Universidade de Aveiro Departamento de Economia, Gestão, Engenharia Industrial e Turismo

Ano 2019

MARCELLO FERNANDES CHEDID

RELAÇÃO DE COLABORAÇÃO ENTRE UNIVERSIDADE E INDÚSTRIA DE SOFTWARE COM BASE NA GESTÃO DO CONHECIMENTO: UMA ABORDAGEM EXPLORATÓRIA

COLLABORATION RELATIONSHIP BETWEEN UNIVERSITY AND SOFTWARE INDUSTRY BASED ON KNOWLEDGE MANAGEMENT: AN EXPLORATORY APPROACH

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Tese apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Doutor em Engenharia e Gestão Industrial, realizada sob a orientação científica da Doutora Leonor da Conceição Teixeira, Professora Auxiliar do Departamento de Economia, Gestão, Engenharia Industrial e Turismo da Universidade de Aveiro.

Thesis submitted to the University of Aveiro for fulfillment of the necessary requirements leading to the Doctoral degree in Industrial Engineering and Management, carried out under the scientific supervision of Doctor Leonor da Conceição Teixeira, Assistant Professor of the Department of Economics, Management, Industrial Engineering and Tourism of the University of Aveiro.

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palavras-chave Relação de colaboração, Universidade, Indústria de software, Gestão do conhecimento, Partilha de conhecimento.

resumo

O atual ambiente que carateriza a indústria de software é extremamente dinâmico e, de certa forma complexo, exigindo soluções de alto desempenho, de desenvolvimento rápido e eficientes em termos de custos. A relação de colaboração com as universidades pode representar um recurso fundamental, na medida em que juntas mais facilmente podem promover o desenvolvimento tecnológico que está na base de soluções de inovação. Adicionalmente, são os vários estudos que apontam a partilha de conhecimento como um fator importante e fortemente influenciador de uma relação de colaboração.

Neste contexto, a presente tese tem como objetivo identificar um conjunto de fatores que possam potencializar e/ou facilitar a relação de colaboração entre a universidade e a indústria de software de forma sustentável, com base na gestão do conhecimento. Em consonância com o objetivo geral, foram definidas três questões de investigação: (i) Quais são as principais motivações que levam à decisão de estabelecer uma relação de colaboração?; (ii) Quais são os mecanismos de gerenciamento usados na governança das relações de colaboração?; (iii) Quais são os princípios e a cultura da gestão do conhecimento e da partilha de conhecimento nessas organizações?

Por forma a responder àquelas questões e, consequentemente, ao objetivo geral, numa fase inicial foi conduzido um estudo quantitativo através da aplicação de um questionário cujo objetivo foi o de explorar e compreender a prática da partilha de conhecimento e de colaboração no contexto de uma universidade. De uma maneira geral, concluiu-se que a partilha de conhecimento afeta positivamente o comportamento de colaboração. Os resultados obtidos mostram ainda que, por forma a promover e incentivar a partilha de conhecimento e, consequentemente, fomentar as relações de colaboração, é importante trabalhar os mecanismos baseados na motivação intrínseca e no *networking*.

Seguidamente, foi conduzido um estudo qualitativo com base em entrevistas, com o objetivo de identificar um conjunto de fatores que pudessem melhorar e/ou facilitar a relação de colaboração entre a universidade e a indústria de software de forma sustentável, com base na gestão do conhecimento. Foram entrevistados participantes com visões complementares e experiências diferentes nos dois tipos de indústria envolvidas e, simultaneamente, que ocupassem posições com poder de decisão. Os resultados revelaram que as relações de colaboração estabelecidas entre essas organizações são configuradas apenas como uma ‘conexão’. Esta ‘conexão’ é caracterizada por ser uma troca simples, sem construir uma relação de colaboração sustentável; embora os envolvidos apontem vantagens na existência de uma relação de colaboração sustentável. Os resultados revelaram ainda que as relações de colaboração são, normalmente, conduzidas através de canais informais de comunicação, o que dificulta a captura e disseminação do conhecimento pelos restantes membros de cada uma das organizações envolvidas.

Em jeito de conclusão e em termos práticos este trabalho contribui com a identificação e análise de um conjunto de fatores potenciadores de uma relação de colaboração entre a universidade e a indústria de software, podendo auxiliar as organizações envolvidas na definição de estratégias para o desenvolvimento de ações futuras, a fim de promover uma relação de colaboração sustentável. Em termos teóricos, este trabalho contribui para o aumento do corpo de conhecimento na área, com resultados provenientes de estudos empíricos, uma vez que a literatura aponta como principal lacuna a ausência daqueles (estudos empíricos), por forma a complementar e validar a teoria existente.

keywords

Collaboration relationship; University; Software industry; Knowledge management; Knowledge sharing.

abstract

The current environment that characterizes the software industry is extremely dynamic and somewhat complex demanding high-performance solutions, rapid development and cost efficiency. The collaboration relationship with universities has been represented a key resource, to the extent that together more easily can promote technological development that underpins innovation solutions. In addition, several studies point out knowledge sharing as an important and strongly influential factor in a collaboration relationship.

In this context, the present thesis aims to identify a set of factors that can enhance and/or facilitate the collaboration relationship between the university and the software industry in a sustainable way, based on knowledge management. In line with the general objective three research questions were defined: (i) What are the main motivations that lead to the decision of establishing a collaboration relationship?; (ii) What are the management mechanisms used in the governance of collaboration relationships?; (iii) What are the principles and culture of knowledge management and of knowledge sharing in these organizations?

In order to answer those questions and, consequently, achieve the general objective, an initial quantitative study based on a questionnaire was conducted. This study aims to explore and understand the practice of knowledge sharing and collaboration in the context of a university. Overall it was concluded that, knowledge sharing positively affects the collaboration behavior. The obtained results also showed that in order to promote and encourage knowledge sharing and, consequently, to foster collaboration relationships, it is important to work mechanisms based on intrinsic motivation and networking.

Subsequently, it was conducted a qualitative study based on interviews in order to identify a set of factors that could enhance/facilitate the collaboration relationship between the university and the software industry in a sustainable way, based on knowledge management. Participants with complementary visions and different experiences in the two types of involved industries and simultaneously, with decision-making positions were interviewed. The results revealed that collaboration relationships established among these organizations are set-up only as a ‘connection’. This ‘connection’ is characterized by being a simple exchange, without building a sustainable collaboration relationship; although, those involved point to advantages in the existence of a sustainable collaboration relationship. The results also revealed that the collaboration relationships are usually conducted through informal communication channels, which makes it difficult to capture and disseminate knowledge to other remaining members of each involved organizations.

In nutshell and in practical terms, this work contributes to the identification and analysis of a set of factors that enhance a collaboration relationship between university and software industry. This result can support organizations in the strategies definition for the development of actions, in order to promote a sustainable collaboration relationship. In theoretical terms, this work contributes to the increase of the body of knowledge in the area, with empirical results, since the literature point the lack of empirical studies as the main gap in this area of knowledge.

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List of abbreviations

A3ES	Agency for Assessment and Accreditation of Higher Education, acronym in Portuguese
ATKS	Attitude Toward Knowledge Sharing
AVE	Average Variance Extracted
CAE	Classification of Economic Activities, acronym in Portuguese
CEO	Chief Executive Officer
CR	Composite Reliability
DGEEC	Directorate-General for Statistics of Education and Science, acronym in Portuguese
DGES	Directorate-General for Higher Education, acronym in Portuguese
DSR	Design Science Research
EK	Explicit Knowledge
EM	Extrinsic Motivation
EU	European Union
EUROSTAT	European Statistical Office
FMEA	Failure Mode and Effect Analysis
HEI	Higher Education Institution
HTMT	Heterotrait-Monotrait Ratio
ICT	Information and Communication Technology
IM	Intrinsic Motivation
INE	Statistics Portugal, acronym in Portuguese
IS	Information Systems
KI	Knowledge Intensive
KM	Knowledge Management
OECD	Organisation for Economic Co-operation and Development
PLS-SEM	Partial Least Square-Structural Equation Modelling
R&D	Research and Development
RU	Research Unit
SDO	Software Development Organization
SI	Software Industry
SME	Small and Medium Enterprise
SN	Social Networks
TK	Tacit Knowledge
TRA	Theory of Reasoned Action
UA	University of Aveiro
UIC	University-industry Collaboration
USIC	University-software industry collaboration
VIF	Variance Inflation Factor

Chapter I - General Introduction

I.1 Introduction and motivation

I.2 State of the art and related work

I.3 Objectives and research methodology

I.4 Thesis structure

I.1 Introduction and motivation

The software industry plays a fundamental role in today's modern society, because its products can be found in every field and in diverse sectors (Aurum, Daneshgar, & Ward, 2008). This fact contributes to the current extremely dynamic and somewhat complex environment that characterizes this type of industry (Huzita et al., 2012). This leads companies in the field to suffer the pressure for high performance solutions, rapid development and cost-efficient processes (Du Chatenier, Verstegen, Biemans, Mulder, & Omta, 2009; Dubé & Robey, 1999; Mead, Seshagiri, & Howar, 2016; Vasconcelos, Kimble, Carreteiro, & Rocha, 2017). On the other hand, considering the evolution and influence of the new organizational formats of software development, this type of industry seems to need a greater degree of maturity when it comes to software development processes and at a management level (Aurum et al., 2008; Colomo-Palacios, Casado-Lumbreras, Soto-Acosta, García-Peñalvo, & Tovar, 2014).

The software industry is characterized as being a "high technology, knowledge intensive, highly mutable industry – with weak entry-barriers and short innovation cycles – which demands continuous adaption, learning and access to knowledge" (Salavisa, Videira, & Santos, 2009, p. 1). However, most of the existing companies in this sector are small and medium-sized, operating in a resource scarce scenario, with limited access to finance, specialized personnel and knowledge networks; who are facing competition from large national and international companies (Lippoldt & Stryszowski, 2009; Richardson & Von Wangenheim, 2007; Savolainen & Ahonen, 2015). Many of these companies have been created in the last decades as start-ups or spin-offs from universities, and a significant portion of these still maintains this link (Bjerregaard, 2010; Salavisa et al., 2009; Segelod & Jordan, 2004). This industry is growing rapidly and the needed technologies and tools change frequently which makes the knowledge of these organizations more dynamic, requiring a high number of specialists having to update their skills and knowledge (Aurum et al., 2008; Bjørnson & Dingsøyr, 2008; Johanyak, 2016). In this sense, the collaboration relationship between university and software industry has increasingly assumed an important role in the development and technological innovation (Frølund, Murray, & Riedel, 2018). This happens through knowledge sharing, which represents a fundamental resource in the achievement of innovative solutions for both parties (Ankrah & AL-Tabbaa, 2015; Melese, Lin, Chang, & Cohen, 2009). According to Levy et al. (2009, p. 4), university-industry collaboration relationships "are especially relevant in the case of microelectronic, software and biotechnology, by contrast to the more mature industry of production technology". In fact, the literature points out several strong advantages for this type of collaboration, including a positive impact on the competitiveness and productivity of the related organizations and, consequently, the surrounding society (Boyarchuk, Kharchenko, & Sklyar, 2018; Cohen, Nelson, & Walsh, 2002; Freitas, Geuna, & Rossi, 2013). From the industry's point of view, its relationship with the university provides access to knowledge that provides solutions to particular problems. From the university's point of view, the relationship in addition to contributing to a better

training of its students and offering employment opportunities provides access to the practical knowledge needed to validate basic research and to pursue applied research (Boyarchuk et al., 2018; Freitas et al., 2013).

Organizations belonging to the software industry, as well as higher education institutions designated in this work as universities are recognized as organizations based on intensive knowledge. Given the knowledge intensive nature of the two types of organizations, the collaboration strategy requires the integration of specialized knowledge dispersed between each of the members of the work teams, usually multidisciplinary. The highly specialized knowledge, both tacit and explicit, is created and shared in the different phases of the relationship (Boyarchuk et al., 2018; Salavisa et al., 2009). However, tacit knowledge becomes more important to the relations between these types of organizations (S. Ryan & O'Connor, 2013). Edmondson et al. (2012) add that the true value of a collaboration relationship is often associated with the tacit knowledge that is shared. This implies that possible solutions that aim at the sustainability and success of the relationship should be examined through knowledge management (Gill, 2002; Philbin, 2008).

In general, studies about this topic seek to identify and analyze motivational factors, barriers and results achieved in the relationship. However, despite their importance, the collaboration relationship between these two types of organizations is not always successful (Muscio, 2010; Wohlin et al., 2012). Therefore, understanding how a collaboration relationship can be conducted becomes important, since it is essential not only for the success of the relationship, but also to ensure its sustainability (Salimi & Rezaei, 2018).

Despite the relevance of the topic, the literature has highlighted the lack of empirical studies that adequately investigate the factors that can contribute to the sustainable promotion of the relationship. This is especially studies true for providing improvement recommendations for the management and the collaboration processes in order to promote a sustainable relationship between university and software industry (Feng, Zhang, Du, & Wang, 2015; Santoro & Bierly, 2006). In addition, most research about collaborations between university and software industry occur on an ad hoc or opportunistic basis, as "these collaboration activities are often based on personal relationships between in each individuals organizations" (Melese et al., 2009, p. 503). It is precisely this gap that is at the root of the motivation, leading to the development of this research project. It has the purpose identifying and analyzing a set of factors that can enhance and/or facilitate a collaboration relationship between the university and the software industry, in a sustainable way, based on knowledge management.

I.2 State of the art and related work

I.2.1 University-industry collaboration relationship

Since the end of the last century, factors such as globalization, increasing competition, and rapid technological advances have made the environments of organizations complex, impacting the life cycles of processes, products and services (Kauppila, Mursula, Harkonen, & Kujala, 2015; Mendes, Nunes, & Sequeira, 2012). Considering this scenario, the organizations are forced to search for new partners in order to respond to the new challenges.

