in turn will perform the same actions as *subject B* leading to a cycle that will cease when a common knowledge on the discussed subject is achieved.

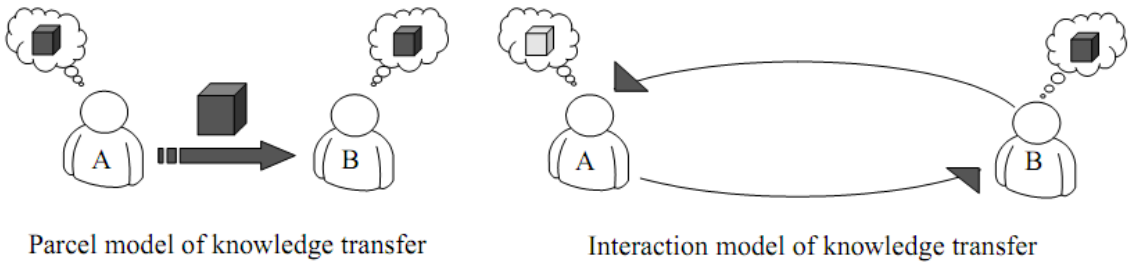


Fig. 3 - Knowledge Transfer Model (Wilkesmann and Wilkesmann, 2011)

The learning process can occur in three levels, intra-organizational and interorganizational levels (Fig. 4). Individuals are the base of the knowledge transfer process (occurring equally within groups of *organization A* and *B*), they compose sections and departments that enable intra-organizational knowledge transfer (between different departments and sections of *organization A* and *B*) and in a broader view, they constitute organizations that enable interorganizational knowledge transfer (between *organization A* and *B*). Following the authors logic *"At the individual level, these "units" are members of an organization, at the intra-organizational level they are business units,*

and at the interorganizational level, units are organizations" (Wilkesmann and Wilkesmann, 2011).

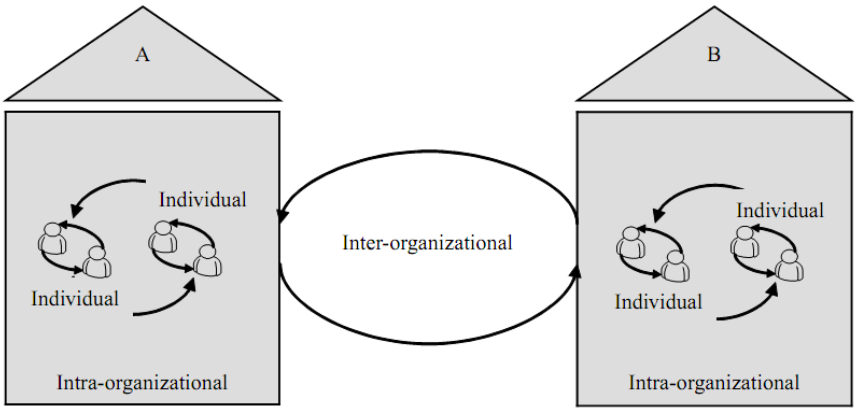


Fig. 4 - Knowledge transfer levels (Wilkesmann and Wilkesmann, 2011)

The learning capabilities of an organization may prepare it to detect informational opportunities that may leverage their advantage in terms of competitiveness and informational assets enrichment. An informational opportunity can be seen as the discovery of relevant information that can be applied to enhance several features or even to lead to determined innovation. These opportunities are affected *"by (a) who they can make contact with, (b) what information that contact can provide, and (c) what contacts exist in their network to whom that information can be forwarded for a positive outcome."* (Haythornthwaite, 1996)

According to what was stated, in Fig. 5 *user A* has more informational opportunities than the other two users due to his position on the network, i.e., by placing themselves properly on the network, users can maximize their informational opportunities through the control of the informational flux, regulating the amount of information that flows from one sector to another (Haythornthwaite, 1996), so, as said before, *user A* has more informational opportunities because, if *user B* has

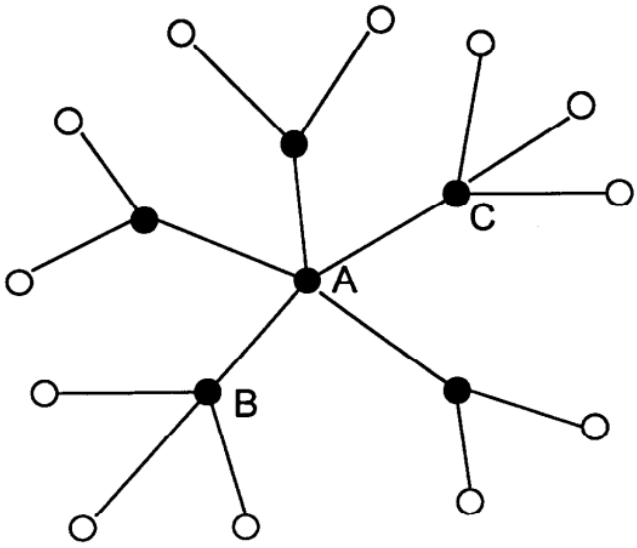


Fig. 5 - Collaborative Network example Haythornthwaite, 1996)

relevant information to *user C*, it will need *user A* to mediate the information exchange.

2 Social Networks

In this chapter we set our attention towards social networks. Acknowledging the importance of social phenomenon as fuel for new knowledge creation and sharing, social networks aim to provide, provoke and contain these events through the use of computer mediated environments, specifically social software. Through the analysis of these platforms, according to several approaches, it is hoped that a balance between technology and social factors is achieved. The motivational aspects and barriers towards knowledge sharing will also be analyzed in order to provide the previous aspect with more grounded and solid results.

A social network can be defined, according to Encyclopedia Britannica (2010), as *"… an online community of individuals who exchange messages, share information, and, in some cases, cooperate on joint activities"* (quoted in Click and Petit, 2010).

2.1 Social Software

Social Software (Fig. 6), can be defined, according to Lawley (2004), as *"the use of computing tools to support, extend, or derive added value from social activity - Including (but not limited to) weblogs, instant messaging, music and photo sharing, mailing lists and message boards, and online social networking tools"* (quoted in Avram, 2006).

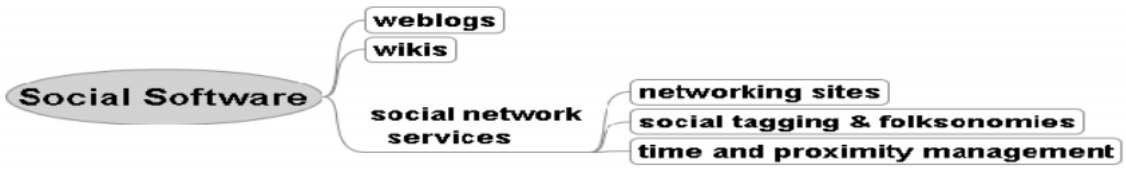


Fig. 6 - Key areas of Social Software (Avram, 2006)

The purpose of social software is to not only enhance the creation and sharing of contents (through weblogs, wikis and other technologies) *"but also in the social interaction triggered and in a shared understanding of concepts and facts, as basis for joint actions"* (Avram 2006).

According the presented features, Social Software also supports innovation. Through the constant evolution of social networking tools, Avram (2006) states that, *"This kind of flexible and rapidly evolving tools in the hands of innovative users will be probably one of the major sources of competitive advantage in the Knowledge Economy of the future."*

2.2 Network Characterization

As said previously, social phenomenon plays an important role in collaborative and social networks by establishing the type of behavior its users manifest. To the purpose of this dissertation it is important to list the available tools and theories that enable a deeper study of social networks in terms of establishment of relations, influence of determined users and the information that is created and shared in these relations. According to the following approaches, the previously mentioned aspects are explained through the study of the influence of social factors, technological factors and their combination on network users' behaviors.

Social Network Analysis

The first approach is the Social Network Analysis and it intends to examine *"both the content and the pattern of relationships in order to determine how and what resources flow from one actor to another"* (Haythornthwaite, 1996). The way these relations are established lead to the social structure of the environment which, according to Haythornthwaite (1996), can be *"hierarchical structures describing those in authority and those over whom they exercise authority, kinship structures describing parental and sibling relationships, organizational structures describing formal Chains of command and informal information exchange structures, interorganizational structures tying suppliers to customers or service providers to clients, and social structures such as age, gender, and socioeconomic class."*

These relationships can be studied and measured according to a set of attributes: content, direction and strength. The content shared among users' depends on the type of relationship established among them (hierarchical, familiar or intimal). The direction can be asymmetrical when there's an informational flow towards one user only; symmetrical when the flow is going to

both sides or it may not exist due to its irrelevancy. The strength of a relationship relates to the frequency with which users communicate among them, so a network with many users is expected to have more informational exchanges (high frequency) than a network with few users (low frequency) (Haythornthwaite, 1996).

The social network analysis considers two perspectives to approach networks, the egocentric network and the whole network. The egocentric network perspective describes the network built by a determined user, mapping the relationships established, the frequency of communication and the contents exchanged among the different connections. The whole network perspective intends to provide a general picture of the network, showing the connections among every users enabling information about network size and amount of connections established (Haythornthwaite, 1996).

The social network analysis defines principles to study the network, principles of cohesion, structural equivalence, prominence, range and brokerage (Haythornthwaite, 1996). These principles use as measure unit, the geodesic unit. Geodesic unit or distance can be perceived as the shortest path between two users in a network (Scott, 1991).

Through cohesion it is possible to determine *"the presence of strong socializing relationships among network members, and also the likelihood of their having access to the same information or resources"* (Haythornthwaite, 1996). In terms of information exchange, is possible to observe that *"information in the low-density graph can flow through only one route, whereas information in the high-density graph can flow from and to a number of different actors"* (Haythornthwaite, 1996). Centralization is used to measure *"the extent to which a set of actors are organized around a central point."* (Haythornthwaite, 1996) As seen in Fig. 5, *"information that needs to pass from Actor B to Actor C can go through one intermediary"* (Haythornthwaite, 1996). Freeman (1979) also presented a set of attributes that may be used to measure the centrality of a user in the network, the degree, closeness and betweenness. *"The degree (i.e., popularity) of an actor is the number of connections he or she has with other actors. The closeness (i.e., accessibility) of an actor means the shortest path length to other actors. The betweenness (i.e., intermediation) of an actor is a function of his or her appearance on the shortest paths between*

other actors" (quoting Shapira and Zabar, 2010), the author states that information professionals should face this aspect as a challenge through which they can rearrange *"information routes to ameliorate information transfers."* (Haythornthwaite, 1996)

Structural equivalence may be used to identify users with similar roles in the network. This can be *"a very useful concept for the study of information. It may lead to the identification of actors who occupy as yet unidentified information roles, and who also shape the information environment in which they are found."* (Haythornthwaite, 1996)

Prominence indicates *"which actor or actors have influence or power in a network"* (Haythornthwaite, 1996) and it can be measured trough the assessment of centrality. The range determines the extent of a users' network through the connections established. Brokerage relates to the role performed by some users that *"carries information from one group to another while retaining a position as intermediary and, thus, retaining control of the information"* (Haythornthwaite, 1996).

Social Capital Approach

Another approach to study social networks is the social capital approach. According to Nahapiet and Ghoshal (1998) and Adler and Kwon (2002), *"Social Capital is a resource based on social relationships that inheres in structures such as organizations and organizational networks and can manifest as trust, norms, cooperation, information benefits and power and that influences the behavior of the members"* (quoted in Bhandar). In turn, Coleman (1990) presents a definition of social capital in which, *"Social capital is defined by its function, it is not a single entity, but a variety of different entities having characteristics in common: they all consist of some aspect of a social structure, and they facilitate certain actions of individuals who are within the structure"* (quoting Widén-Wulff and Ginman 2004). Social capital can be described through three dimensions, structural, relational and cognitive. The structural dimension, according to Fu (2004), *"refers to network ties and the way they are configured"* (quoted in Farshchi and Brown, 2011), Nahapiet and Ghoshal (1998) completes this definition saying that *"structural dimension influences the development of intellectual capital through the ways in which its various facets affect access to parties for exchanging knowledge"* (quoted in

Rangachari, 2009). The cognitive dimension, according to Fu (2004), consists *"of shared codes, meaning and narratives"* (quoted in Farshchi and Brown, 2011), Nahapiet and Ghoshal (1998) specifies stating that *"cognitive dimension facilitates the creation of intellectual capital through its impact on combination capability (…) of resources providing shared interpretations and systems of meaning among parties including shared language, codes, and narratives"* (quoted in Rangachari, 2009).

The second dimension of social capital to Hazleton and Kennan (2000) is the content or communication dimension, it encompasses issues relating to *"four communication functions that provide social capital: information exchange, problem identification, behavior regulation, and conflict management"* (quoted in Widén-Wulff and Ginman, 2004). In spite of different names, the cognitive and communication dimension pursue the same objective, the perception and usage of specific codes used in organizations. The third dimension refers to the relational dimension. This dimension is defined by Fu (2004) as referring to *"trust, norms, obligations and the personal identity which emerges from being part of a network"* (quoted in Farshchi and Brown, 2011). Nahapiet and Ghoshal (1998) defend that *"the relational dimension influences the development of intellectual capital by impacting the anticipation of value and the motivation of parties to engage in knowledge creation (…) focusing on the particular relations people have, such as respect and friendship, that influence their behavior. Among the key facets of this cluster are trust and trustworthiness and norms and sanctions"* (quoted in Rangachari, 2009). The relational dimension to Widén-Wulff and Ginman (2004) refers to *"obligations and expectations"* and identifies three aspects that concern to the relational dimension, trust, identification and closure. There isn't a specific and consensual definition for trust, as it is seen as a result of the interaction of users, solidarity and accomplishment of common goals (Widén-Wulff and Ginman, 2004; Rangachari, 2009; Farshchi and Brown, 2011). However, Fu (2004) divides trust (in an organizational context) as lateral and vertical trust, in which *"lateral trust – trust relations among peers who share a similar work situation; and vertical trust – relationships between individuals and their immediate supervisors, subordinates, and top management"* (quoted in Farshchi and Brown, 2011). The same authors also mention another type of

trust, relational trust, according to them *"Relational trust can facilitate exchange of information and knowledge among parties and encourage flexibility and risk taking, which contributes to the development of intellectual capital within an organisation."* The identification aspect refers to *"the extent to which actors view themselves as connected to other actors"* and the final aspect, closure, *"allows effective sanctions to be enacted by those for whom the system of social capital is valued. The effect of system closure is the emergence of observable norms."* (Farshchi and Brown, 2011)

The existence of social capital can be verified through aspects such opportunity, motivation and ability (forming the OMA scheme), according to it, the opportunity consists in taking advantages of different types of contacts in the network which can result in transactions of various types of intellectual capital, i.e., knowledge (Bhandar). The motivation aspect resides in the willingness of network users in helping other users with no expectations of having any return from those activities. Ability, according to Bhandar, *"construes the competencies and resources of the network members to be able to contribute to the social capital. Shared languages, codes, and narratives build a shared understanding and collective knowledge in the network, thus improving their ability to contribute and comprehend the knowledge in the shared pool."*

Sociotechnical Approach

This approach combines the technical and social aspects of social networks in order to assess how these interact and affect users' behavior in the platform. According to Bostrom & Heinen, (1977a), (1977b), the *"technical system focuses on the processes, tasks, and technologies to produce designated output, the social system takes into account the relationship among people and their attributes such as attitudes, skills, values, etc."* (quoted in Chai and Kim, 2011). In their study, Chai and Kim (2011), state that, according to Davenport & Prusak (2000), *"organizations usually consider their technology infrastructure to be the most important component for successful knowledge projects, which leads to a tendency to focus on only technological factors of the system when they introduce knowledge management systems. However, because users' knowledge sharing behavior in the system is occurring in a social process, implementing knowledge management technology without the consideration*

of other and environmental factors might cause a serious failure in knowledge projects" (quoted in Chai and Kim, 2011). The purpose of the sociotechnical approach (Fig. 7), according to Chai and Kim (2011), is to analyze a social network in their social and technological parameters in order to promote knowledge transfer and creation among its users. As it is possible to observe in Fig. 7, the social system can be analyzed through ethical culture, social ties and the sense of belonging.

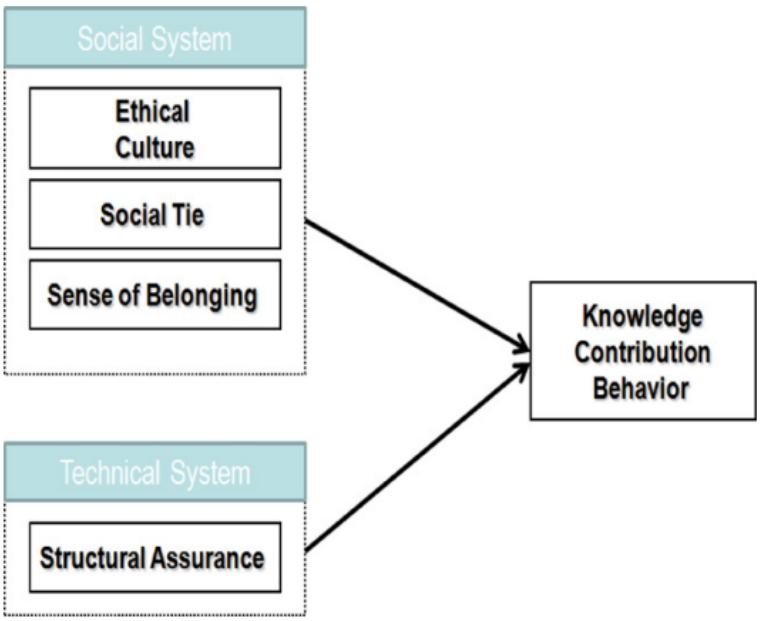


Fig. 7 - Sociotechnical Approach (conceptual model suggested by Chai and Kim (2011))

The establishment of connections among organizations leads to a mixture of different sets of values and ethical cultures. Ethical culture can be perceived, through Trevino, Butterfield, & McCabe (1995), as *"a subset of organizational culture, representing a multidimensional interplay among various formal and informal systems of behavior control that are capable of promoting ethical or unethical behavior"* (quoted in Chai and Kim, 2011). To the sociotechnical approach purposes, Chen and Huang, (2007), state that *"social interaction ties are regarded as one of the antecedents in motivating knowledge sharing behaviors. The social interaction ties among individuals lead to creating trust, and wider communication, producing positive effects on sharing knowledge"* (quoted in Chai and Kim, 2011) and Larson (1992) add, "*The stronger social interaction ties become, the more frequent knowledge exchange behaviors as well as communication are observed"* (quoted in Chai and Kim, 2011). The sense of belonging aspect in the social system, following Bagozzi & Dholakia, 2002; Dholakia, Bagozzi, & Pearo (2004) reasoning, refers to *"members' willingness and commitment to maintaining relationships with the virtual community"* (quoted in Chai and Kim, 2011).

As for the technological system, Evangelou & Karacapilidis (2005) affirm that it is responsible for the structural assurance, i.e., it is responsible for ensuring *"that Internet and websites users feel safe in their transaction of knowledge. Therefore, a lack of structural assurance from service providers and the Internet plays a detrimental role in stimulating knowledge sharing behaviors"* (quoted in Chai and Kim, 2011).

2.3 Motivation factors and barriers towards knowledge sharing

In this last section, several approaches were examined in their features to study social networks evidencing motivators and barriers towards knowledge sharing. However, it is necessary to establish a distinction between knowledge sharing as an object, i.e., information and consequent information management and knowledge sharing as a social process. As an object, *"Knowledge management (...) is the application of principles and processes designed to make relevant knowledge available to the project team. Effective knowledge management facilitates the creation and integration of knowledge, minimizes knowledge losses, and fiills knowledge gaps throughout the duration of the project"* (Reich, 2007) (quoted in Santos, Soares and Carvalho, 2012 [a]). As a social process, knowledge management results of *"social interaction, (...) mutual understanding and trust, allowing the participants to become motivated, committed, and secure in knowledge creating and sharing"* (Santos, Soares and Carvalho, 2012 [a]).

Regarding knowledge sharing as information and its management, Santos, Soares and Carvalho (2012 [b]) identify in their research, seven major barriers related to document control, inadequate IT support, information overload, dispersion of information, updating and adapting, lack of time and codification process. These barriers, as concluded by the authors, constitute problems that affect communication between entities and the efficiency with which information is created and shared due to the specificities of the tools that are used to such purposes.

As for the knowledge sharing as a social process, (Santos, Soares and Carvalho, 2012 [a]) identified eight major barriers, these concern the codification process, the inadequacy of information technology, lack of initiative and strategy by workers, lack of time and resources, learning curve of

information systems, competitive environment, lack of trust and unawareness of other people's work. Hew and Hara (2005) also identified motivators and barriers that affect knowledge sharing as a social process. As motivational factors six categories can be mentioned: reciprocity, personal gain, altruism, commitment to the group, ease of technology use, and external goals. As for the barriers, these can be seen as factors that diminish the will of users in sharing their knowledge; the authors identified six categories of barriers: technology, lack of knowledge to share, competing priority, community, personal attitude, and confidentiality considerations.

3 Knowledge Management in Collaborative Platforms

The last chapter of the literature review assesses the impact that information management has had so far in collaborative platforms evidencing the types of knowledge that manifests in them and how they are managed in such platforms. To obtain a more plausible view of these aspects, the study of four social networks will be performed addressing aspects of classification, organization and retrieval leading to the formulation of a framework that enables the observation of phenomenon related to the previous aspects.

The rapid pace with which knowledge is created and shared leads, consequently, to the creation of policies and practices for knowledge management that can provide support to network users' when they try to search and retrieve it. These platforms were divided previously in innovation networks and collaboration networks. At first sight it makes no sense to do this division, however, if we look at them from a knowledge management scope, it will be possible to see the relevance of such division. For the time being it is important to specify the concept of knowledge so that, an important aspect in Information Science may be defined according to this dissertation purposes; the definition of knowledge and information and consequently, knowledge management and information management. Then, analyze which knowledge management activities are performed in these networks so that, posteriorly, they can be allocated in the respective network type according to the impact that is expected to have.

3.1 Types of knowledge

Through the analysis of several articles, it is possible to conclude that two major types of knowledge are recognized; implicit knowledge and explicit knowledge. Implicit knowledge, according to Nonaka and von Krogh (2009), can be defined as *"the cognitive and technical knowledge such as beliefs, skills, craftsmanship, unique talents, etc. This type of knowledge is deeply embedded in the context and personal experiences through which it is gained, and it is difficult to be codified into written forms"* (quoted in Su and Contractor, 2011). Flanagin (2002) and Zander & Kogut (1995) defined explicit knowledge as being *"more migratory in the form of systematic and symbolic codes, which makes it easier to be encoded and transferred"* (quoted in Su and Contractor, 2011). From the Information Science perspective, those types of knowledge have a different definition. Looking into "The nonsense of knowledge management" by Tom Wilson (2002), what was previously referred as implicit knowledge is now perceived as, simply, knowledge, and *"involves the mental processes of comprehension, understanding and learning that go on in the mind and only in the mind, however much they involve interaction with the world outside the mind, and interaction with others."* (Wilson, 2002) While explicit knowledge is perceived as information as the author states *"Whenever we wish to express what we know, we can only do so by uttering messages of one kind or another - oral, written, graphic, and gestural or even through 'body language'. Such messages do not carry 'knowledge', they constitute 'information', which a knowing mind may assimilate, understand, comprehend and incorporate into its own knowledge structures"* (Wilson, 2002). This comparison was necessary in order to clarify the similarity of actions when, later, talking about knowledge management and information management. As knowledge resides in mind it can't be managed as it is said by Wilson (2002). So the management activities mentioned later is applicable to knowledge that possesses a 'body', i.e., information.

3.2 Knowledge management activities in online platforms

Knowledge management has been lately an area of great study due to the importance it has for organizations that recognize knowledge as source of competitive advantage. Avram (2006) mentions the knowledge management

framework proposed by Despres and Chauvel (1999) and demonstrates how social software support these activities which consisted in:

"1. Scan/map - pointing to the world of business intelligence, perception;
2. Acquire/capture/create – associated with the world of research, development and creation;
3. Package/codification/representation/storing – related to the world of databases, information and knowledge bases, organizational memory;
4. Apply/share/transfer – related to the world of competencies, teamwork, intranets and cross border sharing;
5. Reuse/innovate/evolve/transform – associated to the world of leverage, intellectual assets and innovation" (Despres 1999) (quoted in Avram, 2006).

Social software supports scan or mapping activities in a wide range of areas. Weblogs provide information about users' feedback on products, locating people inside and outside organizations. News feed are a good tool to keep up to new developments of people of interest and *"to know who is speaking about them and their products, and in what terms"* (Avram, 2006). Wikis also represent a good place to collect information due to participation of many people, making continuously upgrades to information. Another way to collect information is through other people's tags. These describe other people's interests and can result in a time saving activity. Social networks are nowadays another, if not the main, place to look for information about anyone, exhibiting people's connections and skills. Time and proximity tools enable the finding of events where interesting people might be allowing the establishment of physical contact with them. (Avram, 2006)

In spite of the support social software provide to knowledge management activities, it is necessary to develop a strategy that ranges all tools and provide a framework to implement across an organization; *"Such a framework should outline the vision, aims and objectives for knowledge management at both the general network level and at center level. A more directed and focused approach to knowledge management would be achieved, knowledge sharing throughout the network would be facilitated and structures that are currently*

impeding knowledge sharing and knowledge creation could be streamlined." (Smith and Lumba, 2008)

The aim of a well-defined knowledge management resides in *"The integration of different modes of computer mediated communications into one application allows knowledge workers to aggregate information in an efficiency manner, by allowing users to add labels (through links, tags and social bookmarks) to make material more persistent for easy retrieval and sharing"* (Brown and Duguid, 2000; Cairncross, 2001; IBM, 2007) (quoted in Zyl, 2008).

3.3 Information and knowledge Management in Social Networks

Focusing on actions concerning classification and organization, and information retrieval issues, the following analysis will allow the observation of how these procedures occur on social platforms. To elaborate such analysis the observation of these actions in social networks such as Facebook, Google+, LinkedIn and *Collaborative Platform Z* will be performed.

Content Classification and Organization in Social Networks

According to the retrieved literature in this aspect, it was possible to observe that folksonomies play an important role in the classification of content shared in social networks. A folksonomy is an unstructured classification scheme that can be described as set of tags (Cantador et al., 2011). A tag, according to Guy and Tonkin (2006), can be seen as *"any word that defines a relationship between the online resource and the concept in the user's mind"* (quoted in Kakali and Papatheodorou, 2010), some web sites have as way to navigate and access the most popular contents, a *tag cloud*, which consists in a group of tags allocated to the contents (resources) (Kiu and Tsui, 2011).

Folksonomies represent a *"personalized conceptual model of the world, rather than a hierarchical model of knowledge categorization"* (Kakali and Papatheodorou, 2010). Laniado, Eynard, & Colombetti, (2007) define folksonomy emphasizing the social and collaborative aspects of it, stating *"A folksonomy is the collectively and/or collaboratively form of the tags that can emerge from user-generated metadata. Folksonomies are often used and function as an alternative to formal taxonomies for organizing and*

categorizing resources in a bottom up, flat and inclusive way" (quoted in Kiu and Tsui, 2011).

Taxonomies, as Guy & Tonkin (2006) says, *"... are usually controlled by experts and are fairly static, tending to use official terminology rather than vernacular phrases"* (quoted in Morrison, 2008). This characteristic contrasts with folksonomies that, according to the same author, *"are distributed systems of classification, created by individual users."* However, taxonomies can also be made of tags. Bischoff et al. (2010), through the analysis of content present in some social networks whose focus are different types of contents, elaborated the following tag classification scheme (Fig. 8) to range all type of tags that could describe the previous mentioned types of content while maintaining compliance with various tagging systems.

No.	Category	*Last.fm*	*Flickr*	*Del.icio.us*
1	Topic	*romance, revolution*	*people, flowers*	*webdesign, linux*
2	Time	*80 s*	*2005, july*	*daily, current*
3	Location	*england, african*	*toronto, kingscross*	*slovakia, newcastle*
4	Type	*pop, acoustic*	*portrait, 50 mm*	*movies, mp3, blogs*
5	Author/Owner	*the beatles, wax trax*	*wright*	*wired, alanmoore*
6	Opinions/Qualities	*great lyrics, rowdy*	*scary, bright*	*annoying, funny*
7	Usage context	*workout, study, lost*	*vacation, science*	*review.later, travelling*
8	Self reference	*albums i own, seen live*	*me, 100views*	*frommyrssfeeds*

Fig. 8 - Tag classification scheme (Bischoff et al., 2010)

With their research, Bischoff et al. (2010) demonstrated that assigning tags to non-textual resources enhanced considerably their retrieval rate. Cantador et al. (2011) in their research analyzed the previous classification and compressed it into a new classification (Fig. 9) that categorized tags according to their purpose.

Our categories	Bischoff et al. [7]
Content-based	Topic Type Author/owner
Context-based	Time Location
Subjective	Opinions/qualities
Organisational	Usage context Self reference

Fig. 9 - Purpose-based categorization of social tags (Cantador et al., 2011) (Based in Bischoff et al., 2010)

This categorization intend to group tags according to their content (*"Social tags that describe the content of the items, such as the objects and living things (animals, plants) that appear in a photo or video, or are mentioned in a text document or a song lyric."*), context (*"Social tags that provide contextual information about the items, such as the place where a photo was taken, the date or period of time when a video was recorded, etc."*), subjectivity (*"Social tags that express opinions and qualities of the items."*) and organizational aspects (*"Social tags that define personal usages and tasks, or indicate self-references"*) (Cantador et al., 2011).

Further studies suggest a hybrid system that conjugates both folksonomies and taxonomies benefits in order to enhance content classification and retrieval. Kiu and Tsui (2011) presented TaxoFolk (Fig. 10), a combination of taxonomy and folksonomy that aimed to *"(1) Enhanced findability of content; (2) improved knowledge searching and retrieval; (3) enhanced taxonomy management process; (4) existence of new navigational facets to better connect and display; and (5) classification of contents/ resources with minimal costs"*.

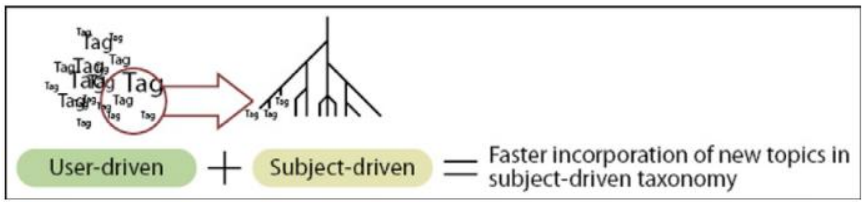


Fig. 10 - Integration of Taxonomy and Folksonomy (Kiu and Tsui, 2011) (based on Owens et al., 2008)

Kiu and Tsui (2011) define on their research, the architecture of a TaxoFolk (Fig. 11) explaining how its formation and new tag integration in a taxonomy are performed.

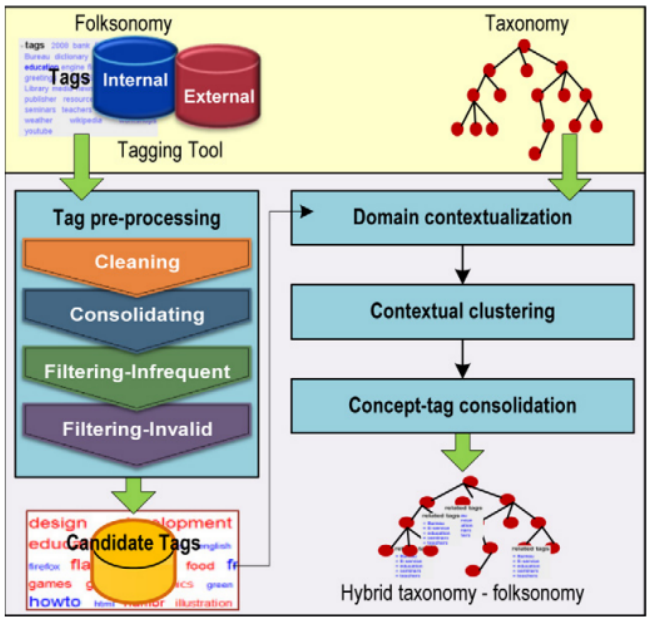


Fig. 11 - Taxonomy-Folksonomy integration algorithm (Kiu and Tsui, 2011)

Other approaches that combine the flexibility of Folksonomies and the organizational structure of Taxonomies can be mentioned. Tsui et al. (2010) suggested a method to automatically incorporate newly allocated tags into a structured taxonomy. This method treats Folksonomies as a knowledge source from which tags are extracted; applying heuristics rules and deep syntactic analysis the "concept-relation-concept" is established creating a taxonomy (Fig. 12).

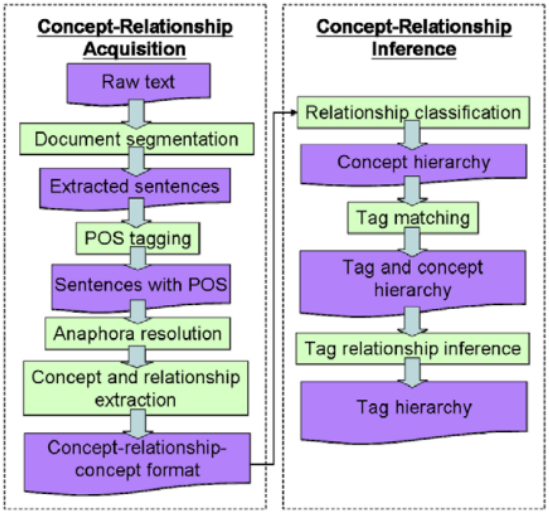


Fig. 12 – Mechanism of automatic concept map construction (Tsui et al., 2010)

Faceted classification can also be an option to classify contents. One crucial aspect that needs to be mentioned is the range of the faceted

classification, i.e., as Denton (2003) states *"The classifications are meant for small or medium-sized sets of things"*. The domain that is being analyzed and classified must have its borders well defined to provide users of such classification a notion of what contents can be identified by it.

Faceted classifications consist of a group of facets that when combined are able to describe objects that belong to a determined domain. Facets can be seen, according to Denton (2003) as, *"a set of mutually exclusive and jointly exhaustive categories, each made by isolating one perspective on the items (a facet), that combine to completely describe all the objects in question, and which users can use, by searching and browsing, to find what they need."* The definition of facets obeys to a set of principles that were firstly established by Spiteri (1998). Following Ranganathan's classification, Spiteri divides classification in three planes, quoting *"the Idea Plane, which involves the process of analyzing a subject field into its component part; the Verbal Plane, which involves the process of choosing appropriate terminology to express those component part; and the Notational Plane, which involves the process of expressing these component parts by means of a notational device"* (Spiteri 1998) (quoted in Denton, 2003). If the construction of the classification follows these planes and their requirements, the system using it will benefit in several aspects, because *"they do not require complete knowledge of the entities or their relationships; they are hospitable (can accommodate new entities easily); they are flexible; they are expressive; they can be ad hoc and free-form; and they allow many different perspectives on and approaches to the things classified"* (Denton, 2003). The major problem of this type of classification resides in *"the difficulty of choosing the right facets; the lack of the ability to express the relationships between them; and the difficulty of visualizing it all"* (Denton, 2003).

Ontologies may also be used to classify contents, entities and the relations that are established between them. Two of the main ontologies that are applied in social networks are FOAF (Friend of a Friend) and SIOC (Semantically-Interlinked Online Communities) ontologies; these connect users to contents through a set of classes and properties that describe how the connection is made.

The FOAF project (Fig. 13), consists in *"a descriptive vocabulary built based on RDF and OWL, for creating a Web of machine-readable pages for describing people, the links between them and the things they create and do"* (Brickley and Miller [a]) (quoted in Carneiro, 2010).

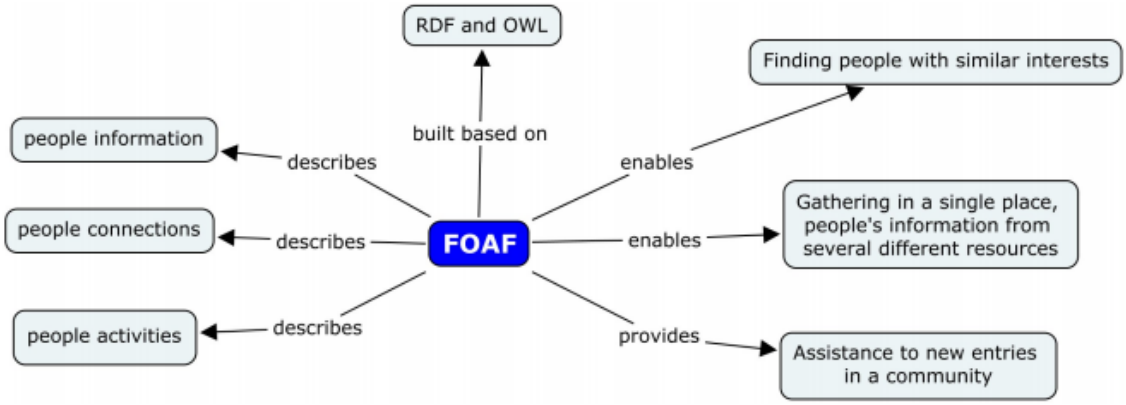


Fig. 13 - Description of FOAF importance (Carneiro, 2010)

It is a tool that, as said previously, through a set of attributes and properties, can represent social networks (Fig. 14) creating the bridge between persons and contents, since *"The things described in the web are connect by people. People attend meetings, create documents, are depicted in photos, have friends, and so on. Consequently, there are a lot of information that might be said about people and the relations between them and objects (documents, photos, meeting, etc)"* (Brickley and Miller [b]) (quoted in Carneiro, 2010).

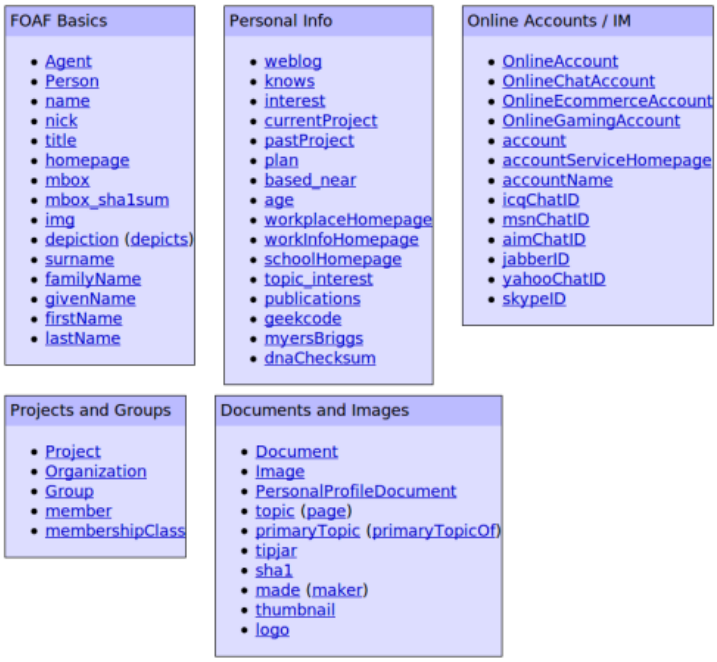


Fig. 14 - FOAF attributes and classes (Brickley and Miller, 2010)

SIOC (Fig. 15) stands for Semantically-Interlinked Online Communities and it aims *"to enable the integration of online community information (wikis, message boards, weblogs, etc.)"* (Bojars and Breslin [b]) (quoted in Carneiro, 2010). SIOC intends to satisfy community-centric contents enhancing their search and retrieval features and capabilities (Bojars, 2008) (quoted in Carneiro, 2010).