The university-industry collaboration relationship represents a fundamental resource in promoting innovation (Lee, 2000) and technological development. This will have a positive impact on productivity and the competitiveness of organizations (Cohen et al., 2002; Freitas et al., 2013; Lee, 2000). This relationship is currently crucial for both industry and university and is an important indicator of the level of innovation of an economy. It has been the subject of analysis and studies in the EU, the USA and other developed countries (Boyarchuk et al., 2018; Melese et al., 2009). It has also been an incentive measure, integrating the policies of governments of industrialized countries (Schuetze, 2000). However, Gibson et al. (2016) and other authors note that, in general, the various studies on the collaboration relationship identify universities as the only providers of knowledge and technology. There is a gap in the university's role as the recipient of the knowledge created, in collaborative processes in the context of its interaction with external institutions (Bozeman & Boardman, 2013; Jongbloed, 2015; Kutvonen et al., 2013; Subramonian & Rasiah, 2016). According to Schuetze (2000), "there are other forms of knowledge and knowledge creation that involve the complex interactions between producers and users, theory and practice and academia and industry". Bozeman and Boardman (2013, p. 88) further emphasize that most empirical studies focus on collaborative research-based relationships and "seldom address outcomes related to education".

In this study, the term ‘university-industry collaboration relationship’ is defined as an activity that involves the interaction between teams composed of people from academia (teachers, researchers and students) and company professionals. The objective of this collaboration is to create and share knowledge and technology, with neither party being relegated to a simple case study (Daria & Kostiantyn, 2018; Schubert & Bjør-Andersen, 2012). This collaboration is expected to benefit the related members and teams (teachers, researchers, students and professionals), the organizations that establish the relationship and, consequently, the surrounding society (Boyarchuk et al., 2018). As suggested by Wholin (2013, p. 43), when universities enter into a collaboration relationship with the industry, they should not see it as just a place to study, but rather as a partner to do the study with.

In a general perspective, Lambert (2003) reports in his work called 'The Lambert review of business-university collaboration' that companies and universities are not natural partners due to differences in their cultures and missions.

Although both the university and industry recognize the potential of this collaboration relationship, it often poses a threat to both due to conflicting objectives and values. The university-industry collaboration relationship is complex; it can vary according to the scope, duration, geographical location and expected results and impacts (Schofield, 2013). Thus, the main challenge is to develop a better understanding of the organizational shape and needs of the other partner – which will result in a large number of opportunities for both (Sherwood, Robinson, & Butts, 2011; Wallin, Isaksson, Larsson, & Elfström, 2014; Wright, 2008). A successful collaboration relationship requires an appropriate balance between university and industry objectives and that each party can realize that their objectives have been met in terms of this collaboration (Barnes, Pashby, & Gibbons, 2002; Wohlin, 2013). In other words, according to Melese et al. (2009), collaboration relationships are important in situations where there are mutual benefits and the knowledge, resources and experience of those involved are complementary.

The collaboration relationships between the university and the industry, depends on the approach and, as such, may assume different typologies. In general, the relationship is associated with the level of involvement from organizations and the types of resources used. It may be associated with problem solving, technology development, idea testing or knowledge creation (Perkmann & Walsh, 2009). Each phase of the collaboration relationship may vary over time and require different types of intervention, sometimes occurring simultaneously or in some cases depending on the other (Bradley, Hayter, & Link, 2013; Nilsson, Rickne, & Bengtsson, 2010).

In this respect, it is possible to classify a university-industry collaboration relationship as:

(i) formal or informal (Hagedoorn, Link, & Vonortas, 2000; Nilsson et al., 2010; Polt, Rammer, Gassler, Schibany, & Schartinger, 2001);

(ii) short-term or long-term (Bruneel, D'Este, & Salter, 2010; Wallin et al., 2014);

(iii) low intensity or high intensity, being differentiated according to the intensity of contacts and activities demanded by the relationship;

(iv) institutional or personal (Freitas et al., 2013; Verheugen & Potocnik, 2005).

The scientific work presented in Chapter II discusses the different types of collaboration relationships in further detail.

I.2.1.1 The main drivers of university-industry collaboration relationship

In order to achieve a successful university-industry relationship, it is important to understand its three main drivers, i.e. the motivations for collaboration, the channels of interaction and the outcomes and benefits of the collaboration. The understanding of these drivers and their proper

articulation allows for the mitigation of barriers, overcoming of differences and creation of an environment of trust and commitment, consequently achieving the desired success in the collaboration (Kauppila et al., 2015). The scientific work presented in Chapter II describes in more detail the main drivers of the university-industry collaboration relationship.

Motivations

In a recent work of systematic review of the literature conducted by Ankrah e AL-Tabbaa (2015), the motivations for establishing a collaboration relationship (Table I.1), according to Oliver's six critical determinants (1990), are categorized as: (i) necessity; (ii) reciprocity; (iii) efficiency; (iv) stability; (v) legitimacy and; (vi) asymmetry. In Oliver's opinion (1990, p. 242), the determinants explain the reasons why an organization decides to establish a collaborative relationship with another organization, and adds that "although each determinant is a separate and sufficient cause of relationship formation, these contingencies may interact or occur concurrently".

Table I.1 - Motivations for universities and industry: a comparison.
Source: Ankrah e AL-Tabbaa (2015, p. 392)

Determinants	University	Industry
Necessity	• Responsiveness to government policy • Strategic institutional policy	• Responsiveness to government initiatives/policy • Strategic Institutional policy
Reciprocity	• Access complementary expertise, state-of-the-art equipment and facilities • Employment opportunities for university graduates.	• Access to students for summer internship or hiring • Hiring of faculty members
Efficiency	• Access funding for research (Government grant for research & Industrial funding for research assistance, lab equipment, etc.) • Business opportunity, e.g. exploitation of research capabilities and results or deployment of IPR to obtain patents • Personal financial gain for academics	• Commercialize university-based technologies for financial gain • Benefit financially from serendipitous research results • Cost savings (easier and cheaper than to obtain a license to exploit foreign technology) • National incentives for developing such relations such as tax exemptions and grants • Enhance the technological capacity and economic competitiveness of firms • Shortening product life cycle • Human capital development
Stability	• Shift in knowledge-based economy (growth in new knowledge) • Discover new knowledge/test application of theory • Obtain better insights into curricula development • Expose students and faculty to practical problems/applied technologies • Publication of papers	• Shift in knowledge-based economy (growth in new knowledge) • Business growth • Access new knowledge, cutting-edge technology, state-of-the art expertise/research facilities and complementary know-how • Multidisciplinary character of leading-edge technologies • Access to research networks or pre-cursor to other collaborations • Solutions to specific problems • Subcontract R&D (for example due to lack of in-house R&D) • Risk reduction or sharing
Legitimacy	• Societal pressure • Service to the industrial community/society • Promote innovation (through technology exchange) • Contribute to regional or national economy • Academics' quest for recognition or achieve eminence	• Enhancement of corporate image
Asymmetry	• N/A	• Maintain control over proprietary technology

Universities and industries seek, through the collaboration relationship, to have access to resources, skills and experiences, often limited in their organization, yet present in the organization with which it is intending to establish the relationship (Wallin et al., 2014; Wright, 2008). The characteristics of the university and industry, the experience in this type of relationship and the specific areas of interest, are factors that differentiate the motivation for the establishment of the relation. Considering that the motivation to establish a collaboration relationship is different between the university and the industry, understanding the real meaning of motivation in the different parts, becomes extremely important (Freitas & Verspagen, 2017). Guimón (2013) states that a successful university-industry collaboration relationship must support the missions and motivations of each partner.

Interaction channels

The collaboration relationship between the university and industry is usually established through certain channels of interaction; such as interface units or tangible media (Feng et al., 2015). The channels of interaction are the forms of communication existing between the university and the industry that allow for the establishment of a relationship of collaboration.

The various authors in the literature consider a variety of channels of interaction that can be established in the collaboration relationships; it may even involve more than one channel (Franco & Haase, 2015; Sherwood et al., 2011).

It is important to emphasize that universities have several ‘access doors’ through which their partners may try to develop a collaborative relationship. Cosh et al. (2006, p. 7) present in their work a taxonomy where they identify a wide variety of interactions and highlight the importance of what they call 'public space'. The 'public space' represents a set of activities where a range of formal and informal interactions can occur. These can contribute to define and conduct activities in terms of problem solving and, consequently, increase the explicit and tacit knowledge base (Figure I.1).

Outcomes and benefits of the university-industry collaboration relationship

The literature identifies an extensive list of possible outcomes and benefits achieved by both universities and industry. These include financial benefits, business expansion, knowledge sharing and experience, fulfillment of the mission of educating/training, improved organizational reputation, source of human resources, etc. (Ankrah & AL-Tabbaa, 2015; Mead et al., 1999). The main results provided by the collaboration relationship differ between their partners and are strongly associated with the initial motivation and the interaction channel used for this purpose (Arza, 2010). However, several studies report that the main benefit is generally based on the search for external competences and is associated with access to new knowledge and experiences. This is a critical factor in improving the innovative capacity of the organizations involved in this type of relationship (Wallin et al., 2014).

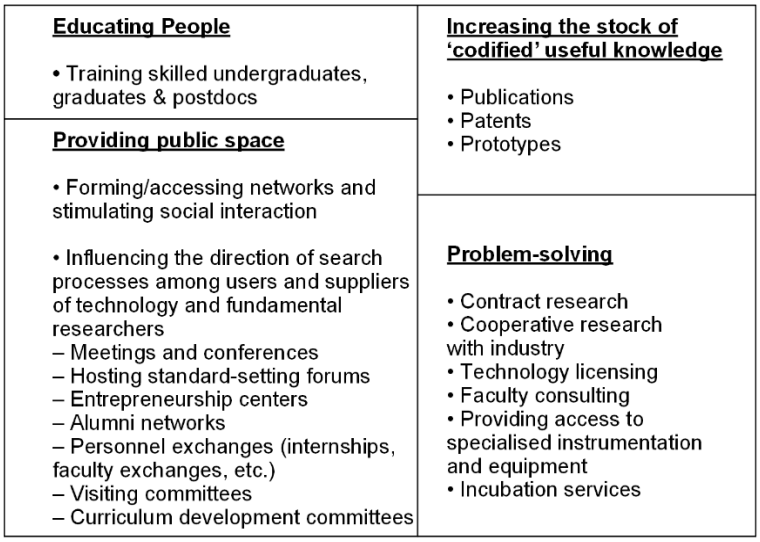


Figure I.1 - University-industry interactions.
Source: Cosh et al. (2006, p. 8)

I.2.2 The university-software industry collaboration relationship

I.2.2.1 About the university

Firstly, it is important to note that the term 'university' used in this study refers to an academic community, made up of schools/departments/colleges, research units, research laboratories and interface units (e.g. technology transfer units, university-company relationship units).

Universities are complex and heterogeneous organizations (Bozeman & Boardman, 2013), fragmented into different knowledge domains, structured through communities (e.g. pedagogical, scientific, and institutional) with inviolable values of freedom and academic autonomy based on traditions and histories (Sporn, 1996; Tippins, 2003). The various communities assume their own culture within a symbolic context, making it difficult to establish a culture with a rational management process and strategic vision (Dill, 1982). Currently, the high level of specialization also contributes to the existence of subcultures within their own universities. Their integration into a single institutional culture is a great challenge that universities have been facing for years (Sporn, 1996). This specialization, according to Dill (1982, p. 312), may result "in declining involvement in institutional requirements and a lessening of social ties with disciplinary and institutional colleagues". Encouraging a higher level of social interactions can be a facilitator in leading to the unification of the various subcultures of the different communities around a main culture (Bartell, 2003; Dill, 1982).

The structuring of the university based on different areas of knowledge also leads to the formation of several subcultures that overlap with the institutional culture (Howell & Annansingh, 2013). Subculture usually exert a strong influence on the behavior and how each member of the institution acts. On the other hand, Howell and Annansingh (2013) define subculture as a set of meanings

shared by members of a group, determining how they taught, develop researches and interact with others members of the institution; regardless of whether they are peers, employees or students.

Kerr suggests that, although the university is one of the sectors of society that can most be affected by political, economic, social and technological changes, unlike other sectors of society, the university has not yet been subjected to any great challenge and "the faculty members continue to operate largely as individual craftsmen" (Kerr, 1987, p. 184). However, Duderstadt (2001, p. 7) stresses that in the current context, we are faced with a "technology that has evolved so rapidly and relentlessly, increasing in power by a hundred-fold or more every decade, obliterating the constraints of space and time, and reshaping the way we communicate, think, and learn".

It should also be noted that universities nowadays suffer from the impact of: (i) life cycles associated with technological innovations (Gill, 2002); (ii) economic and cultural globalization; (iii) the educational needs of an increasingly knowledge-driven society; and (iv) the training needs for high-performing professional activities (Bruckmann & Carvalho, 2014; Duderstadt, 2001). Solutions to these factors – which constitute major reasons for change in higher education institutions around the world – may be found in a collaboration relationship with the software industry.

I.2.2.1.1 Characterization of higher education in Portugal with facts and figures

The Law No. 62/2007, known as *Regime Jurídico das Instituições de Ensino Superior* (RJIES - legal framework of Portuguese higher education institutions), was responsible for the greater reform of the Portuguese higher education system. According this law, the Portuguese higher education system is organized into a binary system that integrates university education and polytechnic education. Public and private institutions offer three academic degrees (graduation, Masters and Doctorate) and a cycle of higher professional technical courses (DGEEC, 2018; DGES, 2018), Figure I.2.

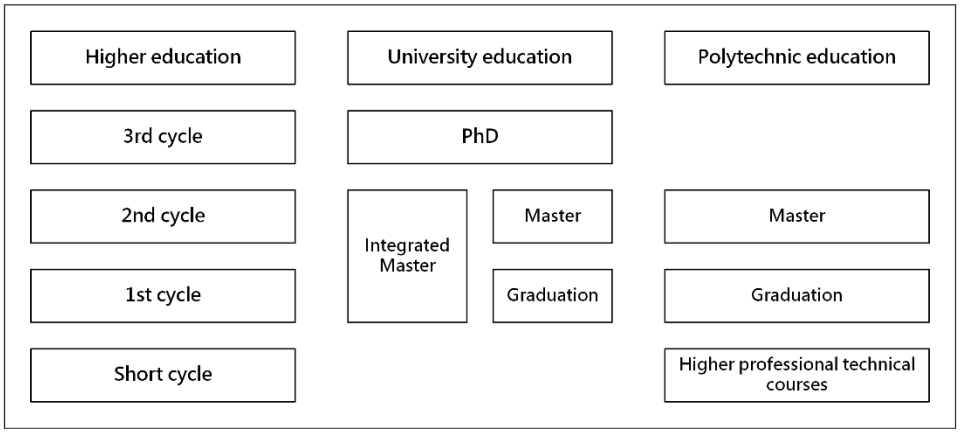


Figure I.2 - Organization chart of the education and training system.
Adapted from DGEEC (2018)

The system of institutions evolved from 1974 onwards with the massification and dispersion of the higher education institutions through the district capitals and in the autonomous regions of Portugal. However, this occurred without almost any effective regulation by the State (Fonseca & Encarnação, 2012). Regarding its distribution, public institutions have a dispersed pattern, covering the entire national territory, while private institutions are concentrated mainly in Lisbon and Porto, and in regions with larger population (Fonseca & Encarnação, 2012). In terms of institutional models, public institutions of higher education can choose between being a public institute or a foundation. Foundations are public institutions under private law, with "a greater autonomy in what concerns financial matters, multi-annual public funding on a contract basis, and greater flexibility for staff recruitment and management" (Bruckmann & Carvalho, 2014, p. 196).

An agency called *Agência de Avaliação e Acreditação do Ensino Superior* (A3ES acronym in Portuguese) was created in 2007, with the mission of assessing and accrediting higher education institutions and their study cycles. This agency also assesses and accredits the performance of the functions inherent in the insertion of Portugal into the European quality assurance system of higher education (Fonseca & Encarnação, 2012).

Currently, the Portuguese higher education system consists of 14 public universities, 2 military and police institutes, 27 public polytechnic institutes, 23 private universities and 58 private polytechnic institutes (DGES, 2018). Fonseca e Encarnação (2012) note that there are institutions, both public and private, that simultaneously offer university and polytechnic education in distinct organic units. The offer of study cycles is dynamic and with frequent changes (cancellations, name changes, etc.). In public institutions, the creation and definition of the number of vacancies of a cycle of studies is determined by the government and will depend on the level of employability of the cycle (Feijó & Tamen, 2017; Fonseca & Encarnação, 2012). In the 2017/2018 school year, the Portuguese higher education system totaled more than 5000 study cycle options, distributed between 2835 universities and 2240 in polytechnics (DGES, 2018). However, despite the geographic dispersion of the institutions and the number of existing study cycles, the OECD (2017b) identifies in its latest study that obtaining the third cycle of higher education in Portugal by the younger population (25-34 year old) "remains an important challenge". Only about 35% of young people attained this level of education. It should be emphasized that the level of employment of Portuguese graduates is statistically high and the projectable financial benefit of a university education in Portugal is one of the most significant in Europe (Feijó & Tamen, 2017). Recently, the Ministry of Science Technology and Higher Education (2018) defined as one of its main objectives for Portugal to fully achieve European convergence by 2030, i.e. reach a ratio of 40% of graduates in higher education in the age group 30-34 year-olds by 2020 and 50% by 2030, with a 60% share of 20 year-olds in higher education by 2030.

After a period of great expansion, access to the higher education system has been declining since 2010, not only due to the effects of the negative evolution of demographic rates, but also to the

economic crisis that has been felt in Portugal in recent years. In Figure I.3, it is possible to observe that in the 2016/17 school year, 361943 students enrolled in higher education, 65% of which in universities and 35% in polytechnic institutes. Public education corresponded to 83.6% of the students enrolled and 16.4% corresponded to students enrolled in private education (Ministério da Ciência Tecnologia e Ensino Superior, 2018). Of the total number of students enrolled, 78.1% were enrolled in initial training courses (higher professional technical courses, graduation and integrated master), 15.4% in master's degrees, 5.5% in doctorates and 1.0% in specializations (DGEEC, 2018).

Students enrolled in higher education institutions by nature of institution (1995/96 - 2016/17)

Nature of institution		1995/96	2000/01	2005/06	2010/11	2016/17
Public Higher Education	University	139 101	171 735	171 575	193 106	192 201
	Polytechnic	59 673	101 795	103 946	114 872	110 395
	Total	198 774	273 530	275 521	307 978	302 596
Private Higher Education	University	89 744	81 544	61 197	60 452	43 013
	Polytechnic	24 897	32 629	30 594	27 838	16 334
	Total	114 641	114 173	91 791	88 290	59 347
Subtotal	University	228 845	253 279	232 772	253 558	235 214
	Polytechnic	84 570	134 424	134 540	142 710	126 729
	Total	313 415	387 703	367 312	396 268	361 943
Students enrolled in Technological Specialization Courses						
Public Higher Education	Total	-	-	1 017	6 054	-
Private Higher Education	Total	-	-	242	1 123	-
Subtotal	Total	-	-	1 259	7 177	-
TOTAL		**313 415**	**387 703**	**368 571**	**403 445**	**361943**

Source:DGEEC

Figure I.3 - Evolution of the number of students enrolled in higher education in Portugal.
Source: Ministério da Ciência Tecnologia e Ensino Superior (2018)

In Portugal, in the 2016/17 school year, the total number of professors in higher education was 33160, 77.5% of which in public institutions and 22.5% in private institutions. In total, 62.1% in university institutions, while in polytechnic institutions there were 37.9%. It should also be noted that, of the total number of professors in 2016/17, the female representation was 14682 teachers (44.3%) (DGEEC, 2018).

The distribution by career categories of 20578 university teaching staff was represented as follows: 7.4% as full professor, 13.4% as associate professor, 49.4% as assistant professor and 29.5% in other categories. In polytechnic institutions, 12582 professors were distributed as follows: 9.5% as coordinating professor, 49.9% as assistant professor, 36.2% as lecturer and 4.4% in other categories (Figure I.4).

NUTS I e II / Tipo de ensino e categoria	Portugal	Continente						R.A. Açores	R.A. Madeira
		Total	Norte	Centro	A.M. Lisboa	Alentejo	Algarve		
Total	**33160**	**32539**	**10788**	**6878**	**12515**	**1401**	**957**	**281**	**340**
Universitário	**20578**	**20108**	**6403**	**3516**	**9056**	**572**	**561**	**244**	**226**
Professor Catedrático	1519	1493	453	266	727	19	28	17	9
Professor Associado	2757	2733	976	420	1200	62	75	9	15
Professor Auxiliar	10235	9922	3287	1699	4252	427	257	161	152
Outras Categorias	6067	5960	1687	1131	2877	64	201	57	50
Politécnico	**12582**	**12431**	**4385**	**3362**	**3459**	**829**	**396**	**37**	**114**
Professor Coordenador Principal	44	42	18	5	16	3	-	-	2
Professor Coordenador	1151	1138	355	328	339	85	31	9	4
Professor Adjunto	6273	6226	1883	1856	1755	488	244	16	31
Outras Categorias	5114	5025	2129	1173	1349	253	121	12	77

Figure I.4 - Distribution of teachers by region, type of teaching and category of teaching career, 2016/17. Source: DGEEC (2018)

Regarding academic qualifications, 19837 (59.8%) of teachers in higher education teaching in Portugal held the academic qualification of doctoral degree, 6884 (20.8%) for master's degree, 6199 (18.7%) degree of graduation and 240 with other qualifications (Figure I.5). In university, most professors had doctorate qualification (70.9%), while in polytechnic only 41.6% (5240) had this qualification, and this number was slightly higher than that of professors qualified with a master's degree, 4078 (DGEEC, 2018).

NUTS I e II / Tipo de ensino e habilitação	Portugal	Continente						R.A. Açores	R.A. Madeira
		Total	Norte	Centro	A.M. Lisboa	Alentejo	Algarve		
Total	**33160**	**32539**	**10788**	**6878**	**12515**	**1401**	**957**	**281**	**340**
Doutoramento	19837	19428	6671	4115	7274	832	536	208	201
Mestrado	6884	6788	2287	1465	2506	345	185	39	57
Licenciatura	6199	6083	1732	1273	2635	217	226	34	82
Outras Habilitações	240	240	98	25	100	7	10	-	-
Universitário	**20578**	**20108**	**6403**	**3516**	**9056**	**572**	**561**	**244**	**226**
Doutoramento	14597	14223	4741	2540	6085	499	358	196	178
Mestrado	2806	2764	877	419	1366	30	72	22	20
Licenciatura	3052	2998	715	545	1568	40	130	26	28
Outras Habilitações	123	123	70	12	37	3	1	-	-
Politécnico	**12582**	**12431**	**4385**	**3362**	**3459**	**829**	**396**	**37**	**114**
Doutoramento	5240	5205	1930	1575	1189	333	178	12	23
Mestrado	4078	4024	1410	1046	1140	315	113	17	37
Licenciatura	3147	3085	1017	728	1067	177	96	8	54
Outras Habilitações	117	117	28	13	63	4	9	-	-

Figure I.5 - Distribution of professors by region, type of education and academic qualification, 2016/17. Source: DGEEC (2018)

An important issue addressed by the Directorate-General for Statistics of Education and Science (DGEEC acronym in Portuguese) in a recent study, has to do with academic inbreeding in public university institutions in Portugal. The study reinforces the point that:

> "*The existence, in a higher education institution, of an excessive proportion of its professors in these conditions is traditionally seen as undesirable, because it may signal a less diverse academic community, more closed about itself, with less openness to external ideas and with greater difficulty in integrating national and international research networks."* (DGEEC, 2017, p. 1)

Sarrico and Alves (2016, p. 159) highlight that, "there is a danger that academics will obtain their doctorates where they work for convenience, rather than because their research is significantly contributing to the body of knowledge in the area". Feijó and Tamen (2017, p. 115) add, as another

effect of inbreeding, that many of the professor who have spent all their lives in the same institution, first as students and then as professors, remain students forever.

The main analysis of the DGEEC's study (2017) relied on the doctoral professors who carried out their doctorate studies in the institution in which they currently teach and only professors belonging to the categories provided in the statutes of the teaching career; namely, the professors in the categories of full professor, associate and assistant professor (DGEEC, 2017, p. 1). The results for the 2015/16 school year suggest a very low teacher mobility. From a global point of view, about 70% of the professors completed their doctoral studies in the same institution in which they currently teach. Only 10% of the professors reported having received their doctoral degree in another Portuguese institution and 19% in foreign institutions (Figure I.6). Despite the effect of internationalization, by obtaining doctoral degrees in institutions outside of Portugal, most of them return to their previous institution suggesting an even more impactful inbreeding process (Sarrico & Alves, 2016). The study stresses that differences may still be more critical, since the global levels of academic inbreeding of institutions typically conceal large differences between their different faculties or organic units (DGEEC, 2017, p. 2).

		Instituição em que o docente se doutorou		
Categoria profissional	Nº de docentes de carreira doutorados	Na mesma IES em que leciona	Noutra IES portuguesa	Numa IES estrangeira
Professor auxiliar	4909	73%	12%	15%
Professor associado	1574	68%	8%	24%
Professor catedrático	921	60%	8%	32%
Total	7404	70%	10%	19%

Fonte: Dados reportados pelas instituições de ensino superior (IES) no inquérito REBIDES - Registro Biográfico de Docentes do Ensino Superior, 2015/16, DGEEC

Figure I.6 - Data by professional category of professor.
Source: DGEEC (2017)

I.2.2.2 About the software industry

The history of software has evolved significantly in the last 30 years and its increasing relevance and criticality is well documented in several studies in the literature (Druffel, 2017). Looking back at the history of software, it can be divided into two important phases: a first phase where software was exclusively associated with technology. In the more recent second phase, emphasis has been put on applications and social changes brought about by software-based innovation processes, with increasingly significant changes in all societal contexts (Campbell-Kelly, 2007).

"Modern society is increasingly more dependent on software that offers quality and reliability" (Mead et al., 2016, p. 28), since these represent cross-cutting solutions for diverse products, services and processes that are part of everyday life in society. Currently, software represents a critical building element for the main types of systems (Druffel, 2017) and remains a fundamental resource for their connectivity and interoperability. This leads companies in this industry to rely heavily on the ability to discover opportunities and create innovative products, devices and solutions, so they can succeed in their marketplaces.

Taking into account the fact that software is present in all domains, being widely used in several areas, the software industry assumes a fundamental role in the economy and distinguishes itself as a type of business with increasing economic importance (Aurum et al., 2008; Lippoldt & Stryszowski, 2009).