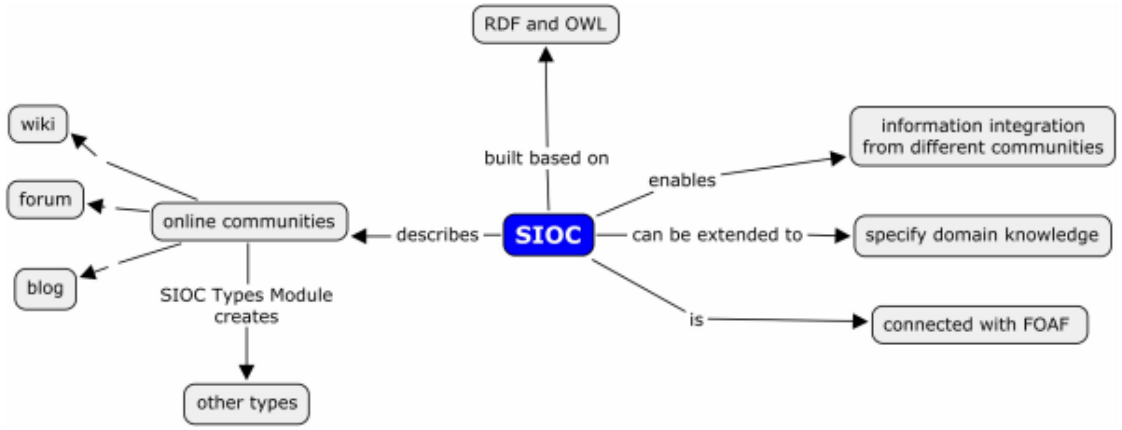


Fig. 15 - Overview of SIOC (Carneiro, 2010)

Given the diverse type of communities mentioned before, it is also relevant to conclude that SIOC also enhances interoperability between such communities (Fig. 16). Through the following diagram it is possible to observe the classes that constitute SIOC and enables the previously mentioned features of this ontology.

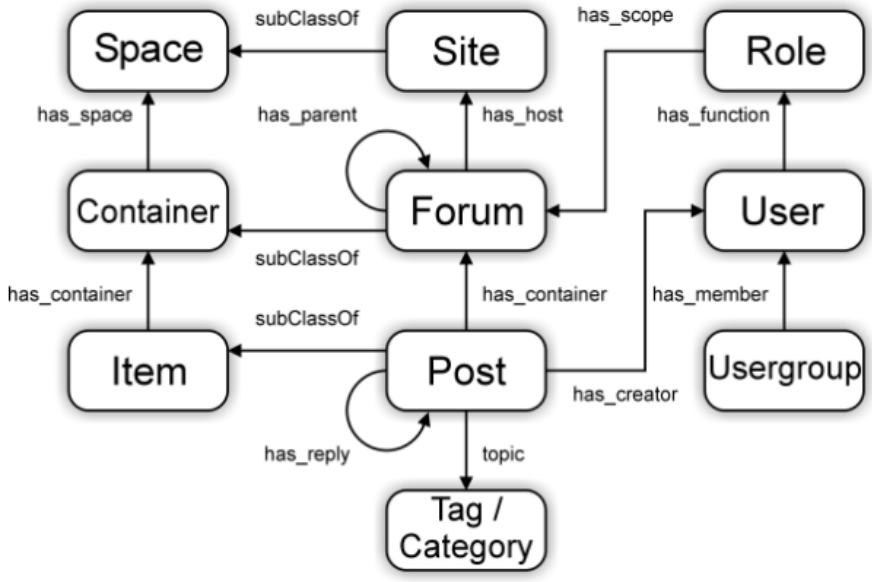


Fig. 16 - SIOC class diagram (Bojars and Breslin [a], 2010)

In his dissertation, Carneiro (2010) mentions the problem as well as the solution found for the problem of this ontology, i.e., being an ontology, it *"can't incorporate on it everything that might be important to know about communities, about their users and about the contents that users create, otherwise it would be too large"* (Bojars and Breslin [a]) (quoted in Carneiro, 2010) so, SIOC adopts a modular design that allows the incorporation of *"additional ontology modules for specializing and further extending classes and properties contained within the SIOC core ontology"* (Bojars et al., 2008) (quoted in Carneiro, 2010) extending the range of the ontology so it can correspond to the community purposes.

Content organization relates with content classification due to the implemented structures (classification schemes), from such classification schemes, content organization can be performed, according to Morville and Rosenfeld (2006), through organization schemes and organization structures; Organizations schemes *"defines the shared characteristics of content items and influences the logical grouping of those items."* (Morville and Rosenfeld, 2006) And organization structures "defines the types of relationships between content items and groups" (Morville and Rosenfeld, 2006). Organization schemes can be exact or ambiguous. Exact organization systems can be alphabetical, chronological or geographical. The ambiguous organization systems don't possess any specificity like the previous systems although they can prove to be more useful because, as Morville and Rosenfeld (2006) say, *"There's a simple reason why people find ambiguous organization schemes so useful: we don't always know what we're looking for"* (Morville and Rosenfeld, 2006). Organization structures define the way users navigate throughout the webpage; we can find Hierarchies, like taxonomies, with their top-down approach; the database model, representing a bottom-up approach and the hypertext structure.

In a social network environment, the linking metadata (Fig. 17) aspect is crucial since, as said in the quotation, the attribution of tags to documents allows strong benefits in classification, searching and retrieval processes.

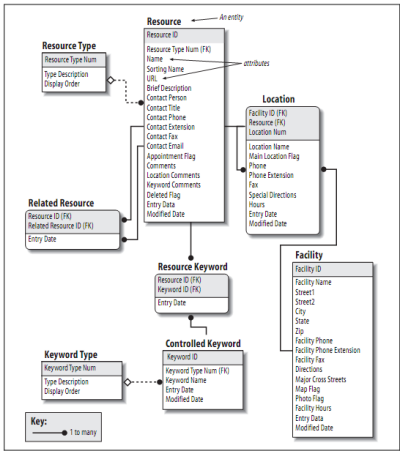


Fig. 17 - An entity relationship diagram showing a structured approach to defining a metadata (Morville and Rosenfeld, 2006)

Labeling systems aim is, through the use of labels, to *"represent larger chunks of information (…) quickly and effectively on an already crowded web page without overwhelming impatient users who might not actually need that information"* (Morville and Rosenfeld, 2006). Labels can be of various types and according to the type may have more functions than just guide users throughout webpages. According to Morville and Rosenfeld (2006), labels can be contextual links, headings, navigation system choices indexing terms or even icons.

Navigation systems can be categorized in three types, global, local and contextual navigation systems. Each one of the previous enables users to perform the navigation in specific ways, *"Sitemaps provide a bird's-eye view of the site. A to Z indexes allow direct access to content. And guides often feature linear navigation customized to a specific audience, task, or topic"* (Morville and Rosenfeld, 2006).

Content organization may be also studied following two perspectives, the user centric perspective and the content centric perspective. As Yelmo et al. (2011) state, *"User-centric service environments support the fast development and supply of innovative services enhancing the whole user experience. End-users can obtain their own, personalized, new services at their disposal, according to their needs and expectations."* The content centric perspective puts contents (about a determined subject) in the spotlight, being the main concerns the vast range of contents (weblogs, websites, photos, videos, and music), their sharing, presentation and posterior retrieval.

Content Retrieval on Social Networks

Different types of content can and are shared nowadays on social networks. Text posts, pictures, videos, links and other document types can be uploaded into these platforms and then retrieved. Tagging activities, as seen previously, are important because they enable the performance of the system when retrieving resources. Proper tag activities can enhance the retrieval of video, pictures and music resources due to their lack of textual elements (Bischoff et al., 2010).

Browsing and query based search constitute the principal means to execute the retrieval of contents. This area also possesses a connection with the previous areas because contents may be classified and organized according to their type (text, picture, video, etc.) and then browsed or even searched and then filtered, if the results aren't already ordered, by type. These features impose significant enhancements in the way contents are retrieved and then selected accordingly to the informational needs manifested by network users.

The area of content retrieval has been studied so that new ways of improve search engines can, consequently, improve the effectiveness of content retrieval in quality and quantity. One way of achieving this is through personalized information retrieval. This system is based in the "query based search paradigm" and intends to *"to modify and evolve established IR techniques in order to produce more personally relevant results"* (Steichen et al., 2012), this would be possible through the access and analysis of users previous queries which may arise privacy issues. Another way of performing and enhancing retrieval is through collaborative information retrieval which combines information seeking with information retrieval activities. It may be defined as *"an information access activity related to a specific problem solving activity that, implicitly or explicitly, involves human beings interacting with other human(s) directly and/or through texts (e.g., documents, notes, figures) as information sources in an work task related information seeking and retrieval process either in a specific workplace setting or in a more open community or environment"* (Hansen, 2005).

As it is possible to see, collaboration is involved in the new trends related to information in the areas of classification (as seen in ontologies and hybrid taxonomy models) and consequently organization and also in the field of

information retrieval through the analysis of users' needs and performed searches in order to implement and enhance continuously these operations in collaborative platforms.

3.4 Comparative analysis of Information Management features in Social Networks

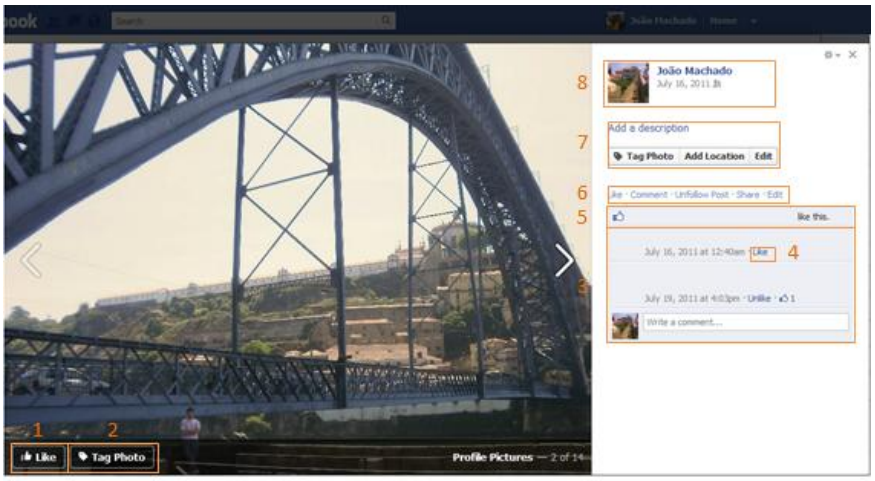
Through the observation and practical experience, Facebook, Google +, LinkedIn and *Collaborative Platform Z* social networks were analyzed in order to assess their capabilities to manage information, specifically in terms of classification, organization and retrieval. A table was created at the end of this subchapter so that all features can be gathered and compared.

Content Classification

A common feature in all studied platforms relates to the connection between user and content posted, i.e., every post is allocated to the user that makes the content available. This feature, jointly with, time references constitute the main aspects for content organization in social networks.

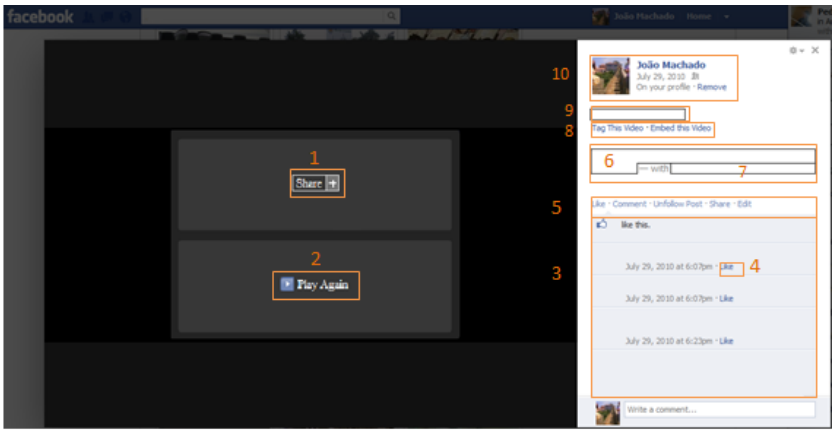
Facebook

Content classification in Facebook can be made through tagging activities. This behavior can relate to folksonomies, i.e., by tagging someone (user or group) in a determined post, a user can, posteriorly, identify and relate someone to the debated topic at the time. Photos and videos (Fig. 18 and Fig. 19) can be tagged as well. Video files are identified also through tags that correspond to the users name on the network. Overall, anyone can add tags to the contents in order to improve their arrival to the persons that appear in the post/picture/video or to those whose contents are dedicated. The numerous ways of performing the same task can be viewed as an effort to enhance and also to motivate users in the classification of the contents they made available as well as user centric emphasizing mechanisms.



Legend:
1 – Like section
2 – Tagging Feature
3 – Photo Comment section
4 – Comment like section
5 – Photo "Like" section
6 – Like, Comment, (Un)Follow post, share and edit buttons
7 – Photo description section:
Adding a description to the photo
Tagging feature
Location where the photo was taken
Edit (allows the edition of all previous fields)
8 – Profile owner, posting date and visualization permissions

Fig. 18 - Facebook photo visualization, rating, comment and tagging screen



Legend:
1 – Share the video to other user profile
2 – Play again feature
3 – Video Comment section
4 – Comment like section
5 – Like, add comment, follow post, share post and edit (only if you have the content in your profile) section
6 – Description section
7 – Tagged users section
8 – Tag feature to add more users; embed feature to share the content in other platforms (blogs)
9 – Video title
10 – Profile owner

Fig. 19 - Facebook video visualization, rating, comment and tagging screen

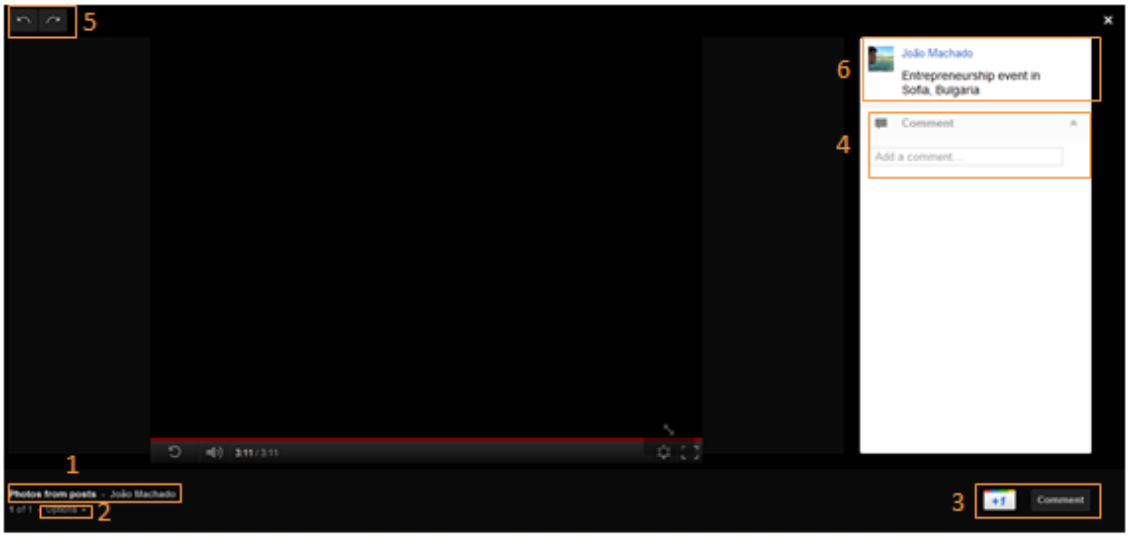
Google+

In Google+ the way content is classified is very similar to what's done on Facebook. Again it can be observed the Folksonomy behavior, being the users

the tags that classify the shared contents. As seen previously in the Facebook context, photo and video (Fig. 20 and Fig. 21) features possess tools that enable the classification (through the identification of users) of these types of contents. However, as it can be seen in Fig. 21, video files lack tools that enable the tagging actions. Text post can be also classified by allocating users identification as tags to such posts.

Legend:
1 – Content location
2 – Option button (allow download of photo, photo details, comment management (deletion) and photo removal (if it is in your profile)
3 – Content related actions
+1 button
Comment button
Share button
4 – Comment section (with possibility to post a comment)
5 – Tagging section (displays who's identified in the photo and allows identification of other people)
6 – Photo edition tools
Rotation buttons
Auto correct button
Creative kit button (add effects to photos)
7 – Profile owner with picture description

Fig. 20 – Google+ photo visualization, rating, comment and tagging screen



Legend:
1 – Content location
2 – Option button (video details and video removal (if it is in your profile)
3 – Content related actions
+1 button
Comment button
4 – Comment section (with possibility to post a comment)
5 – Video rotation buttons
6 – Profile owner with video description

Fig. 21 – Google+ video visualization, rating and comment screen

LinkedIn

Content in LinkedIn also possess tagging features, although, as a more professional social network, it does not have any features to share pictures or videos. Instead, only allow the sharing of text posts (where you cannot tag anyone) and links that can be attached to the posts or shared individually. In spite of these, few, features to pictures and video contents, LinkedIn has a vast range of aspects with which users can be classified, browsed, searched and retrieved which leads us to evidence a faceted classification (Fig. 22). Facets like professional experience, frequented university, academic degrees, personal interests, hobbies among many other aspects are used to classify, connect and share users' likes and personalities. This information can also be used to suggest new connections (users or groups).

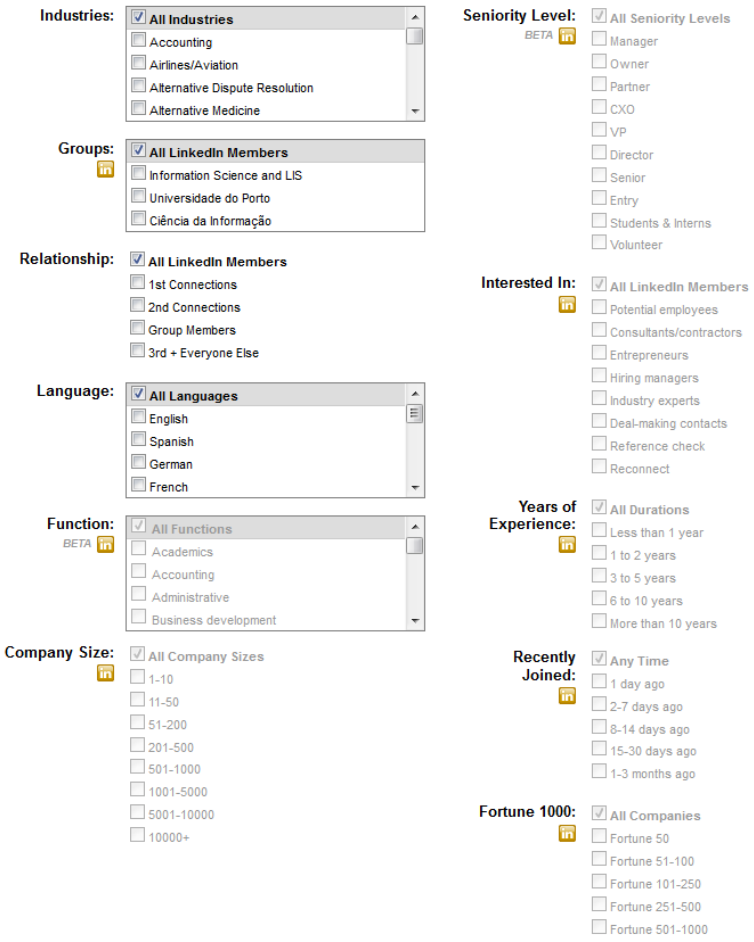


Fig. 22 - LinkedIn advanced search interface

Collaborative Platform Z

The organizations classification in *Collaborative Platform Z* is made through a faceted classification. This classification is made of nine facets:

- Organization type
- EAC (Economic Activity Classification) (it possesses subdivisions in order to provide an accurate classification)
- Commercialized products or services (with a descriptive list)
- Used/available technologies (with descriptive list)
- Scientific domain
- Customers location
- Facilities location
- Organization interests (the values of this field are tags that users input)
- User(s) role(s)

A faceted classification is also verifiable in the news feed zone where users can classify their posts according to the type (text, video, audio, image, link or document). It can also be added tags to complement the classification of content. This behavior is observable in other areas of the platform differing the facets used to classify the type o content that is being created.

Content Organization

This section intends to approach the organizational aspects in social networks, i.e., the way contents are available in the platforms mainly in the home page. One overall aspect relevant to mention regards the chorological order of the contents in the news feed (for Facebook), stream (Google+), updates (in LinkedIn) and news area (in *Collaborative Platform Z*). This aspect induces a time notion in the user enabling a reference in further content retrieval. To analyze this aspect, some guidelines from Morville and Rosenfeld (2006) will be used, in order to assess the availableness of organization, navigation and search systems.