In today's economy, it is difficult to define the boundaries of the software industry, as its limits are increasingly extended, and the profile of the professionals working in this area increasingly complex. In this context, and needing professionals with this profile, we have the most diverse business areas, such as companies dedicated exclusively to software development, companies from other business areas which also use and produce software to integrate their products (e.g. automotive industry), public institutions such as schools and universities, non-governmental organizations, to name a few (Lippoldt & Stryszowski, 2009). In fact, a significant part of software developed by the software industry is not a final product, but rather an integral component of products from other industries (Lippoldt & Stryszowski, 2009). In 2006, Michael Tiemann (2006, p. 3), vice-president of the world's leading provider of open source solutions *Red Hat*, argued that, "the battle of the next 10-15 years will be about who gets to control the ways in which software can be developed, sold, and used". The market for this type of software has been growing rapidly and has taken on an important role outside the traditional software sector (Lippoldt & Stryszowski, 2009).

Nearly two decades ago Watts Humphrey (2002, p. 1), recognized as the 'father' of quality in software and of CMMI (Capability Maturity Model Integration), wrote that "every business is a software business". He stated that although some managers do not recognize this software criticality in their business, almost all, regardless of type, use software directly or indirectly. Humphrey (2002, p. 4) cites the speech from a vice-president of a bank as an example of the importance of software in business: "we are a software business masquerading as a bank". Recently, Bill Ford, the Chairman of the Board of Directors of the centennial automotive Ford company, aware of this context, stated that the future of the automotive industry, particularly in the assembly sector, goes through a paradigm shift, transforming into a software industry (Kevin, 2017). Bill Ford added that the automotive industry should pay attention to start-ups and technology companies, considering that nowadays, they are the real competitors. Similarly, the General Electric Company (GE), the 13th largest company in the world and traditional industry, presented in its 2013 Annual Report (General Electric, 2014), the Shareholder Letter of its CEO Jeffrey Immelt where he clearly states that in the coming years, all companies of the industrial sector will become software industry companies. In pursuit of this strategy, the GE Digital was created in 2015 with the goal of being one of the 'top ten' software companies in 2020. In the 2017 Annual Report (General Electric, 2018), the GE Digital had already accumulated US$ 4.0 billion in annual revenue.

Given the scope associated with the practice of the software industry, this study uses the broad definition adopted by Lippoldt e Stryszowski (2009, p. 41): "the traditional 'software industry' (i.e.

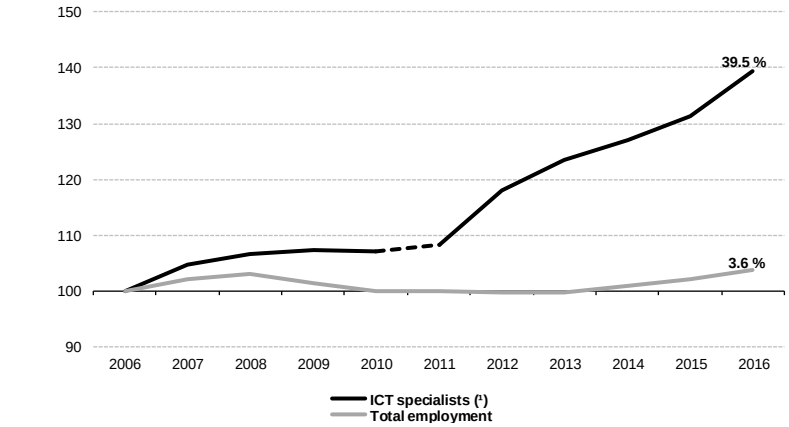
companies or institutions that primarily deal with development of software), as well as the parts of other industries that are involved in software development".

The software industry is characterized as being a "high technology, knowledge intensive, highly mutable industry – with weak entry-barriers and short innovation cycles – which demands continuous adaption, learning and access to knowledge" (Salavisa et al., 2009, p. 1). However, most of the existing companies in this sector are small and medium-sized, operating in a resource scarce scenario, with limited access to finance, specialized personnel and knowledge networks; facing competition from large national and international companies (Lippoldt & Stryszowski, 2009; Richardson & Von Wangenheim, 2007; Savolainen & Ahonen, 2015). Many of these companies have been created in the last decades as start-ups or spin-offs from universities, and a significant portion of these still maintains this link (Bjerregaard, 2010; Salavisa et al., 2009; Segelod & Jordan, 2004). The current technological complexity, resulting from the wide range of economic activities, goods and services, requires extended competences and a constant update in terms of knowledge on the part of work teams; making this aspect one of the most challenging when managing this type of industry (Druffel, 2017; Lippoldt & Stryszowski, 2009). It should be noted that this industry is highly dependent on the availability and access to human resources.

As such, one of the biggest challenges that this industry has been facing for some years now is precisely the scarcity of resources with adequate software skills (quantity) and the lack of preparation in critical and emerging areas (quality) (Lippoldt & Stryszowski, 2009). It is believed that by 2020 there will be a shortage of more than 900 thousand professionals in the European Union (EU) (OECD, 2017a). During the 2006-2016 period, the number of professionals in the market with information and communication technology skills (ICT) increased 39.5%, representing a 10-fold increase in total employment during the same period (3.6%) (Figure I.7). Among ICT activities, 'IT and other information services' and 'software publishing' are the ones with the highest employment growth in the sector (Figure I.8). The European Statistical Office (Eurostat), as well as the Organisation for Economic Co-operation and Development (OECD), define ICT specialists as workers who have the capacity to develop, operate and maintain ICT systems and for which ICT constitutes the main part of their activity. Among the various functions of the ICT specialist, are developers and software and multimedia analysts, database specialists and system administrators, etc.

In the meantime, despite this environment and the evolution of new software development organizational arrangements (e.g. outsourcing, global software development, and open source) Aurum et al. (2008) considered that software development still needs to achieve a higher level of maturity. On the other hand, the software development process is a collective, complex and creative effort that varies according to the organization, the type of software and the members of the teams involved in the process (Bogue, 2006; Falbo, Ruy, Bertollo, & Togneri, 2004; S. Ryan & O'Connor, 2013). Additionally the software development process consists of a set of activities,

which in turn are based on the intensive use of knowledge, through the processing of a large volume of know-how of different domains and technological competencies (Aurum et al., 2008; Mehta, Hall, & Byrd, 2014).



(1) 2011: break in series.
Source: Eurostat (online data codes: isoc_sks_itspt and lfsa_egan)

Figure I.7 - People employed as ICT specialist and total employment, EU-28, 2006-2016 (2006 = 100).
Source: OECD (2017a)

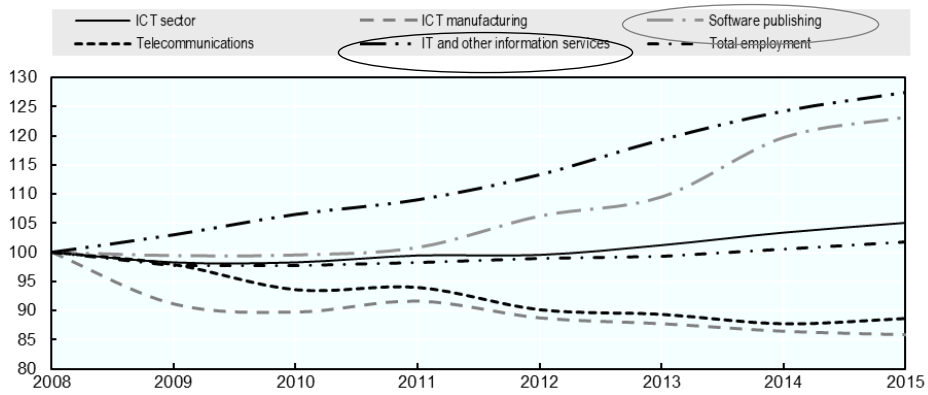


Figure I.8 - Employment growth in the ICT sector and its subsectors in the OECD area - Number of people employed (2008 = 100).
Source: OECD (2017a)

Companies characterized by knowledge intensive activities have a 'stock' of knowledge, resulting from the sum of the different knowledge of each member (denominated knowledge-workers) of their development teams (Pee, Kankanhalli, & Kim, 2010; S. Ryan & O'Connor, 2013; Starbuck, 1992). The term 'knowledge worker' was initially used in 1959 by Peter Drucker in his 'Landmarks of tomorrow' (Drucker, 1994). According to Lee-Kelley et al. (2007, p. 205), it is often used to define "any employee possessing specialist knowledge or know-how who is involved in consultancy based on their specialist knowledge or know-how, or research and development work for new products, services or processes". This 'stock' is mostly of tacit knowledge and has an unusually complex combination of different layers, which requires the development of strong personal and team based

relationships, in order to be able to share and leverage the individual knowledge at the level of a project and/or the organization (Edwards, 2003; Mehta et al., 2014; Nahapiet & Ghoshal, 1998; Shull et al., 2004). This endows knowledge management an important role in software industry operations (Fehér & Gábor, 2006; Meehan & Richardson, 2002).

I.2.2.2.1 Characterization of the software industry in Portugal with facts and figures

The high fragmentation of the software market in Portugal, the heterogeneity of its companies and the almost nonexistent or little significant literature related to the software industry, all hinder an analysis of the activity in this sector (IDC Portugal/APDC, 2017; Sousa, 2013). On the other hand, the use of available statistics requires some care in their analysis, since, in most cases, they do not segregate activities related to software development. These are understood in the ICT or, the compositions of subsectors of the activities are not fully compatible with each other. As can be seen in Table I.2, the Eurostat uses the ICT sector classification according to the International Standard Industrial Classification of All Economic Activities (ISIC). In turn, the OECD, despite using the same activity codes, groups them in a different way. As previously reported, this work addresses the activities according to the codes of the Portuguese Classification of Economic Activities (CAE Rev.3 acronym in Portuguese) whenever possible, as indicated in gray in Table I.2.

Table I.2 - Eurostat, OECD and INE classifications of ICT activities.

Eurostat - ISIC, Rev.4 - ICT Sector	OECD	CODE	CAE Rev. 3 - INE
ICT manufacturing industries	ICT manufacturing	2610	Manufacture of electronic components and boards
		2620	Manufacture of computers and peripheral equipment
		2630	Manufacture of communication equipment
		2640	Manufacture of consumer electronics
		2680	Manufacture of magnetic and optical media
ICT services industries	Software publishing	5820	Software publishing
Telecommunications	Telecommunications	61	Telecommunications
Computer programming, consultancy and related activities	IT and other services	6201	Computer programming activities
		6202	Computer consultancy and computer facilities management activities
		6209	Other information technology and computer service activities
Data processing, hosting and related activities; web portals		6311	Data processing, hosting and related activities
		6312	Web portals
ICT trade industries	ICT services not allocated	465	Wholesale of machinery, equipment and supplies
Repair of computers and communication equipment		951	Repair of computers and communication equipment

In this context, we attempted to search for literature in the area, using the search tools of Google Scholar and Scopus (as it is quite comprehensive). The criteria used were documents with a date equal to or after 2014, written in both Portuguese and English language, with search terms such as 'Portuguese software companies', 'software industry in Portugal', 'Portuguese software industry', 'IT sector in Portugal', 'Portuguese IT sector', etc. These searches have resulted in very few works, most of which came from university repositories and reported results of dissertations on technological solutions. The working paper '*Mapa TIC de Portugal: Análise por Distritos*' (Beira,

Kaldeich, Sousa, & Borges, 2006) is one of the rare available works; however, its data refer to the year 2003.

In Portugal, according to Salavisa et al. (2009, p. 1), the software industry is divided into three segments: (i) multinational affiliates (e.g. Microsoft, and others); (ii) medium and large-sized domestic companies that mainly produce standardized/customized software for business solutions; and (iii) small and medium-sized domestic companies that produce specialized software, exploring market niches and taking advantage of specific technological opportunities. However, most of the existing companies in this sector are small and medium-sized, associated with national entrepreneurs with low R&D investment value (OECD, 2017a). Many of these companies have been created in the last decades as start-ups or spin-offs from universities (Salavisa et al., 2009), and a significant portion of these still maintain this link.

From the database of the Statistics Portugal (INE acronym in Portuguese), Figure I.9 shows the numbers of companies and 'staff at the service' of each respective CAE-Rev.3 code associated with software activities: (ii) '6202 – Computer consultancy and computer facilities management activities and; (iii) '6209 – Other information technology and computer service activities. According to the definition of the INE, 'staff at the service' are all those operating within companies with employment contracts and being paid directly by them. In this figure (Figure I.9) which relates to the year 2016, the software industry in Portugal is mainly comprised of small companies with a limited number of professionals.

	6201 - Atividades de programação informática		6202 - Atividades de consultoria em informática		6209 - Outras atividades relacionadas com as tecnologias da informação		TOTAL	
	Empresas	Pessoal ao serviço	Empresas	Pessoal ao serviço	Empresas	Pessoal ao serviço	Empresas	Pessoal ao serviço
Portugal	4266	14247	3814	25569	1791	10674	9871	50490
Norte	1270	4836	818	3561	487	2722	2575	11119
Centro	827	3102	478	1596	315	874	1620	5572
Lisboa	1717	5365	2210	19384	807	6756	4734	31505
Alentejo	168	387	122	255	69	128	359	770
Algarve	149	271	89	245	49	87	287	603
Açores	49	78	36	57	36	61	121	196
Madeira	86	208	61	471	28	46	175	725

Empresas (N.º) por Localização geográfica (NUTS - 2013) e Atividade económica (Subclasse - CAE Rev. 3); Anual

Pessoal ao serviço (N.º) das Empresas por Localização geográfica (NUTS - 2013) e Atividade económica (Subclasse - CAE Rev. 3); Anual

Nota(s): (1) Ainda no âmbito da implementação do SEC 2010 nas Contas Nacionais, nomeadamente da necessidade de distinguir as Sociedades Gestoras de Participações Sociais (Holdings) das Sedes sociais (Head-offices) procedeu-se a uma atualização das estatísticas das empresas. Estas alterações tiveram reflexos imediatos na delimitação do setor empresarial, pelo que, de modo a aumentar a consistência com as Contas Nacionais, se procedeu a uma revisão da série das estatísticas das empresas para o período 2008-2015, unicamente no setor de atividade onde estas empresas estão classificadas, ou seja na Secção M da CAE Rev.3 - Atividades de consultoria, científicas, técnicas e similares. Os dados de 2008 e 2009 revistos de acordo com SEC são divulgados pela primeira vez. E a informação de 2014 foi também revista para a secção L da CAE Rev.3 - Atividades imobiliárias, na sequência da atualização da informação de uma empresa de grande dimensão.

Última atualização destes dados: 08 de fevereiro de 2018

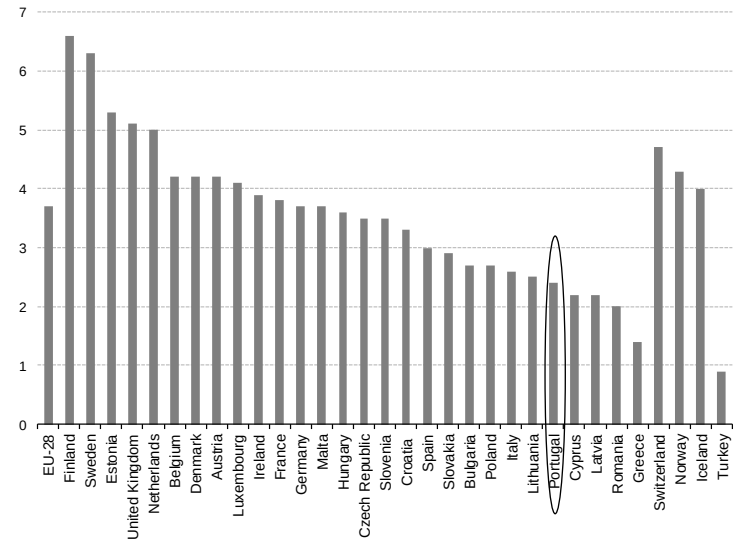
Quadro extraído em 03 de Agosto de 2018 (11:06:14) - http://www.ine.pt

Figure I.9 - Software industry in Portugal – companies and staff at the service, to the economic activity code (Subclass - CAE Rev. 3), 2016.
Source: www.ine.pt

The total of 9871 companies identified in the respective economic activities employs 50490 professionals directly; in other words, each company employs, on average, a little more than 5

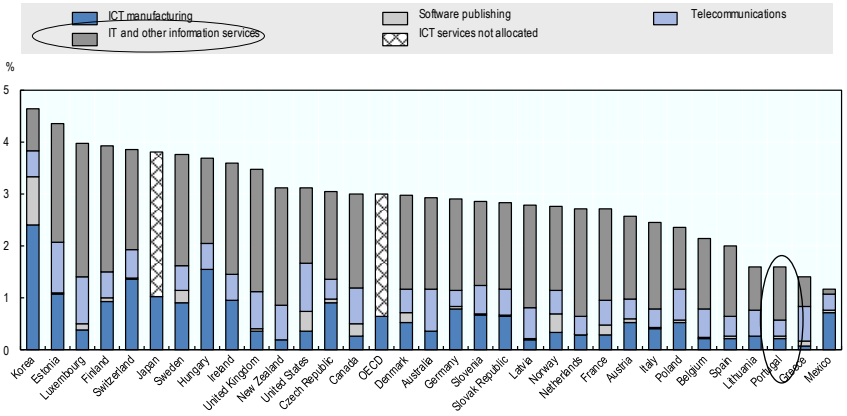
employees. The individual analysis of the code CAE 6201 – Computer consultancy and computer facilities management activities, registers an average slightly higher than 3 professionals per company. Regarding the geographical distribution of companies and staff at the service, there is a large concentration in the metropolitan region of Lisbon, with about 48% of companies and 62% of professionals. The Northern region contains approximately 26% of companies and 22% of professionals, while the Center region registers 16% and 11%, respectively. The other regions account for 10% of companies and 5% of professionals. Given the new formats of software development, as mentioned previously, this company/professional ratio may not represent the reality of this industry. As reinforced by Tiemann (2006, p. 2), "developers can be any people interested in a problem, not merely people employed to work on a specific problem".

In 2016, the percentage of ICT specialists in Portugal represented just over 2% of total employment, close to the lowest end of the ranking, in contrast to the EU average of 3.7% (Figure I.10). However, it is important to emphasize that in Portugal, according to data from 2015, among the ICT specialists, the largest group of collaborators is associated with the sector that the OECD classifies as 'IT and other information services' where, in principle, software development activities are registered (Figure I.11).



Source: Eurostat (online data code: isoc_sks_itspt)

Figure I.10 - Ratio of ICT specialists in total employment, 2016.



Notes: The ICT sector is defined here as the sum of industries ISIC rev.4: 26 Computer, electronic and optical products ("ICT manufacturing" in the legend); 582 Softw are publishing; 61 Telecommunications; and 62-63 IT and other information services. Data for Germany, France, Latvia, Lithuania, Portugal, Spain Sw eden and Sw itzerland are 2014. 2015 data on softw are publishing are estimates based on w eights from 2014. The OECD aggregate is calculated as the sum of persons employed over all countries for w hich data w ere available. IT = information technology; ICT = information and communication technology.

Sources: Author's calculations based on OECD, STAN: OECD Structural Analysis Statistics (database), ISIC Rev.4, http://oe.cd/stan (accessed July 2017) and OECD, SDBS Structural Business Statistics (ISIC Rev. 4), http://dx.doi.org/10.1787/sdbs-data-en (accessed July 2017).

Figure I.11 - Employment in the ICT sector and sub-sectors, 2015 - percentage of total employment.
Source: (OECD, 2017a)

In Portugal, as in many other countries, local companies in the software industry and those wishing to make investments to transfer their operations to the country, have been impacted by the scarcity of specialists or training in critical areas of Software Engineering and Technology. On the other hand, and given the exponential growth of the need for professionals with the aforementioned profile in this area, the universities have not been able to respond with the required amount of graduates demanded by the markets (IDC Portugal/APDC, 2017).

In 2015, Portugal presented an excellent ratio of 28% for higher education graduates in programs related to the areas of science and technology (STEM – Science, Technology, Engineering and Mathematics), above the 23% average of OECD members. However, and after a period of great expansion, only 1,2% of graduates completed ICT courses, one of the lowest ratios of all OECD countries (average of 4%) (OECD, 2017b), and only 2.4% of new students enrolled in courses in this area, as shown in Figure I.12.

NUTS I e II / Área	Portugal	Continente						R.A. Açores	R.A. Madeira
		Total	Norte	Centro	A.M. Lisboa	Alentejo	Algarve		
Total de alunos inscritos no ensino superior	**361943**	**355878**	**116742**	**78606**	**137579**	**14724**	**8227**	**2815**	**3250**
Tecnologias da informação e comunicação (TICs)	8752	8523	3224	1663	3306	278	52	160	69
% do total de alunos inscritos	2,4%	2,4%	2,8%	2,1%	2,4%	1,9%	0,6%	5,7%	2,1%
Universitário	4493	4327	1847	288	2160	31	1	136	30
Politécnico	4259	4196	1377	1375	1146	247	51	24	39
Outras áreas	353191	347355	113518	76943	134273	14446	8175	2655	3181
Total de diplomados no ensino superior	**73086**	**71900**	**24675**	**16360**	**26851**	**2585**	**1429**	**555**	**631**
Tecnologias da informação e comunicação (TICs)	857	844	350	189	279	22	4	13	
% do total de diplomados	1,2%	1,2%	1,4%	1,2%	1,0%	0,9%	0,3%	2,3%	-
Universitário	531	518	252	46	219	1	-	13	-
Politécnico	326	326	98	143	60	21	4	-	-
Outras áreas	72229	71056	24325	16171	26572	2563	1425	542	631

Figure I.12 - Students enrolled and graduated in ICT areas in higher education, 2015/16.
Source: DGEEC (2018)

Regarding the level of training of ICT specialists in Portugal in 2016, 51.2% had completed higher education. The ratio of licensed professionals presented a significant increase (15.9 points) in the

period between 2006 and 2016. However, in 2016 Portugal has remained below the EU average (61.8%) and among the 3 countries with less participation of graduates in this sector (Figure I.13). It is also possible to observe the analysis carried out by Eurostat about the age groups of ICT specialists in the same figure. Eurostat analyzed the distribution of these professionals into two age groups: (i) persons between the ages of 15 and 34 and; (ii) persons with 35 and over. Most EU countries had high ratios of ICT specialists aged 35 years old and over. The EU average was 63.7% and showed an increase of 6.7 points during the 2006-2016 period. In 2016, Portugal presented a ratio very similar to the EU average (63.0%), however this participation increased 19.6 points during the past decade. The increasing participation of professionals over 35 years of age, suggests a reflection of the ageing population in Portugal and a later entry into the professional world by the younger population. Concerning the other workforces in Portugal, recent EU studies indicate that 48% of these have little or no capacity of interacting with digital technology and processes – a situation that makes the majority of those responsible for Portuguese companies say that they are not satisfied with the digital capabilities of their employees (Duarte, Agostinho, & Alves, 2016).

Portuguese companies generally have low levels of research and development (R&D) expenditures in ICT. Among the countries analyzed by the OECD in 2015, Portugal presents the lowest percentage of companies' expenditures in ICT (5.18%), in relation to the total investment in R&D. However, as observed in Figure I.14, the largest share of investment in R&D was dedicated to 'IT and other information services'.

	Distribution by education level				Distribution by age			
	Tertiary education		Non-tertiary education		15-34 years		35 years and over	
	2006	2016	2006	2016	2006	2016	2006	2016
EU-28	55,3	61,8	44,6	38,0	43,0	36,3	57,0	63,7
Belgium	77,0	76,2	23,0	23,8	42,6	35,1	57,4	64,9
Bulgaria	57,9	64,6	42,1	35,4	53,4	47,4	46,6	52,6
Czech Republic	34,0	56,3	66,0	43,7	49,3	44,0	50,7	56,0
Denmark	57,3	53,5	42,5	43,3	36,4	30,4	63,6	69,6
Germany	50,7	49,6	49,0	50,3	35,2	35,9	64,8	64,1
Estonia	61,0	57,6	39,0	42,4	50,7	48,6	49,3	51,4
Ireland	79,1	82,4	19,3	14,8	59,3	33,6	40,7	66,4
Greece	51,9	59,4	48,1	40,6	51,4	39,4	48,6	60,6
Spain	80,1	79,1	19,9	20,9	60,3	35,7	39,7	64,3
France	79,4	78,4	20,6	21,6	48,0	33,8	52,0	66,2
Croatia (1)	50,4	52,5	49,6	47,5	35,7	39,8	64,3	60,2
Italy	25,8	32,8	74,2	67,2	41,5	24,5	58,5	75,5
Cyprus (2)	84,2	73,5	15,8	26,5	64,5	45,3	35,5	54,7
Latvia	45,1	67,7	54,9	32,3	57,5	54,1	42,5	45,9
Lithuania (3)	48,9	80,7	51,1	19,3	42,9	50,2	57,1	49,8
Luxembourg (4)	52,4	71,1	47,6	22,7	36,5	33,4	63,5	66,6
Hungary	38,9	65,6	61,1	34,4	51,2	36,1	48,8	63,9
Malta	18,4	53,9	81,6	46,1	66,3	63,3	33,7	36,7
Netherlands	51,4	60,9	48,1	38,5	37,2	35,0	62,8	65,0
Austria	36,5	61,9	63,5	38,1	48,2	40,6	51,8	59,4
Poland	56,6	69,8	43,4	30,2	56,0	53,6	44,0	46,4
Portugal	35,3	51,2	64,7	48,8	56,6	37,0	43,4	63,0
Romania	51,6	70,0	48,4	30,0	44,1	48,4	55,9	51,6
Slovenia	40,7	56,6	59,3	43,4	45,0	35,3	55,0	64,7
Slovakia	32,2	59,3	67,8	40,7	58,8	46,6	41,2	53,4
Finland	53,1	64,1	46,9	35,8	43,8	28,6	56,2	71,4
Sweden	44,0	56,4	55,9	43,5	33,8	30,0	66,2	70,0
United Kingdom	60,4	64,7	39,2	35,1	35,9	36,1	64,1	63,9
Iceland	34,5	58,9	38,4	41,1	37,9	41,8	62,1	58,2
Norway	61,2	62,2	38,8	37,8	37,7	32,6	62,3	67,4
Switzerland	56,0	60,5	44,0	39,3	40,9	37,5	59,1	62,5
Turkey	43,7	55,3	56,3	44,7	72,1	65,2	27,9	34,8

(1) 2006: low reliability. Women, 2016: low reliability.
(2) Women and non-tertiary education, 2006: low reliability.
(3) 2006: low reliability. Non-tertiary education, 2016: low reliability.
(4) Women, 2006: low reliability.
Source: Eurostat (online data codes: isoc_sks_itsps, isoc_sks_itspe and isoc_sks_itspa)

Figure I.13 - Evolution and distribution of ICT specialists by education and age levels, 2006 e 2016.

I.2.2.3 About the university-software industry collaboration relationship

In a rapidly changing scenario with increasingly disruptive innovation processes, the software industry needs more technology-based solutions to ensure its competitiveness (Wohlin et al., 2012). Companies in this industry have generally sought collaborations with universities, in order to have access to specific knowledge, which allows them to complement the skills that they already possess (Ehrismann & Patel, 2015). On the other hand, universities driven by technological progress and social pressure have also sought solutions to some of their problems by establishing collaboration relationships with the software industry (Coccoli, Stanganelli, & Maresca, 2011). It should be noted, that businesses and universities have faced a common problem related to the lack of professionals in emerging technological fields. This is happening at a time when the paradigm is to migrate to industry 4.0 solutions. This problem is exacerbated by the mismatch/misalignment between the profiles that the market demands and the qualifications that graduates obtain from their university education (Johanyak, 2016; Mead et al., 2016). According to Mead (2016, p. 29), this mismatch is currently "too high, with significant adverse consequences for employers and jobseekers".