Facebook

Facebook displays a strong user centered organization, providing users with a strong and diverse range of tools. Observing the main page (Fig. 23) it is almost immediately noticeable the top blue bar, which according to Morville and Rosenfeld (2006), represents a global navigation system due to its presence independently of the user location inside Facebook. This navigation system enables users to navigate between Facebook home page, friends requests, messages, notifications (being these options presented through iconic labels), search bar (to located people, groups or publications), a button to the user profile, other to the main page and a down arrow to manage the profile options. In the right and left side there are local navigation systems, these systems provide information of the user profile, the favorite places on the platform, groups which the user is part of, applications used in the profile (games and other kind of applications) and the lists from which the user can receive the latest updates from the members of such lists. The right side navigation system

provides information of upcoming events to which the user has been invited, other users that may be known but aren't connected to the user yet. The center section resembles the contextual navigation that the mentioned authors refer to in their book. In this section the users are confronted with options to post new contents to their network, these will afterwards be displayed below in the news feed evidencing the posted content related to the users that made the post.

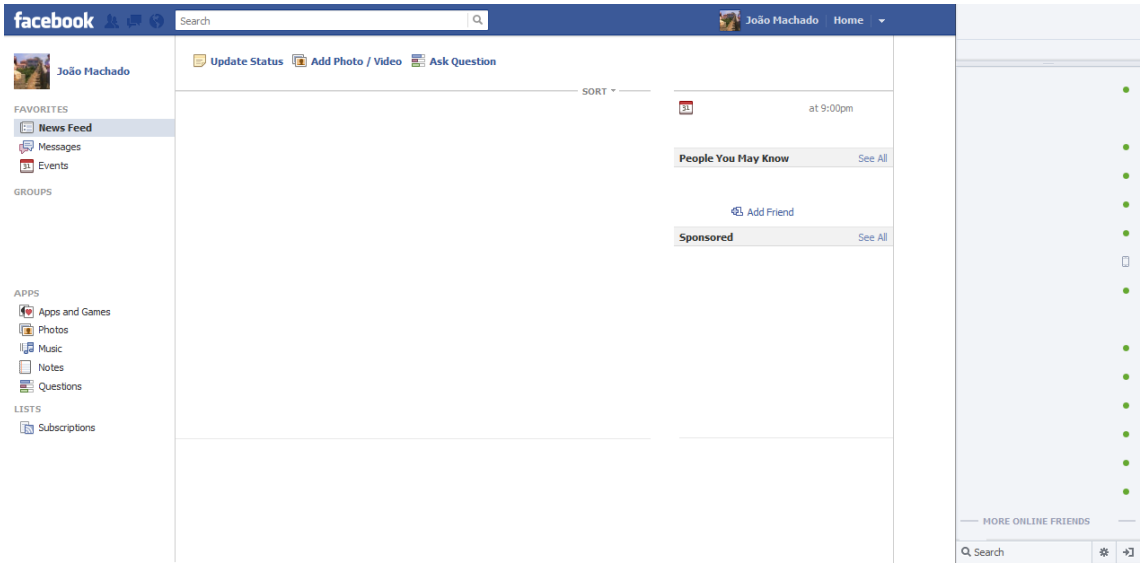


Fig. 23 - Facebook main page interface

In an overall view, Facebook provides its users an intuitive and consistent content organization and navigation among them. The global, local and contextual navigation systems are consistent throughout the entire pages (home, user page and other users pages) gathering conditions for users to establish the behaviors and routines mentioned previously by Morville and Rosenfeld (2006).

Google+

In terms of content organization it is possible to start with a problem about relativity regarding the top bar with all Google products and the top bar of Google+. Which one can be considered a global navigation system? If we consider a products perspective, then the top bar is the global navigation system and the top bar of Google+ is the local navigation system. However, if we consider the social network Google+ (Fig. 24), then the top bar maintains the global navigation system status and the top bar of Google acquires such status too and this last perspective will be the used one. The top bar in Google+, as

global navigation system, provides users means to navigate through the areas of the platform. The instantaneous and noticeable aspect in this bar is the predominant iconic usage. In spite of the short usage of icons (five icons), and as a Google+ user, the use of iconic labels only may turn out a bit puzzling for new users. The left area possesses a local navigation system that allows the execution of several tasks according to area that the user's in, the right side is reserved to recommended connections. Similarly to Facebook, the central area enables the creation and publishing of contents being these displayed in the lower section, evidencing (again) the relation established between user and content.

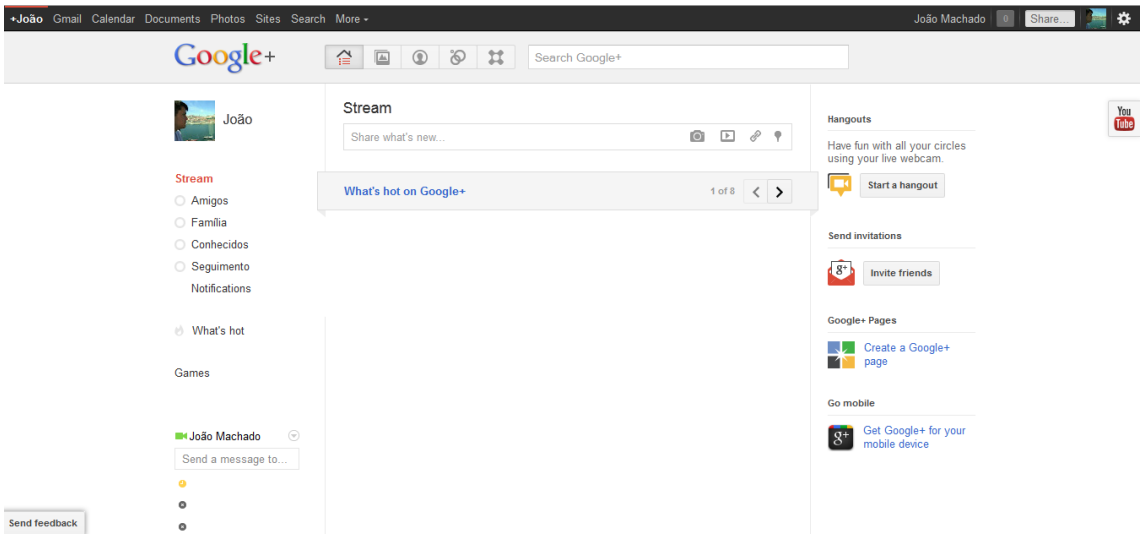


Fig. 24 - Google+ main page interface

Similarly to Facebook, Google+ provides a consistent environment regarding navigation systems, the labels and page positioning used, joining that with a frequent visiting may result in the establishment of a determined set of behaviors.

LinkedIn

LinkedIn opted for a more conservative approach regarding its content organization. As a professional social network it aims to the supplying of contents that may, in any aspect, enrich its user's professional life. According to Morville and Rosenfeld (2007), it is possible to verify that LinkedIn (Fig. 25) chose to "fuse" the global with the local navigation system being this the reason of the conservative approach. The center top bar has the connections to the main areas of LinkedIn and, when hovering the cursor in these areas the user

get the local navigation system with the set of actions that may be performed in such area. The rest of the page is occupied with the usual central post creation and publishing area and also the usual area where posts are placed with the previously mentioned relationship. The right side offers connections that are suggested according to interests or professional background. In an overall analysis, LinkedIn offers a clear and simple content organization that may be justified by the much closed range of services it aims for and provide.

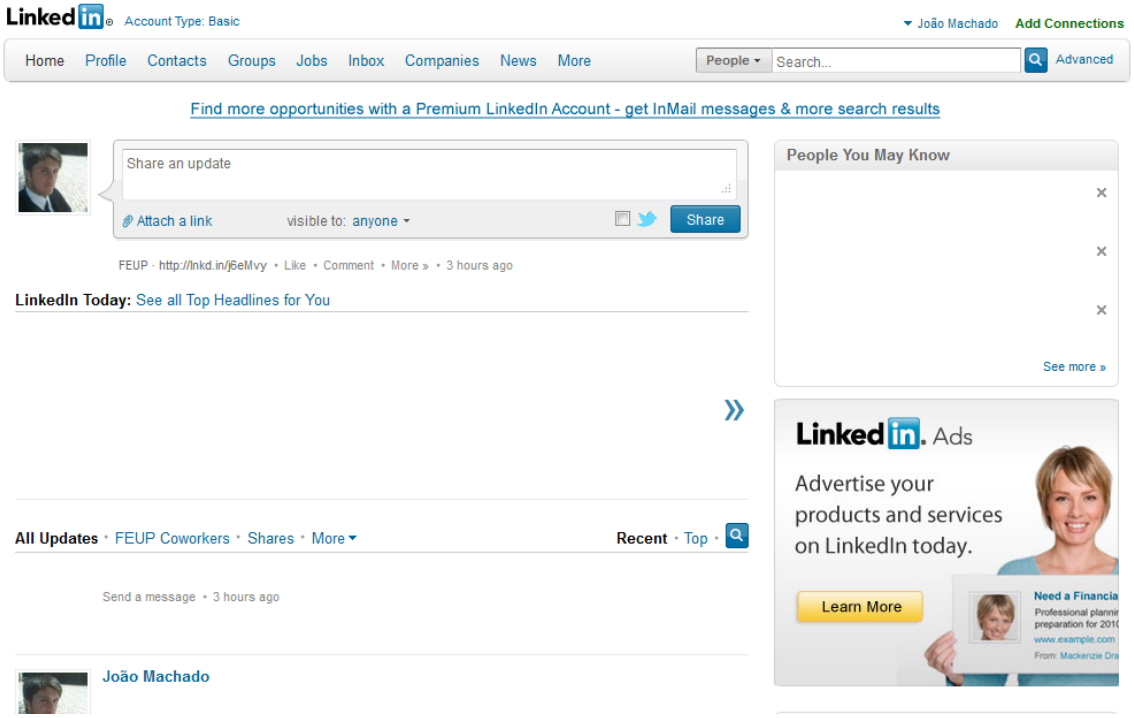


Fig. 25 - LinkedIn home page interface

Collaborative Platform Z

Z platform displays a similar environment than the previous platforms. It has two global navigation systems one on the top of the page and the other in the left side. The usual post box at the center section allows the publishing of new posts. This feature is followed by the news feed that possesses a local navigation system that allows the filtering of news according to their type. The right section of the page is reserved also to local navigation systems depending on the page the user's in. These systems allow users to perform several tasks such as project documents management, top commented blogs and recent challenges.

In an overall analysis, it is possible to conclude that, content organization in social networks follows the logic of the mentioned ontologies, i.e., they are based on people that are connected to each other and (by tagging actions, or sense of belonging to a given group) share diverse types of contents. These contents are associated to the user that posted them, having also connection to the space where they are (in case of having hyperlinks) and reply (posting comments) capabilities (as seen in the description of SIOC, Fig. 16). The chronological placement is a common aspect in the four networks. Another common aspect is the global navigation systems' position (top of the page) as well as the local navigation system (mostly left side). These aspects can induce a sense of transportation of behaviors, i.e., since the options, bars and procedures are located so similarly one user can change of network and still execute behaviors that he performed in the previous network.

Content Retrieval

This final section observes how, through the use of the search features in social networks, contents can be retrieved despite of the type of content that is being searched (text, photo, video or music post).

Facebook

Facebook's main source for retrieving contents is through the search bar located at the top of the page or through browsing. When searching for something in Facebook the results retrieved are pages where the searched terms appear. The results are all mixed up being possible the filtering of these pages according to predefined categories (Fig. 26) enabling the refinement of the results obtained and an effective retrieval.

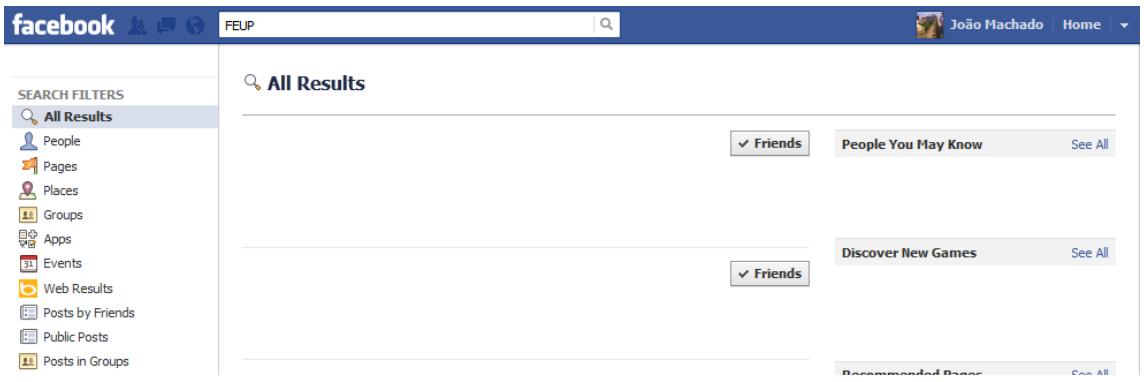


Fig. 26 - Facebook content search and retrieval

In spite of the efforts, there's no feature that enables the retrieval of photos and/or videos that were previously classified through the allocation of tags directly, i.e., these are only retrievable through the search of the connection that posted such content.

Google+

The retrieval of contents in Google+ is made also through the search bar at the top center of the page or through browsing. After the search is made, the results obtained can be described as more accurate than in Facebook. This fact is justified by the retrieval of different types of contents, for instance, if you search for photos, the results will show a user profile followed by photos whose tags reflect the searched terms (Fig. 27). The results can be filtered according to three aspects, type of "place" to perform the search (profiles, posts, pages…), who published the content (the user, users' groups or everyone on the network) or by location (an address can be input).

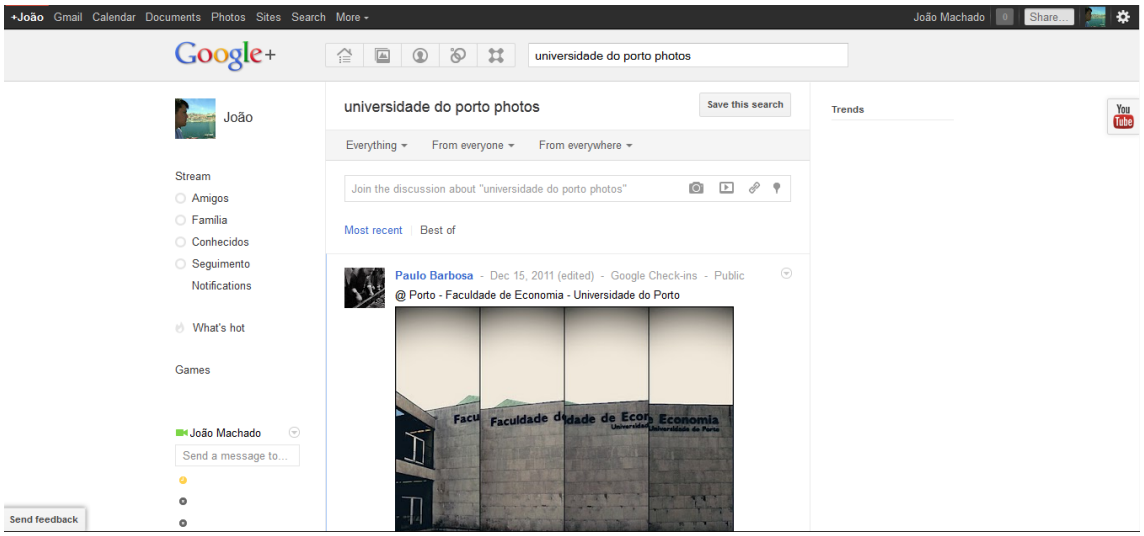


Fig. 27 - Google+ content search and retrieval interface

As it can be observed in the above figure, through the search for "universidade do porto photos", Google+ identified the users that possess photos that, in the description section, manifest the searched terms.

LinkedIn

Being mainly a social network to exchange personal and professional information, LinkedIn content retrieval consists mainly in the search of profiles (that can belong to people, companies or groups) according to specified terms

and aspects, as seen previously. The retrieval of contents can be performed through the search bar at the right upper section of the page, where the search can be refined promptly through the specification of the type of search that will be made (people, companies, groups…). The obtained results (Fig. 28) correspond to the matching of the searched term in the profiles of users.

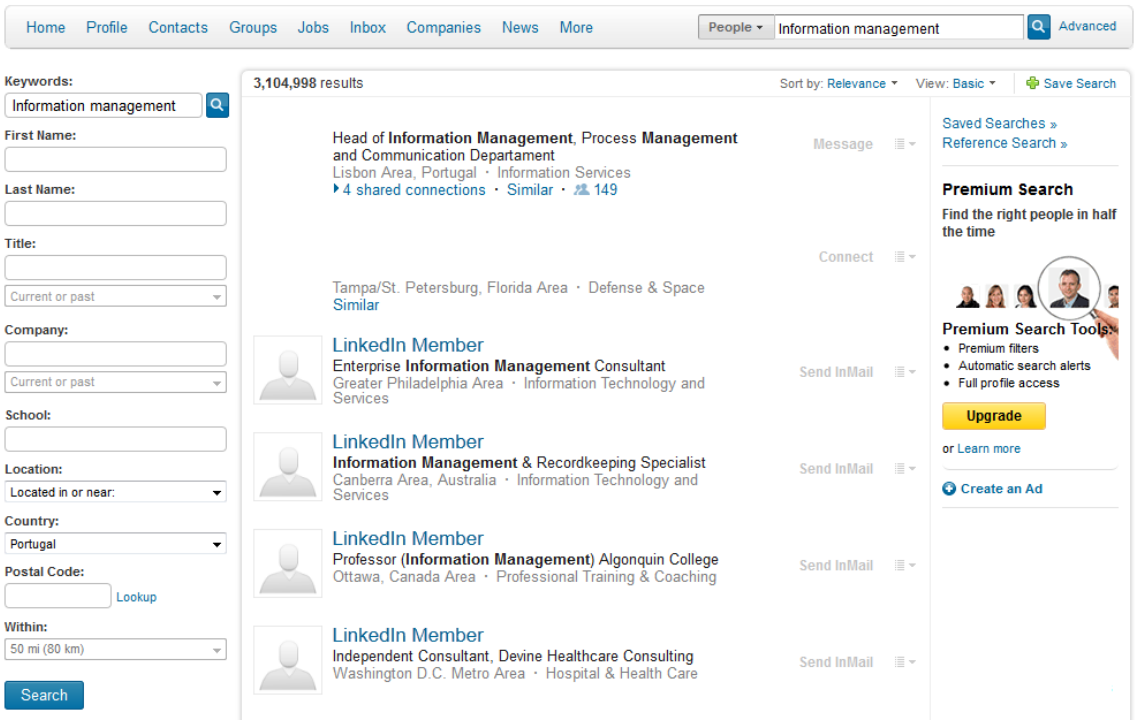


Fig. 28 - LinkedIn search and retrieval interface

In a later stage the results can be refined by adding more information in different fields as it can be observed in the above figure. Other way of refining the search is through the filters available on the search interface. Checking these filters will refine the search to the profiles that contain the combined values present on the filters.

This aspect reinforces the previous statements about the faceted classification of contents in LinkedIn, i.e., by allocating values to fields such as company, location, industry and others aspects, users are leveraging the chances of retrieval when a search is made.

Collaborative Platform Z

Contents, people, events, groups, working groups and other kind of contents retrieval in *Collaborative Platform Z* is carried out through browsing

in the respective areas or through the search bar present in every page. After inserting the keywords, all the contents that have the keyword are retrieved. The results presentation is made alphabetically, having the possibility to order (filter) the results according to the area from where they were retrieved. It's important to mention that the use of tags increase the recovery rate due to its proximity to a natural language expression that bonds the user to the content.

Comparative analysis of the Social Networks in their Information management features

The following table (Table 1) demonstrates and enables the comparison of the Information Management activities regarding classification, organization and retrieval of contents in the studied social networks. Classification aspects were analyzed according to the features of identifying entities (people, groups or companies). Organizational aspects relate to the ability of accessing the various functional aspects in social networks and the retrieval features were assessed through the retrieved contents over a given query and the provided filters to refine the retrieved contents.