	ICT manufacturing	Software publishing	Telecommunications	IT and other information services	ICT services not allocated	ICT BERD expenditures as a percentage
Chinese Taipei	1,68	0,00	0,02	0,07		74,81
Korea	1,60	0,09	0,02	0,02		52,89
Israel	0,25				1,36	44,51
Finland	0,85	0,04	0,02	0,19		50,95
United States	0,33	0,21	0,02	0,12		34,57
Sweden	0,47				0,12	25,66
Japan	0,41		0,07	0,05		20,65
Ireland	0,11	0,09	0,01	0,26		45,17
Singapore	0,41	0,01	0,00	0,03		35,22
Germany	0,25	0,00	0,01	0,10		14,02
Switzerland	0,34					30,57
Norway	0,06	0,07	0,03	0,14		38,75
Austria	0,14	0,01	0,01	0,11		16,47
Estonia	0,03		0,03	0,21		18,58
France	0,10	0,04	0,04	0,09		13,06
China	0,26					13,00
Belgium	0,09	0,01	0,02	0,11		31,11
Netherlands	0,10		0,01	0,11		19,72
Canada	0,09	0,03	0,02	0,08		22,28
Hungary	0,01	0,01	0,04	0,15		12,28
Denmark	0,03	0,03	0,01	0,13		10,71
Slovenia	0,07	0,01	0,02	0,10		17,99
Czech Republic	0,01	0,01	0,01	0,15		14,84
United Kingdom	0,02	0,00	0,04	0,11		11,88
Australia	0,02	0,00	0,03	0,08		31,23
Turkey	0,02	0,00	0,03	0,10		15,86
New Zealand				0,13		21,21
Portugal	0,01		0,03	0,08		5,18
Italy	0,04		0,02	0,06		13,82
Spain	0,01	0,00	0,01	0,06		17,06
Slovak Republic	0,01			0,05		12,22
Poland	0,01	0,00		0,05		11,11
Mexico	0,01				0,01	11,86
Chile			0,00	0,01		6,61

Notes: For Canada, Denmark, Finland, Hungary, Israel, Italy, the Netherlands, Poland, Portugal, Romania, Slovenia, the United Kingdom and the United States, data refer to 2014. For Austria, Belgium, France, Ireland, Singapore and Sweden, data refer to 2013. For Australia, data refer to 2011. "ICT services not allocated" refers to ICT services industries within ISIC rev.4 58-63 that cannot be separated. BERD = business expenditure on research and development; GDP = gross domestic product; ICT = information and communication technology; IT = information technology; China = the People's Republic of China.

Source: OECD, "STAN R&D: Research and development expenditure in industry - ISIC Rev. 4", STAN: OECD Structural Analysis Statistics (database), http://oe.cd/anberd (accessed February 2017).

Figure I.14 - Companies expenditure on R&D in the ICT sector, 2015 - % of gross domestic product and total expenditure.
Source: OECD (2017a)

Given this scenario, Boyarchuck (2018, p. 667) states that, "successes in this field are impossible without the fruitful collaboration between universities and the software industry". However, several

authors believe that the traditional models of collaboration relationships are not adequate to the dynamics of these types of industries (Boyarchuk et al., 2018; Coccoli et al., 2011; Mead, 2015). This reinforces the importance of studies based on empirical data, on factors that may be the origin and that sustain a collaboration relationship between these two types of industries. The importance of factors related to new collaboration strategies, with new approaches based on the convergence of technologies, teaching and research, as well as on the increasing importance of knowledge, are also highlighted (Boyarchuk et al., 2018; Garousi, Petersen, & Ozkan, 2016).

Although it seems obvious and that the parties involved recognize the need for collaboration, the difference between their individual expectations may make the opportunity for collaboration impossible, and/or even eliminate it completely (Wohlin, 2013). Rodríguez et al. (2014) also point out that one of the challenges of this type of collaboration relationship is that many software industry professionals view academic research as theoretical and of little value in practical applications (product development). On the other hand, researchers often complain that they do not have access to industry data and practical problems needed to develop their applied research (Rodríguez et al., 2014). A collaboration relationship between these industries can help address these challenges by bridging their interests and converging the expected objectives and benefits. In Ehrismann and Patel's point of view (2015, p. 2), "a clear understanding on common, but also diverging interests is the most truthful and realistic negotiation basis"; which may lead to a successful collaboration relationship. The same authors also point out that understanding and respecting one's organizational culture and combining existing intellectual and technological resources to respond to emerging issues can accelerate and improve the quality of their collaboration relationship (Ehrismann & Patel, 2015).

Figure I.15 summarizes the main outcomes and challenges of the university-software industry collaboration relationship.

This relationship is characterized by the creation and sharing of highly specialized knowledge; this enables the industry to ensure competitiveness in an increasingly demanding market and provides the university the relevance of its investigations based on the real world. However, in order for this relationship to be successful, the university should seek to understand the real needs of the industry in such a way that the industry professionals attribute their real value to this relationship. Similarly, the industry should be aware of the importance of facilitating access to the existing knowledge base related to its business to the university, which will enable it to create knowledge and solutions that are ever closer to the needs of the industry.

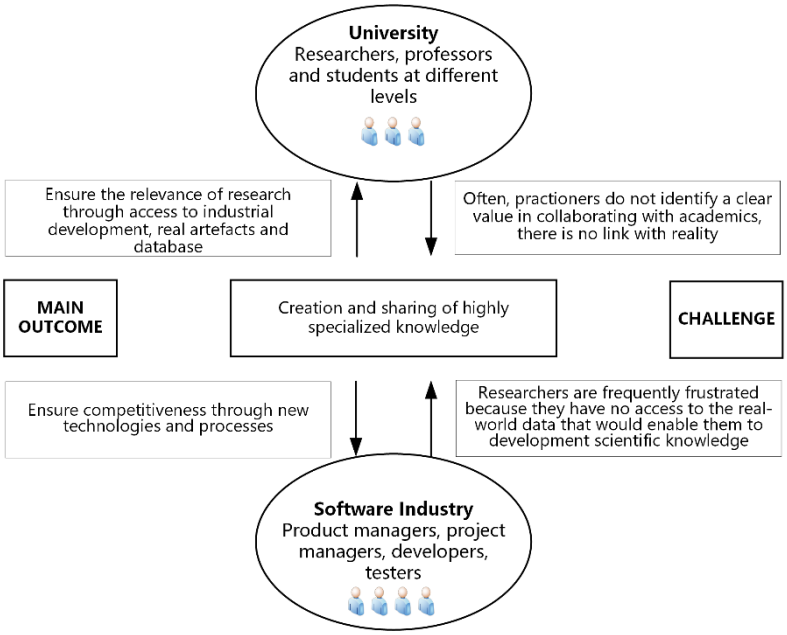


Figure I.15 - Main outcomes and challenges of the university-software industry relationship.

Figure I.16 presents a framework, evidencing some of these characteristics, relative to the objectives, needs and competencies of each of the parties.

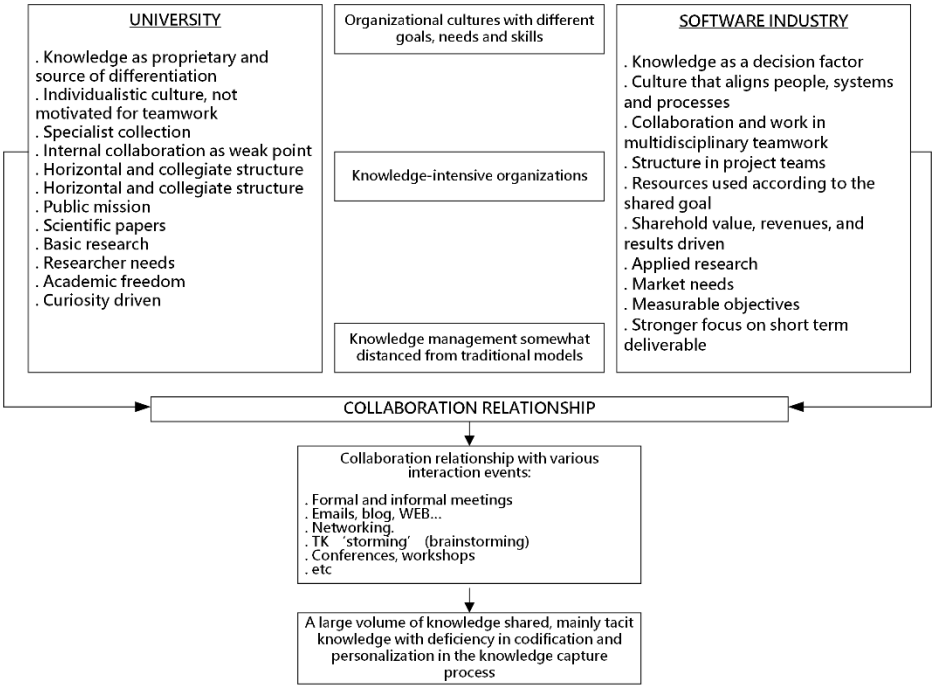


Figure I.16 - Different objectives, needs and competencies of the university and the software industry.

In the framework present in Figure I.16 it is possible to observe that, the university and the software industry are organizations that present different cultures with different objectives, needs and

competencies. However, if this cultural diversity poses a challenge when establishing and conducting of a collaboration relationship (Du Chatenier et al., 2009), the knowledge-intensive characteristic relevant to each of these organizations also represents an excellent source of creativity and innovation.

Given the knowledge intensive nature of the two types of organizations, the collaborative strategy requires the integration of specialized knowledge dispersed between each of the members of the work teams, usually multidisciplinary. The highly specialized knowledge, both tacit and explicit, is created and shared in the various phases of the relationship (Boyarchuk et al., 2018; Salavisa et al., 2009). This implies that possible solutions that aim at the sustainability of the relationship should be examined through the knowledge management (Daria & Kostiantyn, 2018; Philbin, 2008). This view is also shared by Vasconcelos et al. (2017, p. 1502), who understand that in knowledge-intensive environments "knowledge management processes fit like a glove".

I.2.3 Knowledge management

Currently, the factors that lead to the success of businesses are not limited to the financial capital, labor and raw material. Knowledge has, for some years, become the most valuable resource for companies – the only one that can raise companies to the level of innovation and, as such, enhance competitive advantage (Bhatt, 2001). Through knowledge, organizations can improve development by creating new business opportunities (Johannessen, Olsen, & Olaisen, 1999b; Pekka-Economou & Hadjidema, 2011). On the other hand, increasing access to knowledge has made the innovation process complex within organizations (Plessis & du Plessis, 2007), making the innovation process strongly dependent on said knowledge (Gloet & Terziovski, 2004).

Given this context, Peters (1992, p. 382) asks the following question: "if knowledge is the source of most value-added, how do organizations accumulate it?". However, according to Drucker (1994) the great challenge is not how to accumulate knowledge, but how to manage it in order to makes it productive, thus emerging the concept of knowledge management.

According to Prusak (2001), knowledge management, as a field of study, had the conference held in Boston in the year 1993 as its initial milestone, which was specifically dedicated to the theme and organized by him and other colleagues. Some 25 years later, the meaning, application and the comprehensiveness of the concept of ' knowledge management ' are still under discussion (Girard & Girard, 2015). According to Girard and Girard (2015, p. 15), "knowledge management has developed from a premature concept into a mainstream organizational necessity". At present, all scholars of systems, practices and models associated with knowledge management recognize their complexity and, at the same time, their multidimensional and evolutionary nature.

Although knowledge management is a holistic combination of measures involving people, processes and technology management, the literature indicates that organizations in the past have not been consistent in their knowledge management approach. Generally, the efforts to implement

this concept into organizations focused on the development of technologies to support knowledge management activities, while not giving due attention to the integration of people and consideration of processes (Gloet & Terziovski, 2004; Grover & Davenport, 2001). However, Smith (2001, p. 319) suggests that "each organization has its unique way to handle knowledge". Variables such as "degree of maturity of the organization, type of business, core competences, culture, infrastructure and marketplace competition" affect how knowledge is used.

The scientific works contained in Chapters III, IV and V analyze and discuss knowledge management and its various elements in greater depth.

I.2.3.1 About knowledge

Data, information and knowledge

In most of the later literature, defining knowledge is done by approaching the concepts of data and information, and the concept of knowledge emerges at the next level (Rowley, 2007). Some authors point out that the relationship between the above three concepts occurs in a hierarchy, with data at its base and knowledge at the top (Alavi & Leidner, 2001; Rowley, 2007). Some authors add to the hierarchy the concept of wisdom, which has been introduced by Russel Ackoff (Rowley, 2007). However, when compared to the first three concepts, the concept of wisdom received little attention from researchers regarding its impact on organizations (Rowley, 2007). More recently, due to the paradigm associated with the digital age, the concept of wisdom has been associated with the concept of intelligence, attracting more interest by the communities with research dedicated to this area. The correct distinction between these terms is important in order to make the best use of the results generated by each of them.

Data is a set of discrete and objectives facts (raw numbers, symbols, figures), without context and interpretation (Alavi & Leidner, 2001; Davenport & Prusak, 1998). Data is easily obtained and transferred and is often quantitative. Although the concepts of knowledge and information are far from identical, these are often confused and used interchangeably or indistinctly (Mårtensson, 2000; Stenmark, 2001).

Information is inferred from data processed in a context and subject; it is the basis for knowledge (Alavi & Leidner, 2001; CEN, 2004; Davenport & Prusak, 1998). The concept of knowledge has varied considerably over the years, making it difficult to identify a common definition among the authors (Rowley, 2007). In Gill's opinion (2002, p. 252), “each shift in the meaning of knowledge has coincided with a new innovation, be it an industrial, technological, organisational or social one”. The literature presents several distinct definitions and, the term 'knowledge' is usually defined according to the context in which it is discussed (Gloet & Terziovski, 2004; Stenmark, 2001; Stoyanov, 2014). It should be noted that regardless of the concept, knowledge always brings with it a combination of truths, beliefs, judgments, expectations, methodologies, intuitions, attitudes, learning, know-how, etc., that result in an asset that can be used to improve the ability to act and

support decision making (CEN, 2004; Prieto, Revilla, & Rodríguez-Prado, 2009). This study adopts the comprehensive definition of Davenport and Prusak (1998, p. 4), which describes knowledge as a “fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information”.

Although widely accepted and adopted, the traditional hierarchy received some criticisms about the relationship between its data-information-knowledge elements. Stenmark (2001) and Alavi and Leidner (2001) argue that the data-information-knowledge hierarchy is far from being a scale of values. In other words, information does not have a higher value than data and does not necessarily have a lower value than knowledge. These same authors cite the work of Tuomi (1999) that proposes the reversal of the traditional hierarchy, since knowledge can exist even before information can be formulated and before data can be measured to shape the information. Rowley (2007) and Bhatt (2001) add that there are different elements acting at different levels of the hierarchy (e.g. meaning and value, human interference and informatics, algorithms and programming, etc.) and a recursive process of comings and goings between data, information, and knowledge, is often necessary to achieve the desired goals.

Given the premise of Alavi and Leidner (2001), that the need for knowledge is determined by the needs and the existing knowledge base, it is possible to suggest that the whole relationship of the hierarchy is influenced by the tacit knowledge of the responsible agent. It can intervene and interfere in each level and apply experiences, values, know-how, insights, etc., in order to achieve the desired results, or as summarized by Bhatt (2001, p. 70), "the distinction between information and knowledge depends on users' perspectives”.

The Figure I.17 summarizes the concepts of data-information-knowledge hierarchy.

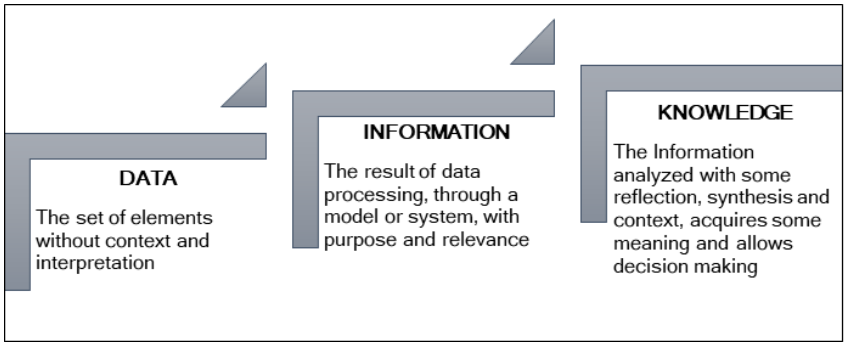


Figure I.17 - Data-information-knowledge hierarchy.

Types of knowledge

Given the diverse nature of studies and areas that apply the concept of knowledge, the result in terms of classification the definition of the concept is also quite different. However, Johannessen et al. (1999a, p. 128) emphasize that "as a basic rule all knowledge is mutually complementary". Table I.3 presents and summarizes the main types of knowledge identified in the literature.

Table I.3 - Different types of knowledge identified in the literature.

Type / definition	Author
Hidden – knowing how we know Tacit – know how Explicit – know what Systemic - know why, i.e. new ways of thinking about (facts) Relationship – know who	Johannenssen et al. (1999a)
Explicit Tacit . Cognitive . Technical	Nonaka e Konno (1995); Polanyi (1966b); Santoro e Bierly (2006); Seidler-de Alwis e Hartmann (2008)
Tacit . Cognitive – mental models . Technical – know how Explicit – articulated Individual – created by and inherent in the individual Social - created by and inherent in collective actions of a group Declarative – know about Procedural – know how Causal – know why Conditional – know when Relational – know with Pragmatic - useful for an organization	Alavi (2001)
Explicit or tacit Individual or collective	CEN (2004)
Formalized and systematic – know what . Factual . Declarative . Explicit rules . Scientific Informal, practical and experience-based knowledge – know how, partly tacit Of knowledgeable persons – know who	Rasmussen e Nielsen (2011)
Specific organizational tasks . Cognitive – know what . Advanced skills – know what . Understanding of the concept - know why Specificity of practical activities . Information – know what . Skills that are inherent in the ethos – know how . Knowledge that answers the questions – know why Specificity of training in the field of knowledge . Equivalent of unconscious incompetence . Equivalent to conscious incompetence . Equivalent to unconscious competence Innovation process . Public (social) – mark trends . Scientific – institutional . Entrepreneurial – potential of owner . General/overall - Not to provide information to competitors	Stoyanov (2014)

The various authors generally adopt the classical division between explicit and tacit knowledge, introduced by the Hungarian chemist and philosopher Polanyi (Polanyi, 1966b) and widely disseminated by Nonaka and Takeuchi.

Explicit knowledge is widely characterized as a type of knowledge that can be easily codified, articulated, documented and stored, and is usually stored and expressed in the form of texts, data, scientific formulas, maps, manuals, books, websites, etc. (CEN, 2004; Nonaka & Takeuchi, 1995; Polanyi, 1966b). On the other hand, tacit knowledge is personal and is stored in people's minds. This type of knowledge is difficult to formalize, register, articulate or share (CEN, 2004; Nonaka & Takeuchi, 1995; Polanyi, 1966b). Tacit knowledge, in general, is associated with organizational and territorial contexts; transmitted and developed through local interactions. It is based on practical

experience and its 'owners' are often not even aware that they possess this kind of knowledge. Tacit knowledge is fundamental to the interpretation of explicit knowledge. Explicit knowledge without the tacit insight quickly loses its value (Seidler-de Alwis & Hartmann, 2008; Shull et al., 2004). Simply put, the value of this type of knowledge is closely related to tacit knowledge. Although it is the main source of knowledge creation, and facilitator of the continuous innovation process (Johannessen, 2008; Polanyi, 1966a), the various discussions and studies are still very focused on explicit knowledge, with few references to tacit knowledge (Seidler-de Alwis & Hartmann, 2008).

I.2.3.2 About knowledge management

Several authors highlight the important role of knowledge management in the creation of new knowledge and innovation process (e.g. Gloet, 2006; Inkinen, 2016). They point out the need of knowledge management practices in organizations since, "knowledge can be likened to a living system, growing and changing as it interact with the environment." (Davenport & Prusak, 1998, p. 8).

There are several definitions of the knowledge management in the literature that bring with them the concepts of the domains in which they are applied. In Rowley's view (2000, p. 327), “knowledge management is a complex process which will be understood differently in different contexts”. Girard and Girard (2015), in their work entitled ‘Defining knowledge management: Toward an applied compendium’, relate more than 100 different definitions in 23 distinct domains. McKellar (2015) adds that, currently, knowledge management is like an 'umbrella' under which are other disciplines such as business intelligence, collaboration, big data, business process management, relationship management/customer experience, competitive intelligence, etc., Figure I.18.

Figure I.18 - Knowledge management 'umbrella'.

Table I.4 summarizes the different definitions identified in the literature regarding knowledge management.

Table I.4 - Different definitions of knowledge management identified in the literature review.

Definition	Author
The essence of knowledge management is to make knowledges productive.	Drucker (1994)
The systematic underpinning, observation, instrumentation and optimization of the firms' knowledge economies.	Demarest (1997)
Knowledge management is the task of developing and exploiting an organization's explicit and tacit knowledge resources.	Davenport et al. (1998)
Knowledge management is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives.	Davenport e Prusak (1998)
Knowledge management is a comprehensive process of knowledge creation, knowledge validation, knowledge presentation, knowledge distribution, and knowledge application.	Bhatt (2001)
Knowledge management is a planned and ongoing management of activities and processes for leveraging knowledge to enhance competitiveness through better use and creation of individual and collective knowledge resources.	CEN (2004)
Knowledge management is the formalization of and access to experience, knowledge, and expertise that create new capabilities, enable superior performance, encourage innovation, and enhance customer value.	Gloet e Terziovski (2004)
Knowledge management is an integrated approach to identify, manage, share and capitalize on the know-how, experience and intellectual capital of staff in an organization.	Steyn (2004)
Knowledge management involves practices for gaining external knowledge and interacting with other organizations, and for sharing and utilizing knowledge within the enterprise.	Oslo Manual (2005)
Knowledge management is the overall set of processes that are put in place for identifying sources of relevant data and information in organizations, the eventual conversion of these data and information to knowledge, and their subsequent dissemination to different points in the organization where they are needed.	Lakshman (2007)
Knowledge management is the process of creating, capturing and using knowledge to enhance organizational performance.	Pekka-Economou e Hadjidema (2011)
Knowledge management is the transformation process of knowledge from the individual to the group and further to organizational level.	Rasmussen e Nielsen (2011)
Knowledge management is a continuous network for interactions among agents aimed at handling, management, controlling, coordination, planning and organization of other agents, components and activities, through a process of generation and integration of knowledge.	Huzita et al. (2012)
Knowledge management includes all processes or activities for acquiring, capturing, sharing and using knowledge, wherever it may be, to enhance learning and performance in organizations.	Sadeghi e Salemi (2013)
Knowledge Management is the management process of creating, sharing and using organizational information and knowledge.	Girard e Girard (2015)
Knowledge management is an attitude, an approach, not an application.	McKellar (2015)
Knowledge management is the conscious organizational and managerial practices intended to achieve organizational goals through efficient and effective management of the firm's knowledge resources.	Inkinen (2016)

As mentioned earlier, although knowledge management relies on three different pillars – technology, people and process – and aims at achieving the objectives of organizations (Davenport & Prusak, 1998; Kalkan, 2008; Prieto et al., 2009), a special dedication to technology has been verified in practice (by organizations). There were substantial investments in highly structured knowledge management solutions, and little attention to knowledge creation processes (Grover & Davenport, 2001; Kakabadse, Kakabadse, & Kouzmin, 2003). Gill (2002, p. 255) observed that "an increasing tendency of excluding human participation, interpretation and mediation from all sorts of processes and systems in the name of notions such as efficiency, objectivity, transparency and certainty". Technology, by itself, is not a knowledge creator, but can become a process accelerator if used correctly (Malhotra, 2005). According to Webber (1993), the location of knowledge is not in technology, but in the human mind.

I.2.3.2.1 Knowledge management system processes

As a result of the wide diversity of definitions related to knowledge management, the literature presents different sets of process that comprise a knowledge management system (see Table I.5). In his study, Heisig (2009, p. 4) analyzed 160 models from diverse origins (academia, companies, consultants and associations and standardization bodies) and identified that "despite the wide range of terms used in the knowledge management frameworks an underlying consensus was detected regarding the basic categories used to describe the knowledge management activities".

The results of the Heisig study (2009) also show that the number of processes per model varies between 2 and 9, although, on average, 5 are observed. In general, the types of processes/activities identify the knowledge management model and each of them is related to the creation, sharing, or change of state of knowledge and its type of codification. For the purposes of this research, the following processes defined in the '*European guide for good practice in knowledge management'* (CEN, 2004) are considered: (i) knowledge creation; (ii) knowledge sharing; (iii) knowledge capture and; (iv) knowledge application.

Table I.5 - Definitions of knowledge management processes according to several studies in the literature.

Knowledge processes	Author
socialization, externalization, combination, and internalization	Nonaka et al. (1995)
creation – experimentation, adoption – standardization, distribution – diffusion, and review and revision - refinements	Bhatt (2000)
creation, storing/retrieving, transfer, and application	Alavi e Leidner (2001)
generation, codification, transfer, and realization	Grover e Davenport (2001)
creation, capture, sharing, and application	CEN (2004)
creation, acquisition, capture and articulation, assembly, sharing, integration and re-combination, leverage – realization of potential for use, and exploitation of (new) knowledge – realized application	Nielsen (2006)
creation, storage, distribution, application	Reimer e Karagiannis (2006)
capture, organizational learning, discovery, sharing, and application	Hoffman et al. (2008)
capture and acquisition, transfer, creation, and application	Birasnav e Rangnekar (2010)
application, capture, sharing, and discovery	Becerra-Fernandez and Sabherwal (2010)
identification, creation, storage, sharing, and application	Heisig (2015)

Knowledge creation

The creation process is one of the essential elements of knowledge management (Reimer & Karagiannis, 2006) and is related to the creation of new capacities, skills and knowledge in organizations. Knowledge creation is a non-systematic process with a tendency to progress (Bhatt, 2000; Nonaka, Toyama, & Nagata, 2000); that is to say, it is an endless and constantly evolving process (Bhatt, 2000; Pekka-Economou & Hadjidema, 2011). The process of knowledge creation is based on practices and technologies that can support the development of new knowledge.

Although some forms of knowledge management have ignored the human dimension in the process of knowledge creation (Malhotra, 2000), this process is led by people and is first created in people's minds (Becerra-Fernandez & Sabherwal, 2010; Bhatt, 2000). Malhotra (2000) argues that the latent imagination and creativity of the human mind, the unexplored tacit dimensions, the subjective and meaningful basis of knowledge, and the constructive aspects of knowledge creation and renewal, are important human aspects of knowledge creation that are difficult to replace with technology. Given these characteristics, the creation of knowledge can be considered an extremely difficult activity and, therefore, one of the most difficult to manage.