Table 1 - Comparative analysis of Information management aspects (classification, organization and retrieval) in Social Networks (Facebook, Google+, LinkedIn and Collaborative Platform Z)

Social network / IM activities	Facebook	Google+	LinkedIn	Collaborative Platform Z
Classification				
Type of classification	Folksonomy/tagged based classification	Folksonomy/tagged based classification	Folksonomy/ Faceted classification	Faceted classification/ tag based classification
Identify (tag) people in text posts	Yes	Yes	No	Not available
Identify (tag) people in pictures	Yes	Yes	Not available	Not available
Identify (tag)	Yes	No	Not available	Not available

people in videos				
Embed links in posts	Yes	Yes	Yes	Yes
Identify photo albums	Yes (through tags)	Yes (through users' profile name)	Not available	Not available
Identify (tag) people in text posts comments	Yes	Yes	Not available	No
Identify (tag) people in pictures comments	Yes	Yes	Not available	No
Identify (tag) people in videos comments	Yes	No	Not available	No
Organization				
Posts organization	User-centric and content-centric	User-centric	Content-centric	Content-centric
Event organization	Yes	No	Not available	Yes
Group creation	Yes	Yes	Yes	Yes
News feed filtering	Yes (according to groups or lists)	Yes (according to circles)	Yes	Yes
Photo organization	Yes (Albums)	Yes (Albums)	Not available	Not available
Video organization	No (mixed up with music posts)	Yes (main page - through YouTube playlists) No (mixed up with other photos)	Not Available	Not available
Music organization	No (mixed up with video posts)	No	Not available	Not available
Retrieval				
Access user profile	Yes	Yes	Yes	Yes
Access users' contacts	Yes	Yes	Yes	Yes
Access users' events	Yes	No	No	Yes
Access news	Yes	Yes	Yes	Yes

feed				
Access groups	Yes	Yes	Yes	Yes
Access own photos and videos	Yes	Yes	Yes	Not available
Access other users' photos and videos	Yes	Yes	Yes	Not available
Access subscribed applications	Yes	Yes	Yes	Not Available
Access users' posts and comments	Yes	Yes	Yes	Yes
Access suggested connections	Yes	Yes	Yes	Yes
Access suggested news highlights	No	No	Yes	Yes
Search text posts	Yes (tagged and not tagged)	Yes (tagged and not tagged)	Not available	Yes
Search photo posts	Yes (tagged and not tagged)	Yes (tagged and not tagged)	Not available	Yes
Search video posts	Yes (tagged and not tagged)	Yes (tagged and not tagged)	Not available	Yes
Search events	Yes (tagged and not tagged)	No	Not available	Yes
Retrieve connections	Yes (established and not established connections)	Yes (established and not established connections)	Yes (established and not established connections)	Yes
Retrieve music/audio posts	Yes (through movie clips, web links and former posts from connections and general posts)	Yes (through movie clips, web links and former posts from connections and general posts)	Not available	Yes

The former analysis was designed to compare information management features in social networks through classification, organization and retrieval aspects. In spite of the close range of analysis, this matching constitutes a first view over such aspects in social networks being further studies required to improve this analysis, enabling the observation of other issues regarding information management in other areas of Social Networks and creating a framework that allows a direct and explicit observation of such aspects and issues.

PART II: EMPIRICAL STUDIES

This part of the dissertation is responsible to provide information about the empirical studies performed in the pursuit of the established objective in this dissertation. The first study pictures a collaborative platform, *Collaborative Platform Z.* through social network analysis tools. This platform was studied aiming at the collaboration and information management features. The second study takes after the Parque de Ciência e Tecnologia da Universidade do Porto (UPTEC). The aim in this study was the same as in the previous one, although a different methodology, based in interviews and observation, was applied. The results are presented and discussed posteriorly.

4 Network Analysis

The following chapter intents to reveal the studies performed to two collaborative networks in order to assess the collaboration aspects between its actors and also to observe how the role that information management affects collaboration outcomes. The next subchapters identify the studied networks as well as the purpose of the performed studies, data gathering and obtained results in pursuit of the established objectives.

4.1 *Collaborative Platform Z*

Collaborative Platform Z, name adopted to protect the platforms', as well as its users, identities is a digital platform with reserved access created with the purpose to gather and instigate collaboration between a restrict universe of enterprises with other organizations of the National Innovation System. This collaborative platform enables direct interaction between participating institutions through typified modules that allow, for instance, the search for strategic partners and cooperation challenges.

Apart from configure itself as joint work stimulus, *Collaborative Platform Z* is a "*virtual space of knowledge and experience sharing focused in innovation among these entities, allowing them to increase and perfect knowledge between them.*"

Social Network Analysis in Collaborative Platform Z

The Social Network analysis in *Collaborative Platform Z* was performed to assess how relations were established and what actors were more influent (*stars* of the network) when other actors manifested any informational need and to have a perception of how is processed the informational flow between users. This analysis follows what was stated by Haythornthwaite, (1996) when referring to the capabilities of Social network analysis being able to assess *"both the content and the pattern of relationships in order to determine how and what resources flow from one actor to another"*. Towards this study purpose, the main assessed aspects were density, centrality (in its degree, betweenness and intermediation levels) and the connectedness of the network. These measures will allow us to observe what connections are already established, and in those connections we will be able to assess what users have important roles towards the activities that are performed in the platform.

The density, according to Palau et al. (2004) *"is the proportion of all ties that could be present that actually do in fact exist."*. Centrality can be addressed by it's in and out levels, in which *"in-degree is the number of ties an actor receives (*and*) out-degree is the number of ties which begin with the actor himself"* (Palau et al., 2004). The closeness centrality refers to the proximity that a determined user has towards the other users that belong to its network. And the intermediation centrality, as the name refers, indicates what user is crucial in the network to bridge other users' relation. The connectedness level indicates how, in a determined network, users are connected to each other.

The interactions were registered through observation of activity between users in the platform. Relations, in this context, were considered to be any interaction that users make between themselves, whether is a comment, a forum entry and subsequent responses. To this study purpose responses addressed by the creator of the forum or post to himself were excluded.

Using NetMiner3 application, a relational matrix was made in order to figure all the relations among the *Collaborative Platform Z* users. This matrix was then analyzed in the previously mentioned aspects, whereas, centrality was studied at betweenness and proximity levels, for in degree, i.e., users that receive more connections and out degree, i.e., users where more connections are departing from.

In a first instance, the network properties were analyzed resulting in the following table (Table 2). A visual representation (Fig. 29) of the network follows, in order to provide a detailed and graphical perspective of the network.

Table 2 - Properties of Collaborative Platform Z network

Property	Value
# Links: O(m)	23
Density: O(m)	0,11
Average Distance: O(m)	2,701
Diameter: O(nm)	5
Connectedness O(m)	0,171

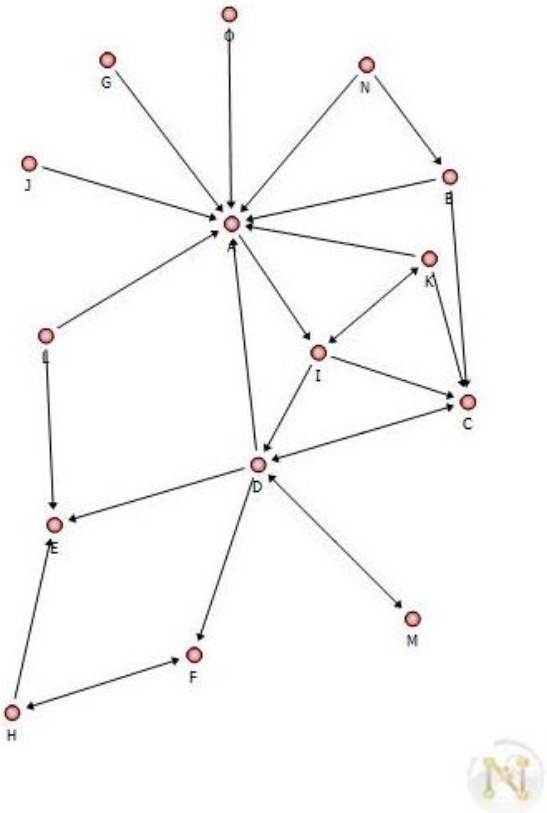


Fig. 29 - *Collaborative Platform Z* sociogram

According to Table 2, it is possible to verify that in a universe of 15 users there are 23 relations, which in terms of density (quotient between the existent relations and possible relations), returns a low value (0,11). If we consider the total number of users in the platform (504)[1] this value reduces drastically, being almost null ($1{,}02 \times 10^{-4}$). To collaboration purposes it is possible to conclude

[1] Value verified in 16/04/2012

that, according to this density value, the platform is failing in its main objective, innovation through collaboration, once there are not many connections between users, how will they exchange information and collaborate?

Regarding the network diameter (biggest geodesic distance between any pair of network users), the obtained result was 5, being the average distance 2,701 geodesic units. Analyzing these aspects, and considering the "sample" we were studying, it is possible to conclude that, this "portion of the network" constitutes a low dynamic and poorly connected (with a connectedness level of 0,171) organism that share and refutes ideas through content sharing.

Centrality can be studied generically considering the in-degree centrality (Fig. 30), i.e., determine the quantity of adjacent nodes (users) in each node on the network, or through the out-degree centrality (Fig. 31) determining the quantity of nodes leaving from each node in the network. In this study, in-degree centrality can be described as *user A* receiving a comment from *user D*, for example. Following the same reasoning, out-degree centrality can be described as *user A* commenting a post from *user C* and a forum entry form *user F*.

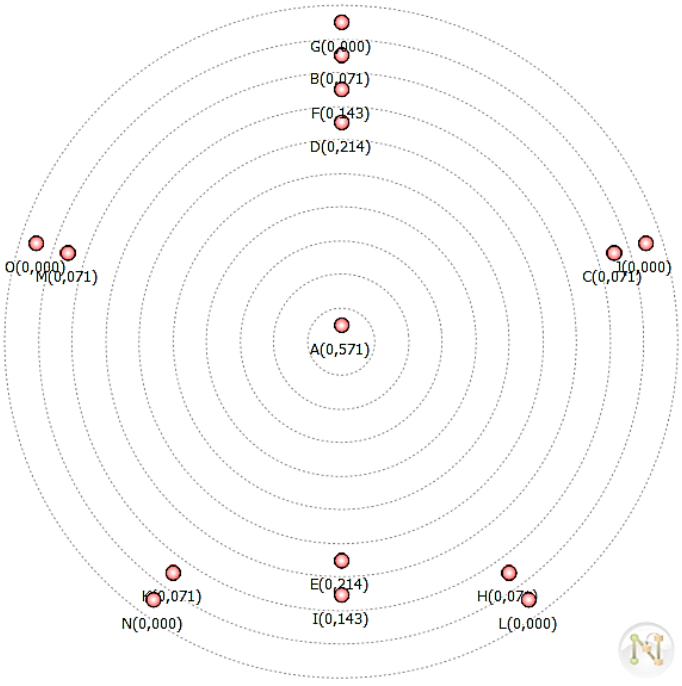


Fig. 30 - In-degree centrality

From the provided figure, it is possible to verify that the user "A" has the biggest in-degree centrality with a value of 0,571. In this analysis, standard values were used to measure centrality. The values oscillate between zero (0) = periphery and one (1) = center. One relevant aspect to mention is that, the referred user belongs to the entity that manages the platform so, its centrality results of actions to induce more dynamism in the platform making users connect more between themselves.

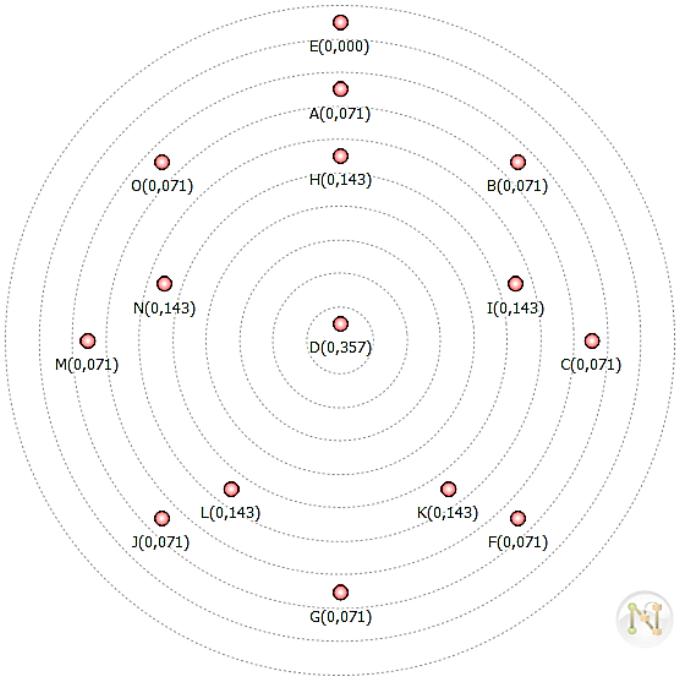


Fig. 31 - Out-degree centrality

In this figure it is possible to verify that, differently from the previous one, in terms of out-degree, the user "D" has the biggest out-degree centrality value (0,357). This result is justified by the participation (mostly answering and commenting any questions) of the user in the platform. The mentioned user is also a member of the platform managing team so this result may indicate efforts to increase the dynamism of the platform as said previously.

Centrality can also be studied through a set of features such as proximity and betweenness. The proximity centrality studies how easy it is for two users to

communicate wherever their position in the network is, therefore, the closer the users, the easier and faster these can establish an interaction. This feature can be viewed from an in closeness level (Fig. 32) and out closeness level (Fig. 33).

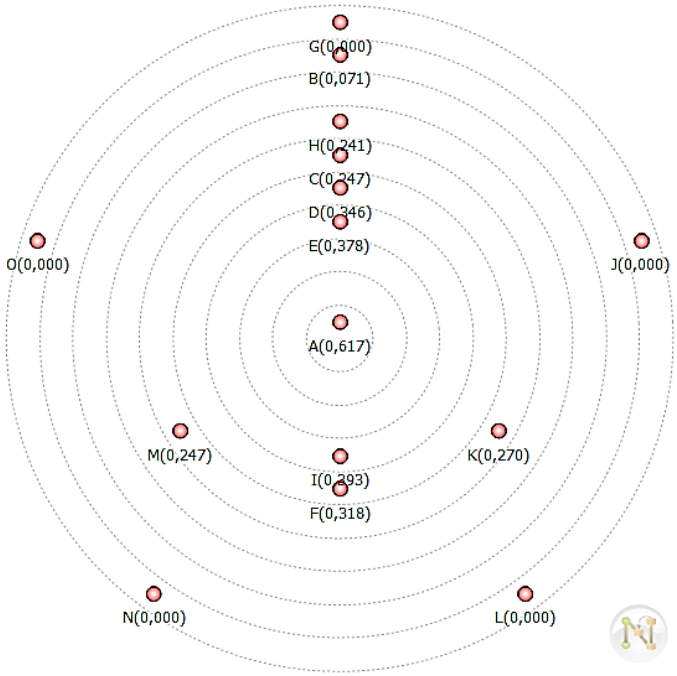


Fig. 32 - In closeness centrality

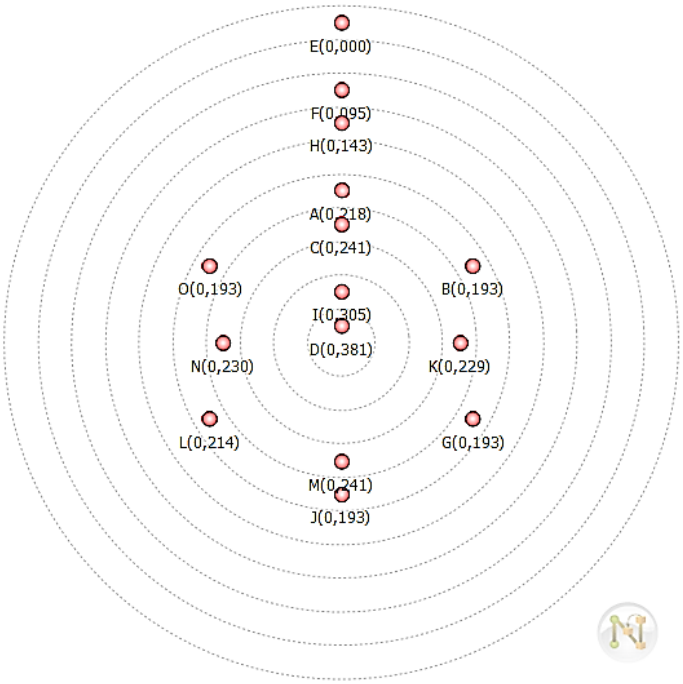


Fig. 33 - Out closeness centrality

Similarly to the previous situations, the same users occupy the same positions depending on the considered level (in/out), with the respective values of 0,617 to in closeness and 0, 381 to out closeness.

As for the betweenness centrality (Fig. 34), it measures the value that determined users have in the network so that other pair of users can establish communications between themselves. This definition can also be related to the position of *broker*, once this position not only enables the user to establish connection between other pairs of users as well as have access to the exchanged information.

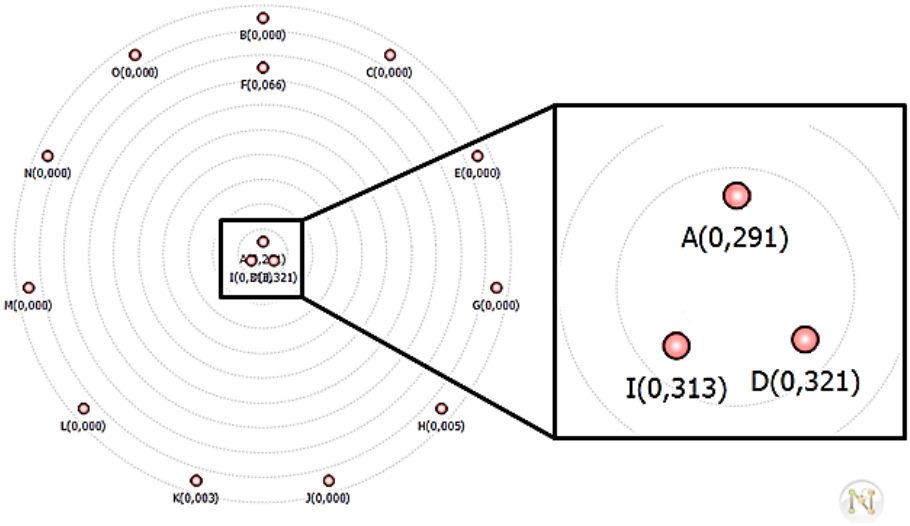


Fig. 34 - Betweenness centrality

From the presented figure, it is possible to say that the network communicates among itself through the users "D" with a value of 0,321; "I" with a value of 0,313 and "A" with a value of 0,291. These results demonstrate that only one of the users doesn't belong to the platform managing team, so if these users leave the network, it will collapse because the remaining users possess low values of betweenness centrality, occupying peripheral positions as it is possible to verify.

In an overall analysis, the presented results draw a poor connected network in which few contents are published and do not attract users enough to deserve their comments, critics or reviews. In spite of the considerable number of users registered in the platform only a few uses it in an almost consistent frequency, this problem may also be related to the previous cause. Another

important conclusion that may be mentioned, relates to the sociotechnical approach, i.e., in spite of the *Collaborative Platform Z* represent a well-designed and conceived platform from the technological scope, it does not possess the same features in term of social aspects. These social aspects must be valorized in order to make the platform dynamic and appealing so that its users face it as a necessary mean to connect to other people, to establish collaborative projects, to contact and ask for peer reviews and opinions towards their services. Bottom line, in social terms, the platform must transmit to its users an informal environment where opinions are debated between people and not companies.

4.2 UPTEC – Science and Technology Park of University of Porto

The study performed at UPTEC aimed at the assessment of the existing needs regarding collaboration and information management. To achieve this goal, open interviews were realized in order to obtain first hand necessities reported by UPTEC staff, managers and incubated enterprises. Some events were also attended in order to assess the dynamic of enterprises when in group situations and to observe pattern behaviors. The gathered data was processed with the support of the NVivo 7 qualitative analysis software. Through the program, a tree of subject nodes was built to analyze the interviews, allocating the interviewees citations to the elaborated nodes. This allowed an organization of the surveyed subjects which, consequently, facilitated the elaboration of the following sections. Due to the inexistence of a computer mediated collaborative platform, the UPTEC directing board, evaluate this study as an added value to a future collaborative platform design based in the assessed necessities.

The Science and Technology Park of University of Porto (UPTEC), is an innovating institution focused in empower business ideas so these can become enterprises. These ideas are sheltered in four Poles scattered throughout Oporto city. There are the Technological Pole, the Creative Industries Pole, the Sea Pole and recently it was created the Biotechnological Pole which does not have its own facility yet.

To reach its goal, UPTEC has a network of contacts, one of them it's the University of Porto, besides the University, it is also connected to wide range of entities whose areas are vital to the success of the business ideas such as law, accountability, finances and a whole network of suppliers.

In its structure, UPTEC also shelters anchor projects and innovation centers whose necessities and goals are distinct. Anchor projects represent established enterprises that look upon UPTEC as a source for developing new products or services. They are like landmarks of the different areas that UPTEC ranges and through them it's expected that more and new projects can incorporate UPTEC. The innovations centers embody national and international enterprises departments whose main purpose is to cooperate in the development of new technologies.

The UPTEC team is constituted by a directing board, a technical support team and a team of pole managers. The technical team is responsible for treat and solves problems that may emerge related to logistics, accountability, company invoicing, infrastructures maintenance, security, communication, administration and other issues that may occur.

The pole managers are responsible for a more direct and personalized contact with the enterprises located in the park. They support enterprises in management and technological issues, events divulgement, complementary training and enterprise counseling throughout the whole enterprise construction process. Pole managers know all the enterprises that are sheltered in their pole and know superficially the enterprises sheltered in the other poles. This reason is due to the pole managers' role which is, to serve as bridge to relationships among enterprises from the same pole or from different poles. These operations purpose is not only to make acquaintances between the entrepreneurs but also to encourage them to exchange information about their projects, areas of expertise, products or services they provide so that potential partnerships, subcontracting, joint projects establishment or co-development initiatives may be realized.

UPTEC's advantage in this field, relates to its unique "ecosystem" where relationships are based in trust and in the informal "environment" that results in an openness of all the entrepreneurs that, when facing any doubt or challenge, look for help without embarrassment.

Relationship establishment in UPTEC environment

According to the previous identified entities the first aspect to consider is the intense dynamism among them; such dynamism is justified and promoted by networking activities scheduled by the technical and management teams. In such events, enterprises find a place designed not only to acquire complementary knowledge to their skills but also to get acquainted with other entrepreneurs and exchange information.

The poles also represent place of strong interactions through the provided structures, break room, garden or even a snack space where basic human needs may be satisfied but acquaintances can be made also.

Relations between enterprises and technical team, as well as with the management team are identified as strong. This strength is defined by the availability of the technical team to support enterprises in every problem, related to the previous defined areas that may emerge.

About the poles managers, the relationship with enterprises is based in trust and informality to input a sense of ease in both entities leading to what was identified as “the door is always open” state, meaning that help will always be given when asked.

Technical team and managerial team have, between them, a relationship based in a constant and dynamic interaction with the purpose of providing services in a faster and efficient way so that, problems that concern enterprises can be resolved. Below, Fig. 35 provides a view of all potential relationships in the inner environment of UPTEC.

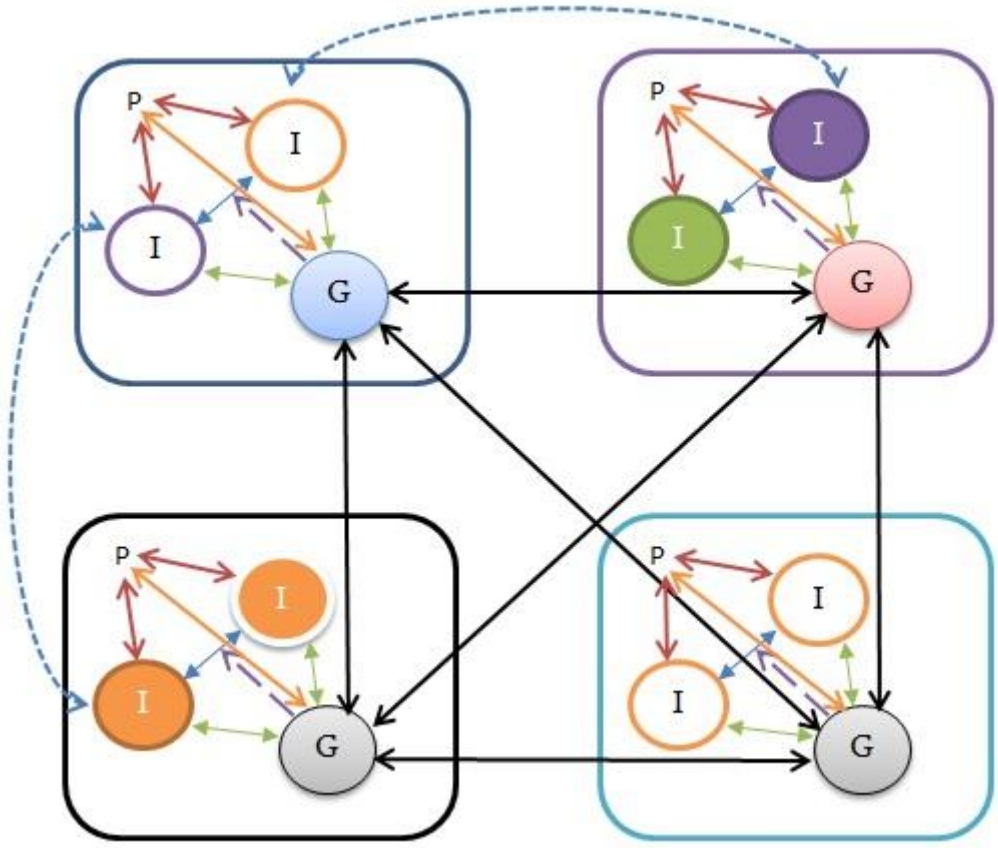


Fig. 35 – Established relationships in the INNER UPTEC environment

Legend:
I – Incubated Enterprise;
G – Pole Manager;
P – Pole/Central Services/Technical Support Team;
- Relation between Incubated Enterprises and Central Services;
- Relation between Pole Manager and Incubated Enterprises;
- Relation between Pole Manager and Central Services;
- Relation between Pole Managers;
- Pole Manager mediation in the Relation between Incubated Enterprises;
- Relation among Incubated Enterprises within the same Pole;
- Relation among Incubated Enterprise different Poles;

Related to this subject, it is important to mention that the interaction between Poles is not as dynamic as it is within each Pole. A potential justification to such point lies in the fact of each Pole possess its own "environment, dynamic and ecosystem", as assessed by the realized interviews.

This fact, leads to a bigger predisposition from enterprises to relate within their own Pole than with others located in other Poles, however, there are some exceptions where this relation is in fact established.

Concerning collaboration in UPTEC, it is crucial to mention its drastic growth mainly between enterprises. In the considered "ecosystem", collaboration is a result of the culture that populates the park. This culture is based in trust and informality and openness which leads enterprises to look for help, swap experience or contact with managers or central services in a proactive manner. In a general overview, collaboration is verified in all levels making this enterprise incubator main differentiation factor. However, there are also some barriers to collaboration. The main identified barriers are the physical distance between Poles, the UPTEC's exponential growth in the past two years and the personality of some entrepreneurs relatively to their predisposition to establish relations with other people. To reduce this last aspect, Pole Managers are essential because they serve as a bridge between enterprises, making the first contact easy to begin. The "suffered" growth makes that, more and more help requests, these may result in communication fail which in turn will result in a slow and ineffective resolution.

Information and Information Management

In terms of information, UPTEC has a varied and distinct vision of the concept. This subject received different opinions throughout the interviewees, who, in an indirect and unconscious mode, pictured several levels within the UPTEC's (Fig. 36) team as well as their informational needs. The figure below displays the levels and the information they deal with. As it can be observed, the different levels of action inside UPTEC, give its team distinct informational needs that correspond to a set of activities whose satisfaction meets their roles in a narrow scope and meets UPTEC's objectives in a broader scope.

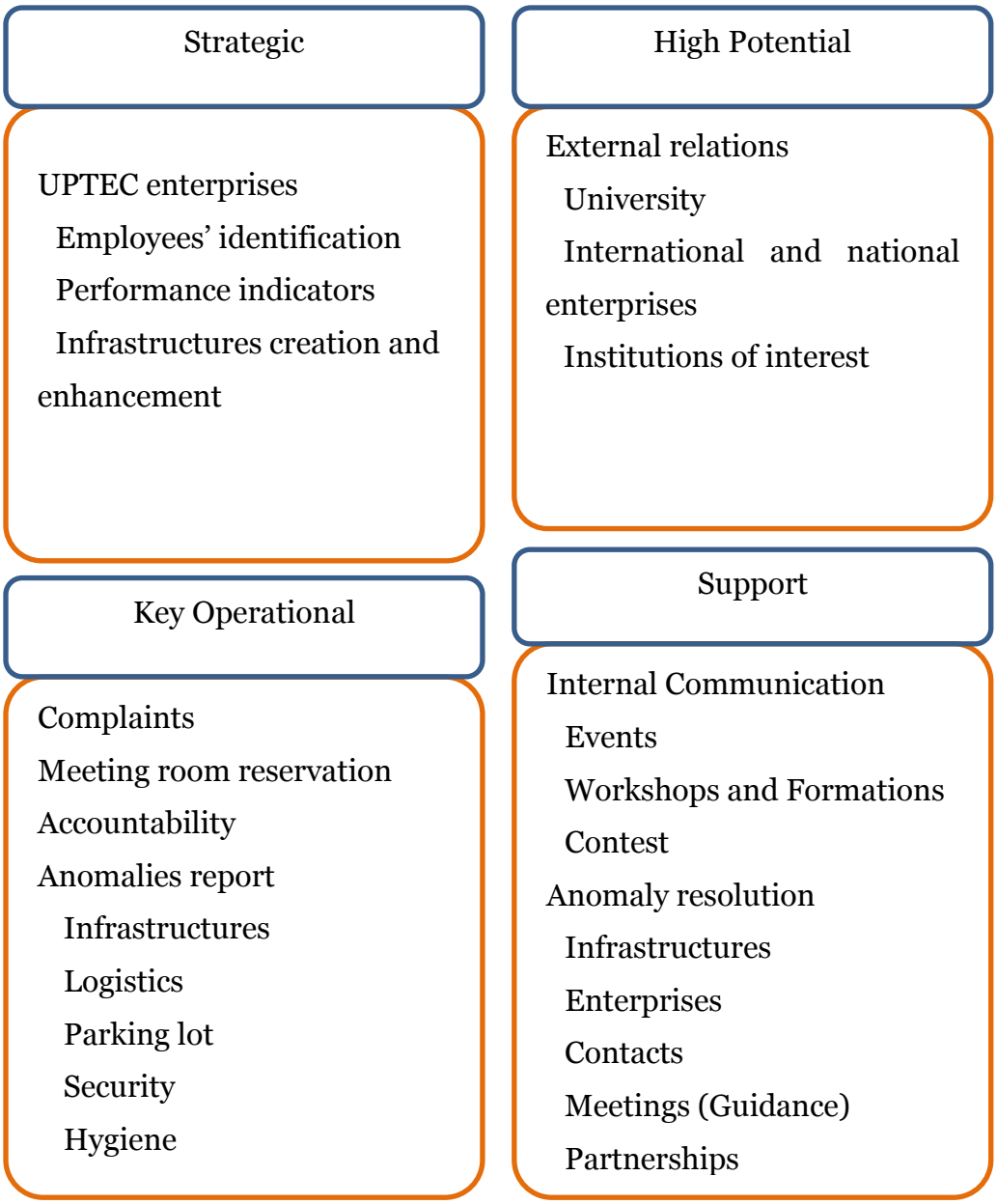


Fig. 36 - Information types in the several levels of UPTEC's INNER environment (according to the model of Ward and Peppard, 2002)

In terms of information management, there is an absence of concern about it. In certain cases, there is no awareness about the basic concepts of Information Management nor the processes and activities involved in it. In one hand there are people who do not know the concept of information management and affirm that it is made in a very primary mode ("from mouth to mouth") or through a kind of entry log to register the name of the company and the situation it has reported. In the other hand, there are people who state the existence of a server with a set of folders organized hierarchically where the information management is made by blocks. There are also people who identify

an ERP (Enterprise Resource Planning) system as the main responsible for suppliers' management fully and partially responsible for clients' management. In spite of this "disagreement" between the several entities, even if unconsciously, some information management practices are executed. In the operational level, information duplication is avoided, since there are a lot of enterprises reporting the same situation, there is no need to bother people over and over because of the same problem. There is a concern in knowing what was reported, who reported it and who is aware of such situation. This report may be made in person, through email (the general mail or the technical support mail) or phone call.

In the strategic-operational level, there is a sort of filtering of the information that is created outside of UPTEC and inside of UPTEC. The main ways of transferring this information is through email or phone. The information created outside UPTEC, after pass by a process of decision, is organized and then transmitted in blocks through the several means such as newsletters, social networks (Facebook, LinkedIn and Twitter). As for the internal information, it is possible to mention an UPTEC's manager considerations about the subject, *"we have a server in which there is an hierarchical structure for organizing folders, we have the concern of, every two months, one month and a half, update the information, then we have a series of "excels", a series of Outlook data bases that congregate that information"*.

Strategic level acknowledges the existence of an ERP system responsible for suppliers and clients management, although, it also acknowledges that a more practical approach to their clients, the incubated enterprises, is needed so that a more effective information gathering can be executed.

Information Management issues

One of the main problems pointed towards information management has to do with processes establishment. In a transversal way to UPTEC, procedures to perform in each and every situation need to be defined, identifying the information production entities, document types created during work actions, classification, organization, storing and availableness of the information. So, as it can be seen, the main need here lies in the standardization of behaviors towards the way information is managed in the different areas of UPTEC.

In the different levels previously identified, several and distinct problems may be identified, these affect the performance of the team when resolving problems. In the operational level, there is the need for transparency, centrality and information access. In the previous mentioned situations, the effort to careful avoid information duplication could be reduced if, as it was assessed, *"there was a follow up in the evolution of situations"*, this would lead to a better performance and feedback from enterprises. Still in this level, was reported an enormous waste of time providing basic information (enterprises' names, contacts, etc.).

In the strategic-operational level there is the need to expand *core* information management (mostly information about enterprises), as well as make faster the gathering of such information. These needs aim at the acquaintance of monitoring mechanisms that allow the realization of an active and effective accompaniment towards enterprises. It is also recognized the existence of large amounts of information that is being undervalued, constituting the main objective, make such information become available to all UPTEC network so that, not only some processes may be automatized but also, the access to the identified entities to "*a sea"* of information may be enabled in a faster and precise manner so that geographic distance can be softened. This fact was pointed as a major obstacle to relationship establishment.

In the strategic level, the needs are similar to the previous level, being the main concern related to the gathering of information from the enterprises. This is a serious problem because, without the necessary information, UPTEC's performance assessment becomes harder to execute.

The interviewed UPTEC enterprises mentioned the establishment of partnerships with other companies from within the same pole and some, very

few, mentioned partnerships with enterprises from other poles. The established partnerships have as purpose the co-development of products or services, outsourcing (in order to complement some areas of expertise that are missing) and also share resources like software code.

When asked about how they managed information in these situations, a set of tools were mentioned transversally, email and Dropbox are the main tools for information storing and exchange. The reasons for such choice are mainly connected to the price, which is none. Other solutions were also identified, shared servers, online tasks managers, external drives and personal contact (due to the proximity within poles). However, it is recognized the need for information classification and organization, a lack of control in document versions and knowledge retention and control as the project unfolds. One enterprise tried to soften these problems through the use of Dropbox, they established *"standards among us to define what a document is. If anyone wants to edit a document, two people at the same time, we use two different versions to work simultaneously, we define folders, the directory architecture is specific and we've already designed it and implemented it."*

Most enterprises mentioned the Facebook group as an excellent way of sharing information between enterprises, meet other entrepreneurs, share news and events and post doubts and challenges, although there is the risk of someone do not possess a Facebook account, as it was mentioned by an interviewee, *"my boss does not have Facebook account, which implies that I am not informed of anything through him"*. One aspect that was observed is that a little number of people uses the Facebook group which can be lead to an ineffective information exchange and can come in favor (if some opportunity emerge) of that small group of users.

When asked about what could solve their problems in term of informational needs and even collaboration issues, the answers lead to one way, a centralized information system where all companies could access information about upcoming events, enterprises contacts, solicit UPTEC's resources and services, search for certain sets of skills within UPTEC's enterprises (which would imply a thorough description of enterprises), information about basic enterprise management guidelines like tax payment and social security forms filling and also information about European funds to determined projects or

project proposal. In terms of collaboration, a shared server was mentioned. This server would allow enterprises to have their own folder with their information and when a partnership was established, a folder would be created to serve all informational exchanges between the enterprises.

This solution is also seen as a way of performing several tasks without contacting the central services which is one of the main objectives of the management team of the park. It will also, according to the interviewed enterprises, enhance collaboration because when a certain need emerges, this information system will enable them to search for information that satisfies such need.

4.3 Discussion of Results

In this last subchapter the gathered and processed results are discussed in order to verify if the hypothesis established in the beginning of this dissertation are refuted or supported by them.

Knowledge Management Systems affect collaboration because through them, information is kept updated and available transversally which in turn allows the fulfillment of informational needs that may emerge. As it was assessed in the UPTEC study, *"a calendar with information about upcoming events in UPTEC could exist"*, or other needs that through *"an Information System from UPTEC to enterprises where information could be shared, like internships from the diverse faculties, contacts of the professors responsible for such internships, tips to fill the form of a professional internship solicitation, things that make a daily enterprise life"*. So, hypothesis 1, *"Knowledge/Information Management Systems when applied to social networks affect collaboration between network users"* was validated, once, as verified in the mentioned study, the availableness and access to a wide range of information about enterprises constitutes an favorable aspect towards the establishment of contacts and potential partnerships. As an interviewee affirmed, *"consult the information on that enterprise, what type of technologies uses, what coding languages (…), that was really useful. It was much easier than have to call here (central services) because sometimes even they do not know. Enterprises could share the technologies with which they work, the products, the business area, the type of partnerships established, it would be very interesting*". This last quotation leads us to an additional relevant aspect, efficient resources management, which is an objective, held by UPTEC's board, achievable through the establishment of processes that automatize the supply of several services headed for enterprises, so that enterprises can, on their own, use these services without the intervention of UPTEC's resources, mainly human ones.

In case of hypothesis 2 *"Collaborative Network users' positions affect knowledge/Information flow and consequent knowledge/Information Management activities"*, the results provided by the Social Network Analysis performed in *Collaborative Platform Z* validate it. It is relevant to mention the low density and connectedness levels in the network, once from the 504 users

and the 253512 potential connections, only 23 were established. In these 23, the studied centrality measures allowed the discovery of the users that have the privileged position as "bridge", connecting groups of users. The in/out centrality degree it is relevant due to the referred users belong to the entity that manages the platform so, their centrality results of actions to induce more dynamism in the platform making users connect more between themselves. Betweenness centrality results demonstrated that only one of the users doesn't belong to the platform managing team, so if these users leave the network, it will collapse because the remaining users possess low values of betweenness centrality, occupying peripheral positions as it was possible to verify in Fig. 34.

A fact that can be noticed and contrasts with the studies of Anderson (2002) and Sykes et al. (2009) is the influence of users towards other users in order to make them use the platform and face it as a source where answers can be found. In his research, Anderson (2002), concluded that, by implementing influential individuals may facilitate the implementation of new technologies, so, according to Anderson (2002) *"these influential individuals can be enlisted in planning and implementing new information technology"*. In his turn, Sykes et al. (2009) use the term of *power user*, quoting Jones and Prince (2004) they say that, *"[Organization] used a power user concept for training users. They identified users in each of the business units that were influential in their units and that were interested in [system], and trained them extensively in how to do transaction processing as well as in how processes were changing and being integrated. However, there was more emphasis on the "how-to" than on process changes. Users largely learned the latter on the job as they began to use the system. As power users shared their knowledge with other users, knowledge about how to use [system] began to permeate the organization."* (quoted in Sykes et al. 2009). Transporting this concept to the *Collaborative Platform Z* and the results gather from its analysis it is possible to conclude that the users with central position in the network don't have a strong influence in other users or else the results would be others.

Through the obtained results it is also possible to conclude that the platform failed in its primary objective which is to leverage innovation projects between organizations through collaboration activities and through the features present in the *Collaborative Platform Z*. The lack of innovation projects and

information about them constitutes a major problem. As Jin et al. (2009) mentions, *"individual's' perceived information usefulness and satisfaction are determined by information quality and source credibility in the context of computer-supported social networks"*, so if the platform does not provide its users with relevant and trustworthy information (about innovation projects and related initiatives) they will stop using the platform. Regarding this subject, Jin et al. (2009) mentions the IS continuance model stating that this model *"is determined by user satisfaction with prior IS use and post-adoption performance – perceived information usefulness. Satisfaction and perceived usefulness were in turn affected by expectation-performance discrepancy (i.e., disconfirmation)"*. In other words, the obtained results are a clear picture of the users' discontentment and it should be seen by the platform's management team as a crucial indicator to initiate a severe and profound intervention to the platform in order to identify and alter the aspects that are leading to the actual results.

As for the hypothesis 3, *"Information Management activities represent an important (or a major) part of collaboration and innovation activities"*, was verified through the performed interviews in the UPTEC's study. In spite of Information Management methods and technics not being practiced active and effectively, which sometimes leads to uncomfortable situations, as it was told, *"enterprises call us to know how the situation is evolving and we only tell them that the situation was reported in and we are not making a follow up of the situation and sometimes we notice that people are not pleased with the way we answer them"*, the established partnerships had a good closure. It is possible to conclude that an information management suited to UPTEC's needs, may be a way of improve the relationship between enterprises, managerial team and central services.

Following this reasoning, it is possible to mention the need that enterprises have to gather information on a certain enterprise or set of skills would also be solved due to the previous mentioned aspects, so it is also possible to conclude that through information management, enterprises and other entities (such as directing board) would be able to collect information about UPTEC's enterprises in an autonomous and automatic way creating conditions

to establish contacts, connections and potential collaboration and innovation projects.

4.4 Study Limitations

In spite of the utility of the obtained results, the performed studies also possess their limitations. These limitations can be taken into account in further studies in which this dissertation may be used.

The Social Network analysis was performed as it was described earlier, lead to the results and conclusions that are useful to this dissertation's purpose although, the anonymity of this study represented a major constraint in diverse areas. In terms of data gathering, the realization of interviews to users and also the platform's management team could provide further insights about the collaboration in the *Collaborative Platform Z*. What went wrong, what was being planned to strike the unsuccessfulness of the platform and other information that could and would complement the assessed results and refine the attained conclusions.

The UPTEC study's major constrain was the lack of time by enterprises to provide their opinion on the subject at hand. Consequently the assessed needs and results may not be as precise as desired. The geographical dispersion was also a constraint in terms of time and effort consumption. Because the study was performed as autonomous as possible (as requested by UPTEC's board), the access to certain documentation regarding information types, performance indicators and the available platforms was not possible.

PART III: SOCIO-TECHNICAL DESIGN PROPOSAL

This last part of the dissertation will result in the concept creation and requirement specification to information management in organizational innovation networks. To achieve that, the platform H-KNOW was used as reference to specify the requirements to manage information in this kind of platforms. After defining what can be perceived by Information Management, H-KNOW platform is presents as well as its features to foster innovation and collaboration projects. Follows the concept proposal, where innovation, collaboration and information management converge and finally the requirements to support the created concept are presented.

5 Requirements specification for knowledge Management in Innovation Networks

This chapter describes the requirements for information management in innovation networks. The requirements were specified following the approach of Information Management given by Detlor (2010). A detailed set of requirements is available in Annex I, Table 4. Following, is the requirements explanation through the IM processes they affect.

Before advance any further, it is important to specify what can be understood as Information Management. According to Detlor (2010), there are many views about Information Management, in his study, Information Management *"is the management of the processes and systems that create, acquire, organize, store, distribute, and use information"* (Detlor, 2010). This notion of Information Management results from three different perspectives that Detlor identifies as the librarianship perspective, the personal perspective and the organizational perspective. Having the purpose of this dissertation in mind, the organizational perspective relates more to this ongoing study.

The organizational perspective is the most predominant and deals with the management of information processes so that these can be aligned with the organization's objectives in order to grant competitive and strategic advantages. As Detlor (2010) affirms that, in *"this perspective (...) terms like information systems management, information technology management, data*

management, business intelligence, competitive intelligence, content management, and records management have relevance".

To the purpose of requirements specification, Detlor's (2010) view was adopted, i.e., the requirements were specified according to the information lifecycle focusing processes of *"information creation, acquisition, organization, storage, distribution, and use"* (Detlor, 2010). According to the same author, the mentioned processes can be explained as follows:

> *"Information creation is the process where individuals and organizations generate and produce new information artifacts and items. Information acquisition is the process where information items are obtained from external sources. Information organization is the process of indexing or classifying information in ways that support easy retrieval at later points in time. Information storage is the process of physically housing information content in structures such as databases or file systems. Information distribution is the process of disseminating, transporting, or sharing information. Information use is the process where individuals and organizations utilize and apply information made available to them." (Detlor, 2010)*

According to the aim of this dissertation and the importance of emphasizing the Social Network paradigm, the "distribution" process will be addressed as "sharing" process, because the concept of sharing identifies the purpose of existent Social Networks. Given these processes, and following the previous mentioned aspect, it is also necessary to establish the bridge between the technological aspects with the social aspects that are significant for the success of a collaborative network. These will be given through examples taken from the studies performed and presented previously.

5.1 The H-KNOW – Collaborative Platform

H-KNOW is an European research project in the area of old building restoration and maintenance, particularly in the cultural heritage domain. The main objective is to support small and medium enterprises (SMEs) operating in the field of construction. In practical terms, this solution offers SMEs possibilities to access specific knowledge through a collaborative online community. In this community, SMEs can share knowledge about restoration and maintenance activities, which induces learning and training of partners and collaboration amongst partners. Among its range of features, it is possible to highlight some that are directly related to the subject of this dissertation such as the creation of collaborative spaces where users can gather the information created or captured during a determined project, the calendar where events can be scheduled, providing information about the subject of the event, day, location starting hour and has the capability of make the event private so that it's only available for users invited to it. The features for information creation and sharing, commenting and perspectives debate make H-KNOW a platform with suitable conditions for collaboration and innovation projects fostering (H-KNOW, 2012).

5.2 Concept

H-KNOW platform allows the creation of profiles that can be identify users or organizations that, within a specific field of expertise, create and expose informational needs and answer to questions posted by other users creating a new knowledge creation dynamic, i.e., collaboration. This collaboration can evolve in proportion leading to new necessities (in terms of resources, human or informational, for example). In order to address such issue, the H-KNOW platform enables the creation of groups in order to accomplish the collaboration aspects previously mentioned. As it is possible to verify in Fig. 37 and Fig. 38, these groups can be categorized in two types, organizational groups and collaborative spaces. Organizational groups are created with the purpose of gather people (other organization's employees), joining, consequently, complementary competences, skills and areas of expertise. Collaborative Spaces (CS), as the name refers, are created within the platform allowing collaboration

between organizations through a set of activities. CS's may be one of four predefined types, Proposal, Project, Business Opportunity and Problem Solving.

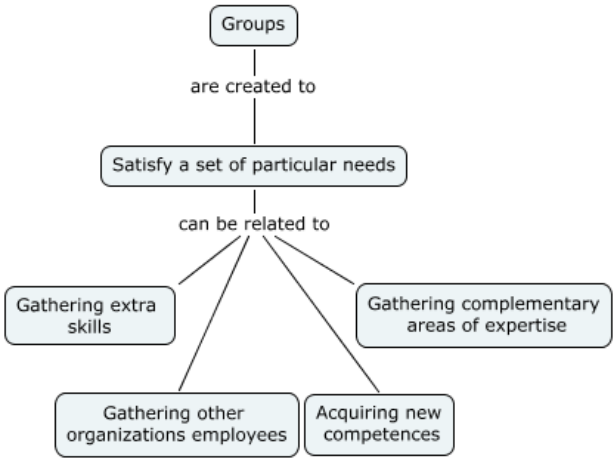


Fig. 37 - Group formation in H-KNOW platform

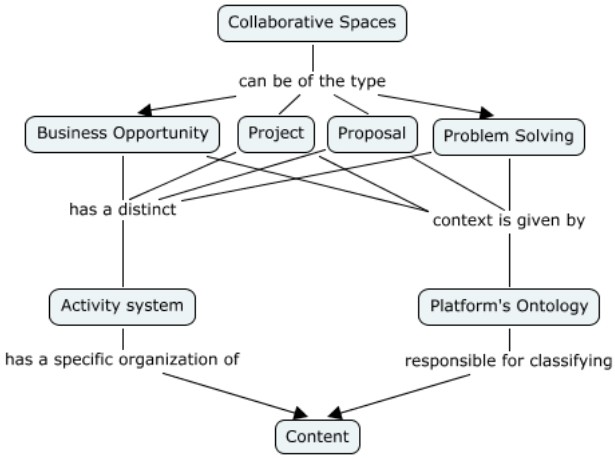


Fig. 38 - Collaborative Space creation in H-KNOW platform

Each type of CS has its own activity system, i.e., a group of activities that must be carried out in order to accomplish the established objective. It is in this activity system that information management has to intervene.

In the platform information is everywhere. The question that is imposed here is, 'How can Information Management support the activity system in the Collaborative Spaces?' well, starting from a narrower scope, it is possible to verify that users have profiles. These profiles contain information about competences, interests, contacts, etc., the created groups have also information about the scope of the group, the scientific and technical area of knowledge and collaborative spaces have their profile as well. In a broader scope, it is visible

that the platform provides tools such as forums, blogs, email, etc., these tools assist in the creation and sharing process of the information.

These groups and CS are created due to a necessity, this necessity is defined by the area in which they're inserted and here is where the support from Information Management begins.

- The first step is the definition of classification schemes that will properly describe the available information. Faceted classification suites better the profiles mentioned before and provide the platform with mechanisms to, in a later stage, search for information in the available areas of the platform. The scientific and technical area of knowledge is given by the ontology created for the platform's purpose.

- The second step is to specify a structure that suits each of the available CS's because each type of CS reflects a specific need to be solved and a specific activity system.

- The third and final step is where Information Management processes converge in order to provide the necessary and existing information to these spaces. Adding to the previous mentioned structure a section named 'Recommended Content'.

Through the 'Recommended Content' section, the system will be able to provide CS users' the information available about their needs by suggesting people or groups with competences or purposes that can be useful and can bring new knowledge to the group; forums, blogs and other collaborative spaces where information and contents about the scientific and technical area (or closely related areas) of the group is debated or researched are suggested as well.

As said previously, H-KNOW platform enables the creation of Collaborative Spaces; these can be one of four types, Proposal, Project, Business Opportunity and Problem Solving. The Collaborative Spaces are classified by the ontology already mentioned. Each type has its own activity system which translates different informational needs and the retrieved information obeys an

organization (1 – more important; 6 – less important) defined by the type of Collaborative Space (Table 3).

Table 3 - Information organization according Collaborative Space

CS type / Content type	Business Opportunity (1)	Project (2)	Proposal (3)	Problem Solving (4)
Forums	6	4	3	1
Pages	1	3	2	3
Blogs	3	5	4	2
Collaborative Spaces	2 (3,1)	6 (2,3)	1 (2,4)	6 (4)
Users	4	2	5	4
Groups	5	1	6	5

The above table displays how contents should be organized, considering the type of CS that is created. If the CS type is Business Opportunity, it is important to find what information exists about the business aim, hence 'Pages, Collaborative Spaces and Blogs' are prioritized. It is relevant to mention that the Collaborative Spaces to search are other Business Opportunity CS's and Proposal CS's so that the created Business Opportunity CS approaches subjects that were not yet approached granting this way innovation. 'Users and Groups' are considered here less relevant because this CS type requires mainly the gathering of information about the subject adjacent to the Business Opportunity.

As for Project type CS, the priorities consist in the gathering of resources and competences. Competences are found through groups or users that marked the subject of the CS as their interest, competences or aim (in case of a group). The gathering of resources, mainly informational resources, is made from a general view of the subject (like in CS) to a particular view (like in Blogs). The CS of interest are of the same type or Proposal type so that complementary information about the subject or technics to use may be assessed although, as the aim of the project is to innovate, other CS's aren't very important toward innovation but are important to collaboration and sharing of knowledge.

Proposal type CS also privilege contents over people. By accessing 'Project' and 'Problem Solving' CS's it is possible to observe how to design the proposal according to the problems at hand. 'Pages, Blogs and Forums' provide information about the subject and 'Users and Groups' provide information about who can be contacted to assist in the proposal definition.

'Problem Solving' CS's are about looking for information about technics and methods to support and innovate actual operation in the subject about what the problem is about. Now a new question emerges 'How will we accomplish that?'

The platform was built in Drupal's Content Management System. This system allows the creation and publishing of content, organizing and sharing, promoting collaboration between entities through the areas that were mentioned previously (Buytaert, 2012). Through the development of modules that allow the integration of RDF (Resource Description Framework) Data Bases it was possible to execute SPARQL queries to the data bases in order to input, edit, search and retrieve information. RDF "*is a language for representing information about resources in the World Wide Web.*" (W3C, 2004) and SPARQL can be defined as a "*query language for RDF. SPARQL can be used to express queries across diverse data sources, whether the data is stored natively as RDF or viewed as RDF via middleware.*" (W3C, 2008)

Using these technologies and resources, it is possible to accomplish the development of a recommendation system to H-KNOW platform, leading to what was proposed previously. The following queries enable the retrieval of content related to the purpose of each type of CS.

```
   SELECT  distinct ?x ?y ?z ?w
from <http://hknow>
WHERE
{
  ?x rdf:type owl:Class.
  ?x rdfs:subClassOf ?y.
  ?x dc:language ?z.
  ?y dc:language ?w.
filter (langMatches(lang(?z), \"en\")).
filter (langMatches(lang(?w), \"pt\"))
  }
```

The previous presented query selects and returns every class and subclass according to the specified language (in this case English or Portuguese). This query was used because, in the platform, it is responsible to show every concept there is. In Annex II – Socio-technical Proposal: concept queries it is possible to find the remaining queries with their respective explanation.

In natural language, the queries can be translated as a single question in which we ask the platform "A Collaborative Space of the type *X* was created under the classification subject *Y*. What do you have classified with the *Y* subject? Give it to me and order the contents by their type".

A feature that will be beneficial is the execution of the queries every time the user enters the platform or collaborative space. This will result in recent and updated contents and, according to this dissertation purpose, will enhance innovation aspects. Other important aspect that must be mentioned is that, the previous queries are responsible to search, retrieve and filter content according to a given classification. The provided results are URI's that show the path to the retrieved content. These URI's are then processed through PHP scripts to result in user friendly collaborative platform with recommended content and users.

5.3 Requirements for Information Management in Collaborative Innovation Networks

As it was possible to observe throughout the dissertation, Collaborative Networks play an important role towards innovation and collaboration between organizations. The numerous types of information and content that are created and shared make necessary the establishment of an information management strategy suited for collaborative environments. Following the reasoning of Detlor (2010) and the previous proposed recommendation system, a Collaborative Platform with Social Network capabilities should be able to define an information strategy that not only establishes a proper information management as well as it supports the innovation cycle (Fig. 39).

Fig. 39 – Supporting relationship between Information and Innovation cycles.

In Annex I - Collaborative Social Network requirement specification for Information Management, is possible to consult a full set of requirements for information management purposes. These requirements were established following the information lifecycle and its processes (following the reasoning of Detlor (2010)) and were also based in the requirements defined by Pereira and Soares (2007) in their study "*Improving the quality of collaboration requirements for information management through social networks analysis*". The approach to CMS systems according to their capabilities towards information management and the specific needs of each process of the IM cycle was considered to be a good basis to begin the requirements specification. A section containing Social Network requirements was also added in order to provide and cover social aspects that leverage collaboration and communication features between platform users.

The first approached process is the creation and/or capture process. In this process, collaboration and classification concerns are the main priorities. This fact has its goal set in later search, organization and retrieval processes that are based in the existing classification schemes.

The organization process is also linked to the previous mentioned processes. Depending on the type of platform space the user's in, the suited classification scheme will be responsible for the retrieval of relevant results.

The classification process mentions the several types of classification schemes and how these should be interlinked in order to enhance search and retrieval aspects as said earlier.

As for presentation, in order to enhance collaboration, it was useful for the users to have real-time viewing and editing capabilities. Not only would improve collaboration as it would also make more agile the knowledge sharing process.

Search and retrieval processes, as said before, are deeply connected to the creation and organization processes due to the categories or classes in which documents or content are classified and how their search and retrieval can be performed.

The following processes of storage, share and use contemplate basic requirements that are common to standard social networks or CMS systems.

The final, and added, section refers to Social Network Features. This section mentions the type of features that are verified in Social Networks and should migrate to CMS systems in order to leverage contact between users, improve collaboration and enhance innovation factors by, as mentioned before, making the knowledge exchange process more agile.

CONCLUSIONS AND FUTURE STUDY

Achieved this part of the dissertation it is possible to say that the established goals were accomplished. Through the study of the two collaborative platforms a distinct and unique view over collaboration and information management needs was assessed providing insights towards issues that, if not resolved, can become constraints to collaboration between organizations. The definition of a concept to support collaboration between organizations was also achieved under the shape of a recommendation system. It is hope that this system can provide useful and meaningful contents to organizations leveraging collaboration, knowledge exchange and consequently innovation. This concept was translated in a set of requirements that define how a collaborative platform should manage the information that is created and shared between its users.

As for the initially formulated hypothesis, it was verified, regarding hypothesis 1 that through the UPTEC study that Knowledge Management Systems usage in a collaborative platform can enhance collaboration between enterprises due to the availableness and organization of the required information according to users' interests, leading them to search and retrieve information about enterprises that work in complementary areas so that new projects can be developed under a collaborative environment. Hypothesis 2 was verified according to the results of the Social Network analysis in the *Collaborative Platform Z* where it was possible to detect who detained higher values of centrality occupying a privileged position "bridging" the relationships of other users and accessing the exchanged information. So it is possible to conclude that, users' position in the network affects how information flows and is managed. The last hypothesis was verified by the UPTEC study. The performed interviews allowed the assessment of issues regarding organization and classification of information causing barriers to collaboration and information exchange. These issues could be solved if a suited information management strategy was studied and implemented. By providing useful information in the right places at the right time, enterprises could benefit from efficiency and effectiveness gains regarding information management aspects. In terms of collaboration and innovation, it would enable organizations to find information about other organizations faster. Enabling the communication and creation of partnerships to develop a certain product or service or even, in a

collaboration situation, to create contents collaboratively while exchanging knowledge and know-how. According to these aspects it is possible to affirm that IM activities represent a significant part of collaboration and innovation activities.

This dissertation allowed the assessment of an alternative way to look at information. Through the study of social networks it was possible to see that society is walking towards a different way to create and disseminate information. People depend strongly on social networks and trust in them as a reliable and updatable source of information. These networks moved the world to a new era where boundaries between people, organizations, cultures and traditions are mixed with others. A constant flow of information and the fast pace with which it is produced leads to the need of implementing strong measures to manage it in order to capitalize its use.

It is possible to affirm that social aspects play also an important role in this type of platform. It can be said that if technological aspects are the mean to produce and share information; social aspects are definitively the root of new knowledge creation and are responsible for its conversion in information and posterior recombination leading to the cycle of innovation that was previously shown. The performed case studies allowed a comprehension and consolidation of what was searched, retrieved and analyzed in the literature review. It is a curious fact to find things that were wrote decades ago yet still applies and fits so well in nowadays context, being the main difference the technological advances and the IT tools that we have in our favor. The symbiotic relationships between technology and social aspects were assessed to be of added value to the organizations. However, as seen in *Collaborative Platform Z*, there must exist a balancing between technological and social features in order to create a suitable place to create, use, share and update knowledge and information.

In terms of Information Management it's still possible to verify that people and consequently organizations, do not possess a clear picture, or awareness of what it is information management, what activities are included in it and mainly what benefits can be collected from it. As assessed through the performed case studies, some IM activities are performed in an unconscious level due to their integration in work routines.

For future studies, I believe that it is necessary to research other contexts. By applying the same methodology, collecting data, processing and analyzing the results will allow the creation of a clearer picture about collaboration and innovation networks in the organizational world. These researches must always have as a complementary objective, the propagation of the Information Management processes so that in a medium term period (like five years), a comparison can be made and an evolution analysis of, not only collaboration and innovation but also, information management awareness and practice may be realized.

The existence of a wide range of technics to study social networks and different assumptions about what to consider information management, it would be interesting to perform several researches using different methodologies so that, in a posterior stage, they could be analyzed in order to assess the main similarities and differences of the used methodologies presenting an explanation for such aspects. From this analysis a new or hybrid methodology for study information management in social networks could emerge.

To finalize this dissertation, I believe that it is correct to say that the main objective was achieved. The analysis of the *Collaborative Platform Z* and the case study realized in UPTEC allowed the specification of the requirements that should be applied to manage information in Collaborative Social Networks. A relevant aspect that all people should be aware about is that society is like a living organism and it shifts directions without noticing anyone, so the job for us, Information Scientists, should be to perceive and anticipate such changes through the analysis of available information technologies, trends and behaviors.

Bibliographic References

1. Allen, James, Andrew D. James, e Phil Gamlen. «Formal Versus Informal Knowledge Networks in R&D: a Case Study Using Social Network Analysis». *R&D Management* 37, n 3 (2007): 179–196.

2. Andrea, Passarella. «A survey on content-centric technologies for the current Internet: CDN and P2P solutions». *Computer Communications* 35, n 1 (January 1, 2012): 1–32.

3. Anderson, James G. «Evaluation in health informatics: social network analysis». *Computers in biology and medicine* 32, n 3 (May 2002): 179-193.

4. Andreeva, Tatiana, and Aino Kianto. «Knowledge processes, knowledge-intensity and innovation: a moderated mediation analysis». *Journal of Knowledge Management* 15, n 6 (October 25, 2011): 1016–1034.

5. Avram, Gabriela. «At the Crossroads of Knowledge Management and Social Software», n. d. http://www.ejkm.com/volume4/issue1/p1.

6. Bhandar, Mamata. «A Framework for Knowledge Integration and Social Capital in Collaborative Projects», (January, 2006). http://www.ejkm.com/volume8/issue3/p267.

7. Bischoff, Kerstin, Claudiu S. Firan, Wolfgang Nejdl and Raluca Paiu. «Bridging the gap between tagging and querying vocabularies: Analyses and applications for enhancing multimedia IR». *Web Semantics: Science, Services and Agents on the World Wide Web* 8, n 2–3 (July 2010): 97–109.

8. Bojars, Uldis and John G. Breslin. SIOC Core Ontology Specification. 2010. http://rdfs.org/sioc/spec/

9. Brickley, Dan and Libby Miller. FOAF vocabulary specification. 2010. http://xmlns.com/foaf/spec/.

10. Buytaert, Dries. «About Drupal | drupal.org». *About Drupal*, 2012. Available at: http://drupal.org/about. (Last accessed, 1st July 2012)

11. Cantador, Iván, Ioannis Konstas and Joemon M. Jose. «Categorising social tags to improve folksonomy-based recommendations». *Web Semantics: Science, Services and Agents on the World Wide Web* 9, n 1 (March 2011): 1–15.

12. Carneiro, Luís Carlos Pacheco Soares. «Semantic integration of social and domain knowledge in a collaborative network platform». *Engineering Faculty of Oporto University*. (June 2010).

13. Chai, Sangmi and Minkyun Kim. «A socio-technical approach to knowledge contribution behavior: An empirical investigation of social networking sites users». *International Journal of Information Management* (September 2011).

14. Click, Amanda and Joan Petit. «Social networking and Web 2.0 in information literacy». *The International Information & Library Review* 42, n 2 (June 2010): 137–142.

15. Denton, William. «Denton – How to Make a Faceted Classification and Put It On the Web 1 How to Make a Faceted Classification and Put It On the Web» (2003). http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.118.1787.

16. Detlor, Brian. «Information management». *International Journal of Information Management* 30, n 2 (April 2010): 103-108.

17. Farshchi, Mahtab Akhavan and Mark Brown. «Social networks and knowledge creation in the built environment: a case study». *Structural Survey* 29, n 3 (July 12, 2011): 221–243.

18. H-KNOW Consortium. *H-KNOW | It's never too much for H-KNOW*. (2012) Available at http://platform.h-know.eu/. (Last accessed 24th June 2012)

19. Haythornthwaite, C. «Social network analysis: An approach and technique for the study of information exchange». *Library & Information Science Research* 18 (1996): 323–342.

20. Hansen, Preben, e Kalervo Järvelin. «Collaborative Information Retrieval in an information-intensive domain». *Information Processing & Management* 41, n 5 (September 2005): 1101-1119.

21. Hew, Khe Foon and Noriko Hara. «Knowledge Sharing in Online Environments: A Qualitative Case Study». *Journal of the American Society for Information Science and Technology* 58, n 14 (December 1, 2007): 2310–2324.

22. Janhonen, Minna and Jan-Erik Johanson. «Role of knowledge conversion and social networks in team performance». *International Journal of Information Management* 31 (June 2011): 217–225.

23. Jin, Xiao-Ling, Christy M.K. Cheung, Matthew K.O. Lee, e Hua-Ping Chen. «How to keep members using the information in a computer-supported social network». *Computers in Human Behavior* 25, n 5 (September 2009): 1172-1181.

24. Kakali, Constantia and Christos Papatheodorou. «Exploitation of folksonomies in subject analysis». *Library & Information Science Research* 32, n 3 (July 2010): 192–202.

25. Kim, Heung-Nam, Abdulmajeed Alkhaldi, Abdulmotaleb El Saddik and Geun-Sik Jo. «Collaborative user modeling with user-generated tags for social recommender systems». *Expert Systems with Applications* 38, n 7 (July 2011): 8488–8496.

26. Kiu, Ching-Chieh and Eric Tsui. «TaxoFolk: A hybrid taxonomy–folksonomy structure for knowledge classification and navigation». *Expert Systems with Applications* 38, n 5 (May 2011): 6049–6058.

27. Mariotti, Francesca. «Knowledge mediation and overlapping in interfirm networks». *Journal of Knowledge Management* 15, n 6 (October 25, 2011): 875–889.

28. Mishra, Bijaya and A. Uday Bhaskar. «Knowledge management process in two learning organisations». *Journal of Knowledge Management* 15, n 2 (April 5, 2011): 344–359.

29. P., Jason Morrison. «Tagging and searching: Search retrieval effectiveness of folksonomies on the World Wide Web». *Information Processing & Management* 44, n 4 (July 2008): 1562–1579.

30. Palau, Jordi, Miquel Montaner, Beatriz López, e Josep de la Rosa. «Collaboration Analysis in Recommender Systems Using Social Networks». Em *Cooperative Information Agents VIII*, editado por Matthias Klusch, Sascha Ossowski, Vipul Kashyap, e Rainer Unland, 3191:137-151. Lecture Notes in Computer Science. Springer Berlin / Heidelberg, 2004. http://www.springerlink.com/content/gj8hfv7bq2p6gxd0/abstract/.

31. Pereira, Carla Sofia, e António Lucas Soares. «Improving the quality of collaboration requirements for information management through social networks analysis». International Journal of Information Management 27, n 2 (Abril 2007): 86-103.

32. Rangachari, Pavani. «Knowledge sharing networks in professional complex systems». *Journal of Knowledge Management* 13, n 3 (May 29, 2009): 132–145.

33. Rycroft, Robert W., and Don E. Kash. «Self-organizing innovation networks: implications for globalization». *Technovation* 24 (March 2004): 187–197.

34. Santos, Vítor Ricardo, António Lucas Soares, e João Álvaro Carvalho. «Information Management Barriers in Complex Research and Development Projects: An Exploratory Study on the Perceptions of Project Managers». *Knowledge and Process Management* 19, n 2 (2012): 69–78. [a]

35. Santos, Vítor Ricardo, António Lucas Soares, e João Álvaro Carvalho. «Knowledge Sharing Barriers in Complex Research and Development Projects: An Exploratory Study on the Perceptions of Project Managers». *Knowledge and Process Management* 19, n 1 (2012): 27–38. [b]

36. Scott, John. Social network analysis: a handbook. London: Sage; 1991.

37. Smith, J. Gretchen, and Lumba, Patricia Mweene. «Knowledge Management Practices and Challenges in International Networked NGOs: The Case of One World International», (2008) http://www.ejkm.com/volume6/issue2/p93.

38. Shapira, Bracha, and Boaz Zabar. «Personalized Search: Integrating Collaboration and Social Networks». *Journal of the American Society for Information Science and Technology* 62, n 1 (January 1, 2011): 146–160.

39. «Social networking and the workplace: Making the most of web 2.0 technologies». *Strategic Direction* 25, n 8 (June 19, 2009): 20–23.

40. Steichen, Ben, Helen Ashman, e Vincent Wade. «A comparative survey of Personalised Information Retrieval and Adaptive Hypermedia techniques». *Information Processing & Management* 48, n 4 (July 2012): 698-724.

41. Su, Chunke and Noshir Contractor. «A Multidimensional Network Approach to Studying Team Members' Information Seeking from Human and Digital Knowledge Sources in Consulting Firms». *Journal of the American Society for Information Science and Technology* 62, n 7 (July 1, 2011): 1257–1275.

42. Sykes, Tracy Ann, Viswanath Venkatesh, e Sanjay Gosain. «Model of acceptance with peer support: a social network perspective to understand employees' system use». *MIS Q.* 33, n 2 (June 2009): 371–394.

43. Taatila, Vesa P., Jyrki Suomala, Reijo Siltala and Soili Keskinen. «Framework to study the social innovation networks». *European Journal of Innovation Management* 9, n 3 (July 1, 2006): 312–326.

44. Thorgren, Sara, Joakim Wincent and Daniel Örtqvist. «Designing interorganizational networks for innovation: An empirical examination of network configuration, formation and governance». *Journal of Engineering and Technology Management* 26 (September 2009): 148–166.

45. Tomaél, Maria Inês, Adriana Rosecler Alcará and Ivone Guerreiro Di Chiara. «Das redes sociais à inovação». *Ciência da Informação* 34 (August 2005).

46. Tsui, Eric, W.M. Wang, C.F. Cheung and Adela S.M. Lau. «A concept–relationship acquisition and inference approach for hierarchical taxonomy construction from tags». *Information Processing & Management* 46, n 1 (January 2010): 44–57.

47. W3C, RDF primer, in: F. Manola, E. Miller (Eds.), W3C Recommendation, 10 February 2004. Available at: http://www.w3.org/TR/rdf-primer/. (Last accessed, 2nd July 2012)

48. W3C, SPARQL query language for RDF, in: E. Prud'hommeaux, A. Seaborne (Eds.), W3C Recommendation, 15 January 2008. Available at: http://www.w3.org/TR/2008/REC-rdf-sparql-query-20080115/. (Last accessed, 2nd July 2012)

49. Ward, John and Pat Griffiths. Strategic Planning for information Systems. Chichester : John Wiley, cop. 1996. 2nd ed.

50. Widén-Wulff, Gunilla, and Mariam Ginman. «Explaining knowledge sharing in organizations through the dimensions of social capital». *Journal of Information Science* 30, n 5 (October 1, 2004): 448 –458.

51. Wilkesmann, Maximiliane, and Uwe Wilkesmann. «Knowledge transfer as interaction between experts and novices supported by technology». *VINE* 41, n 2 (May 17, 2011): 96–112.

52. Wilson, T.D. «The nonsense of "knowledge management"», n. d. http://informationr.net/ir/8-1/paper144.html.

53. Yelmo, Juan C., José M. del Álamo, Rubén Trapero and Yod-Samuel Martín. «A user-centric approach to service creation and delivery over next

generation networks». *Computer Communications* 34, n 2 (February 15, 2011): 209–222.

54. Zyl, Anria Sophia van. «The impact of Social Networking 2.0 on organisations». *Electronic Library, The* 27, n 6 (November 13, 2009): 906–918.

Annexes

Annex I - Collaborative Social Network requirement specification for Information Management

Table 4 - Collaborative Social Network requirements for Information Management

IM process	Requirement	Related requirements
Creation	R1. The system should allow the creation of collaboration areas. These areas will serve as repositories to all the created and exchanged information/documents/content between the working groups.	R26
	R1.1. The system should allow the creation of collaborative spaces.	R8 R9
	R1.2. The system should allow the creation of work groups.	
	R1.3. The system should allow the creation of blogs.	
	R1.4. The system should allow the creation of forums.	
	R1.5. In the moment of creation a set of permissions must be attributed in order to define who will be responsible and able to edit, remove, alter, approve and review created and captured documents/content.	
	R2. The system should allow the creation of entities.	
	R2.1. The system should allow the creation of the user profile.	
	R3. The system should provide tools to create content.	
	R3.1. The system should provide text processing tools.	
	R3.2. The system should provide tools to create spreadsheets.	
	R3.3. The system should provide tools to create presentations.	
	R3.4. The system should provide tools to create project planning documents.	
	R3.5. The system should provide tools to create multimedia content.	

	R4. The system should allow the collaborative creation of documents and content.	R3.1 R3.2 R3.3 R3.4 R3.5
Capture	R5.The system should provide features to capture documents/content from external sources.	
	R5.1.The system should allow the attachment and/or storage of the captured documents/content to email messages.	
	R5.2. The system should allow the attachment and/or storage of the captured documents/content in forums.	
	R5.3. The system should allow the attachment and/or storage of the captured documents/content in blog entries.	
	R5.4. In case of the captured document/content possesses text elements, the system should have OCR software in order to allow posterior text selection and use in other documents/content creation.	
Organization	R6. The system must display its areas, tools and capabilities in a consistent and homogenous way.	
	R6.1. The system must provide users with a global navigation system in order to allow faster transitions between areas enabling, however, the option to locate and go to previous visited areas.	
	R6.2. The system must provide a local navigation system in order to allow users to verify what's in each platform area and what tasks they may execute.	
	R6.3. System's areas must be identified by homogenous labels in order to avoid confusion or mislead users.	

	R7. Retrieved documents/content should be organized according to the type of Collaborative Space.	R8.1 R8.2 R8.3 R8.4 R9.2 R9.3
Classification	R8. The system must provide users with classification schemes.	
	R8.1. The system should classify its documents/content and users/groups through domain based ontology.	
	R8.2. The system may classify its documents/content and users/groups through a taxonomy.	
	R8.3. The system may classify its documents/content and users/groups through a faceted classification.	
	R8.4. The system should classify its users through a folksonomy stating interests, skills, organization and other elements that allow the users' identification.	
	R9. The system must impose its users the prompt classification of the created or captured documents/content.	
	R9.1. The system should allow the attribution of tags to documents and content.	
	R9.2. The system's classification system must be able to classify users, entities, groups, collaborative spaces, blogs, forums, documents and content.	
	R9.3. The system should typify Collaborative Spaces according to their purpose.	
	R10. The system should enable the existence of multiple classification schemes, establishing connections between them.	
Presentation	R11. The system should provide means to enable the presentation, on the platform, of the existing documents/content.	
	R11.1. While presenting the documents, the system should allow users to edit them, highlighting the changes that were made.	

	R12. The system must allow users to visit other users' profile.	
	R13. The collaborative spaces, forums and blogs may be organized according to their scope, permissions, name, and other elements that may help identify them.	
	R14. The users and entities may be identified by their username, interests, skills, areas of knowledge, location and other elements that may help identify them.	
Search and Retrieval	R15. The system must provide its users searching features.	
	R15.1. The system should ensure that whenever a document/content is created/captured and stored in the system, a set of metadata is associated to it.	
	R15.2. The search system must be available in every area of the platform.	
	R15.3. The system must provide basic search capabilities through a given set of keywords or query.	
	R15.4. The system must provide advanced search capabilities according to the classification schemes it owns, allowing the combination of several aspects.	R10
	R16. The system should allow the search for users.	R11
	R16.1. It should be possible to search users according to name, projects in which they participle or participated, interests, role in the organization, skills and performed activities.	
	R17. The system must provide browsing features.	
	R17.1. The system must provide browsing capabilities in all platforms' areas.	
	R18. The browsing system may be organized according to the classification schemes present in the platform.	
	R19. The browsing system should be supported by a tree scheme in order to provide users with a specific location and also to enable the fast transition and browsing of other areas.	
	R20. The retrieved results provided by search	

Search and Retrieval	should display information about title, author and location in the platform.	
	R21. The search engine should be able to recommend related results to aid in the search process	
	R22. The browsing areas may be organized alphabetically; however an option to customize de browsing parameters may be available.	
	R23. The retrieved results by search and the results provided by search may be filtered according to users' needs.	
	R23.1. The system must provide a set of aspects that allow an effective filtering process	
	R24. The system should allow users to search for other users or entities through simple or advanced search.	R14
	R24.1. Users and entities should be searchable through name, institution, skills, interests and other elements that may be relevant to search purposes.	
	R25. The system should allow the search for users and entities through the browsing system.	R13 R14 R15
	R25.1. The browsing system should be organized by categories according to users' interests and needs.	
Storage	R26. The created/captured documents/content should be stored in a specific space related to where they were created or captured.	
	R26.1. The system should establish the connection between user and created/captured document/content by enabling its access from the users' personal area.	
	R27. The system must create a private area in the user profile so that exchanged emails, IM and created, updated or shared documents/content logs may be stored.	
Share	R28. The system should provide features for sharing documents/content.	
	R28.1. The system should allow the sharing of documents/content in collaborative spaces.	
	R28.2. The system should allow the sharing of documents/content in users' blogs.	

	R28.3. The system should allow the sharing of documents/content in forums.	
	R28.4. The system should allow the sharing of documents/content through email.	
	R29. The system should allow the sharing of users' and entities' contacts.	
	R29.1. The system should provide tools to manage the shared contacts	
Use	R30. The system should provide access to information.	
	R30.1. The system should enable access to any information available in the platform according to users' profile and permissions.	
	R30.2. The system should allow the update of documents/content in collaborative activities	R4 R6 R31 R32
Social Network Features	R31. The system must have and provide social network features to its users.	
	R31.1. The system should provide blogging tools to its users.	
	R31.2. The system should provide forums tools to its users.	
	R31.3. The system should provide its users with a calendar in order to schedule events.	
	R32. The system should facilitate synchronous and asynchronous communications between users and entities.	
	R32.1. The system must provide its users with Instant Messaging tools.	
	R32.2. The system should allow the creation of mailing lists and project oriented forums to ensure communication between working groups and allow the storage of all exchanged information between working groups.	R24
	R33. The system should have a notification system.	
	R33.1. Users should be notified when other users try to contact him.	
	R33.2. Users should be notified when the	

Social Network Features	documents/content created by him/her are viewed/updated/downloaded/shared.	
	R33.3. Users should be notified when they are invited to a group or summoned to a meeting or collaborative space.	
	R34. The notifications shall be presented in the global notification system.	
	R34.1. The notifications may be organized according to the type of notification	R28.1 R28.2 R28.3
	R35. The system should provide collaborative creation of documents/content.	R4
	R35.1. Collaborative creation should be supported by communication and sharing tools.	R28.1 R28.2 R28.4

Annex II – Socio-technical Proposal: concept queries

```
     SELECT  distinct  ?y ?z
from <http://hknow>
   WHERE
   {
    ?x rdf:type owl:Class.
    ?x dc:language ?z.
    ?x dc:source ?y.


    FILTER regex(str(?z), numId).
    filter (langMatches(lang(?y), "en")).
          }
```

The second query is responsible for returning to the user the available content that is classified with a given value. The content is then filtered by language and by its ID number.

```
     var type "blog,colspace, forum"

SELECT  distinct  ?y ?z
from <http://hknow>
   WHERE
   {
    ?x rdf:type owl:Class.
    ?x dc:language ?z.
    ?x dc:source ?y.
    ?x sioc:topic type.
    ?w dc:date ?x.

    FILTER regex(str(?y), numId).
    filter (langMatches(lang(?z), "en")).
          }
order by dc:date DESC;
```

The third and last query is responsible for organizing the retrieved contents by their type (`?x sioc:topic type.`) which can be blog, collaborative space or forum and other areas. It is important to mention that this query requires a previous work in order to function. The `var type "blog,colspace, forum"` must be declared first.