Nonaka and Takeuchi's SECI model (**S**ocialization, **E**xternalization, **C**ombination, and **I**nternalization) was at the forefront of how knowledge is created and managed in organizations. According to Nonaka et al. (1995), the creation and expansion of organizational knowledge occurs through the continuous interaction between tacit and explicit knowledge, rather than the two independently. This model considers that the process of knowledge creation is based on a continuous interaction between tacit and explicit knowledge, resulting from interactions between individuals or groups of people. It proposes four modes of knowledge conversion: (i) socialization - from individual tacit knowledge to tacit knowledge of the group; (ii) externalization - from tacit knowledge to explicit knowledge; (iii) combination - from distinct explicit knowledge to explicit systemic knowledge; and (iv) internalization - from explicit knowledge to tacit knowledge.

M.T. Hansen et al. (1999), in line with the definition of Nonaka and Takeuchi, use an analogy with the concept of 'LEGO' blocks. Existing 'blocks' (explicit knowledge) are reused while people apply the 'blocks' of their competencies (tacit knowledge) to construct something new; meaning that the tacit dimension reflects the human dimension being essential to the process of creation and innovation (Gill, 2002). The result is new and greater knowledge than the existing one. Figure I.19 represents the 'LEGO' concept.

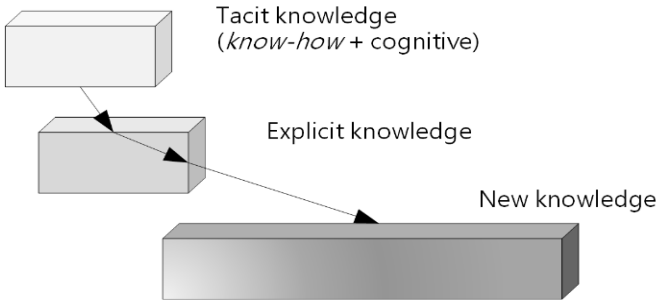


Figure I.19 - The concept 'LEGO' of knowledge creation.

Given that the process of knowledge creation is an extremely difficult activity, requiring skills that some organizations do not possess, knowledge acquisition is another form of knowledge creation that can be developed. Some authors also refer to this process as knowledge adoption (Bhatt, 2000; H.-C. Huang, Davy, Shih, & Fan, 2014). The acquisition of knowledge occurs when new knowledge

is obtained from external sources – such as individuals, groups and/or organizations (Nielsen, 2006). Acquisition of knowledge accelerates the process of developing new knowledge, an important factor in fast-changing environments (Kang, Rhee, & Kang, 2010), and enables the improvement of existing knowledge and the development of new skills and abilities (Liyanage, Elhag, Ballal, & Li, 2009; Nielsen, 2006). Given its characteristics, the acquisition of knowledge has been a feature widely used by small and medium-sized enterprises (Segelod & Jordan, 2004).

However, this is an activity that requires more of those on the receiving end; it is not enough to have acquisition capacity. In addition to the acquisition capacity, it is essential that the acquirer has the necessary skills to seek, identify and absorb new knowledge (Jantunen, 2005; Liyanage et al., 2009; Santoro & Bierly, 2006). Some authors consider that absorptive capacity plays a fundamental role in the acquisition of knowledge. Bierly et al. (2009, p. 483) distinguish the absorptive capacity between two components: (i) potential absorptive capacity - acquisition and understanding of external knowledge; and (ii) realized absorptive capacity - internalization, conversion and use of knowledge.

Knowledge sharing

Within the general context of knowledge management, knowledge sharing is a critical process that requires appropriate attention on the part of organizations. Knowledge sharing refers to the process of making individual knowledge, ideas and experiences available through conversion, so as to be understood and used by other individuals or communities (Ali, Gohneim, & Roubaie, 2014; Wang & Noe, 2010). This process can occur in written form, through documentation and systematization of knowledge, or in a social context, through the interaction between individuals or groups (Bosua & Scheepers, 2007). Knowledge sharing is associated with the collaboration process, since it is possible to leverage and create new knowledge, solutions, processes or products (Seonghee Kim & Ju, 2008; Tan, 2016).

Successful knowledge sharing is an important factor in knowledge management performance (Gaál, Szabó, Obermayer-Kovács, & Csepregi, 2015; Wang & Noe, 2010). However, several authors identify this process as a weakness in traditional knowledge management models (e.g. Ford & Mason, 2013; Sigala & Chalkiti, 2015; von Krogh, 2012). Organizations have been challenged in terms of effective knowledge sharing – especially tacit knowledge – and in ways to mitigate the effects of the loss of this type of knowledge. According to Gill (2002), the responsible factors for these challenges are the current business models with geographically dispersed enterprises and ongoing partnership and restructuring actions, as well as the increasing tendency to replace face-to-face communication with digital communication (which in turn increase the risk of exclude or reduce the human dimension of the knowledge cycle). Given this scenario, organizations "are faced with the challenge of how to get people to share their knowledge" (Gaál et al., 2015, p. 185), feeling increasingly forced to adopt better knowledge sharing practices, often using new technologies to support this practice.

Given that knowledge sharing is a process based on close relationships between the parties involved (Santoro & Bierly, 2006), several authors emphasize the importance of developing a trust relationship. They even point it out one of the main factors which can contribute to the success of the sharing process (Kuo, 2013; Sherwood et al., 2011; Webber, 1993). Moreover, it is common sense among these authors that trust becomes an important issue when the knowledge to be shared presents itself more in tacit than explicit form.

According to Currall and Inkpen (2006, p. 236), "trust is the decision to rely on another party (i.e. person, group, or organization) under a condition of risk" and Kuo (2013) adds that its evolution is a spiral process that occurs during the various interactions between the elements involved. However, due to the asymmetry between distrust and trust, the parties involved in the process tend to be reluctant, often turning it into a slow and incremental process of trust development (Cook, Hardin, & Levi, 2005). Its progress is the result of continuous relationships, which must be accompanied by adjustments of expectations among participants (Ankrah & AL-Tabbaa, 2015; Currall & Inkpen, 2006). Mehta et al. (2014) emphasize that the people involved in these relationships begin to trust each other as the relationship progresses and becomes increasingly successful and that increased trust results in greater likelihood of success. According to Webber (1993), the process of developing trust is difficult because it is always associated with vulnerability, conflict, ambiguity and ease of violation. Webber (1993, p. 38) supplements his view, by quoting Jack Welch - "trust and respect take years to build and no time at all to destroy". It is possible to suggest that the diffusion of mistrust in a network of relationships can be very fast, whereas trust is only disseminated in a set of highly special circumstances.

Despite the point of view expressed by various authors that trust is necessary for successful knowledge sharing, current business models, as already mentioned above, also constitute a challenge for the development of trust in relationships. In the opinion of Cook et al. (2005), trust is no longer the central pillar of the social order and may not even be considered very important in most processes of sharing and collaboration that are managed quite effectively. This happens even in situations with difficulties in establishing interpersonal trust. Interactions where there is methodology, successful management and stable common goals can achieve success without the involvement of trust (Cook et al., 2005).

Knowledge capture

Knowledge capture is a fundamental process of preservation and formalization of knowledge and the result is the incorporation of knowledge into the existing knowledge base, allowing its reuse and update (Becerra-Fernandez & Sabherwal, 2010; Rus & Lindvall, 2002). Although knowledge capture is one of the main objectives of knowledge management, Hoffman et al. (2008) point out that some organizations fail to use weak methods in this process.

The capture process has several methods and each method selected must be related to the knowledge type. The explicit knowledge (created or acquired) can be captured in various forms such as printed reports, meeting records, manuals, books and similar documents. On the other hand, the capture of tacit knowledge can occur during discussions and meetings with co-workers, stakeholders, institutional partners, consultants and specialists. Seminars, conferences and workshops also offer excellent locations for capturing tacit knowledge, which can come either from speakers or participants.

The challenge of the capture process is to properly identify that knowledge that is relevant and useful, while discarding those that do not meet the needs of the organization (Nielsen, 2006). According to Koskinen (2001, p. 2) "the capability to solve a problem is dependent on the richness of the existing knowledge structure". Bhatt (2000, p. 22) proposes a process of validation of some dimensions of the new knowledge: (i) adaptability - possibility to modify and revise knowledge in a way that makes their use possible in current and future problems; (ii) adequacy - possibility to offer different perspectives on the problems; (iii) coverage - allow for the detailed solutions of problems conceptualization, (iv) robustness - ability to map different problem levels with correct solutions and; (v) modularity - allow for the identification of knowledge components needed to be developed. Once captured, knowledge must be continuously evaluated to ensure its quality and relevance.

Knowledge application

This is the process of knowledge management that justifies the existence of all others. It makes no sense to create, share, and capture knowledge if it is not to be used and disseminated. According to Grant and Baden-Fuller (2004), the efficiency in the application of knowledge depends upon, first, the ability to integrate many different types of knowledge and, second, the ability to utilize knowledge to its full capacity.

Existing infrastructures and technologies in organizations – knowledge management systems – are only a means to promote knowledge and create an environment that facilitates and encourages the use of knowledge and its updating (Cabrera, Collins, & Salgado, 2006; Desouza, 2003b). It should be noted that only people are able to decide on the use of a particular knowledge. According to Van de Ven and Johnson (2006, p. 804), users of knowledge "selectively interpret and use knowledge as it serves their own purposes, fits their unique situations, and reflects their relations with their practicing community".

I.2.3.3 About knowledge management in knowledge intensive organizations

According to Swart and Kinnie (2003), the term 'knowledge intensive' can be used to characterize three contexts: (i) knowledge-intensive activities; (ii) knowledge workers and; (iii) knowledge-intensive organizations.

Knowledge-intensive organizations are those where knowledge is of more importance than other inputs. Their main activity is intellectual in nature, and therefore knowledge workers constitute the largest part of their teamwork (Alvesson, 2001; Drucker, 1994; Starbuck, 1992; Tzortzaki & Mihiotis, 2014). The absence of formal hierarchical structures and teamwork, where collaboration is fundamental, are the main characteristics of these organizations (Starbuck, 1992). This type of organization generally presents a robust ability to solve complex problems through creative and innovative solutions (Wong, 2005), as well as producing good results during collaboration activities with external specialists (Alvesson, 2001). Typical examples of this type of organization are consulting firms, research centers, engineering firms, high-tech companies, universities, software development companies, etc. (Aurum et al., 2008; Fullwood, Rowley, & Delbridge, 2013; Howell & Annansingh, 2013; Lindvall, Rus, & Sinha, 2003; Mehta et al., 2014).

Knowledge-intensive organizations have an important stock of knowledge that is the sum of the different expertise of each member of their team and of their daily activities supported by knowledge sharing (Bosua & Scheepers, 2007; Pee et al., 2010). This inventory has extraordinarily complex combinations of different layers, requiring the development of strong personal and team relationships, so that it is possible to share and leverage these competencies at a project and organizational levels (Edwards, 2003; Mehta et al., 2014; Nahapiet & Ghoshal, 1998; Shull et al., 2004). Personal relationship events involve explicit and tacit knowledge and play an important role in knowledge sharing and creation, and in interaction with other specific mechanisms, including technology. This makes the knowledge of these organizations more dynamic, which requires that each member of the team is kept up to date, avoiding the obsolescence of their knowledge (Aurum et al., 2008; Bjørnson & Dingsøyr, 2008; Desouza, 2003a). According to Lindvall et al. (2003, p. 137), "knowledge intensive organizations have realized that a large number of problems are attributed to un-captured and un-shared knowledge, as well as the need to know 'who knows what' in the organization".

Given that the solutions are increasingly multidisciplinary and that, for this reason, each team member has a different specialization, the creation and sharing of knowledge are increasingly fundamental processes within knowledge-intensive organizations (Lauring & Selmer, 2012). In general, specialized knowledge is tacit, which makes knowledge sharing more important in this type of environment (Ghobadi, 2015). The best use of tacit knowledge can guarantee a process of creating more efficient and effective solutions (Bierly et al., 2009).

According to their characteristics and their activities, it is fundamental that knowledge-intensive organizations define a knowledge management strategy (Lee-Kelley et al., 2007). The knowledge management strategy can be developed based on different approaches; however, several studies in the literature regarding knowledge management of this type of organization, have suggested the codification and personalization approaches (Desouza, 2003a; Fehér & Gábor, 2006; M. T. Hansen et al., 1999).

Codification is a 'knowledge conversion' approach to document knowledge, focusing on the use of technology. In this case, the knowledge is properly codified and stored in knowledge bases, so that anyone in the organization can access and reuse it. This approach is closely associated with explicit knowledge. On the other hand, personalization is a 'person-to-person' approach; meaning that knowledge is closely related to the person who developed or holds it and is shared through face-to-face contact. The aim is to facilitate exchanges by creating networks and encouraging face-to-face communication between individuals and teams through informal contacts, conferences, workshops, communities of practice, brainstorming, individual sessions, etc. This approach is more closely associated with tacit knowledge. Technology, given the characteristics of these organizations, plays an important role in supporting these approaches (Bosua & Scheepers, 2007; M. T. Hansen et al., 1999). M.T. Hansen et al. (1999) suggest three questions that may help define the main strategy to be adopted: (i) does the organization offer standardized or personalized products? (ii) does the organization have a mature or innovative product? and; (iii) do the teams of this organization depend, mostly, on explicit or tacit knowledge to develop new solutions?

Fehér and Gábor (2006) warn that the choice of one or another strategy is not a precondition for success. M.T. Hansen et al. (1999) add that organizations that achieve success are those that focus on one of the strategies and use the other as a support. In other words, they find a balance according to the type and use of the prevailing knowledge in each organization. The same authors add that organizations that try to excel in both approaches risk failing in both as well (M. T. Hansen et al., 1999).

Figure I.20 presents the strategy applied for process, technology and people, in each of the approaches.

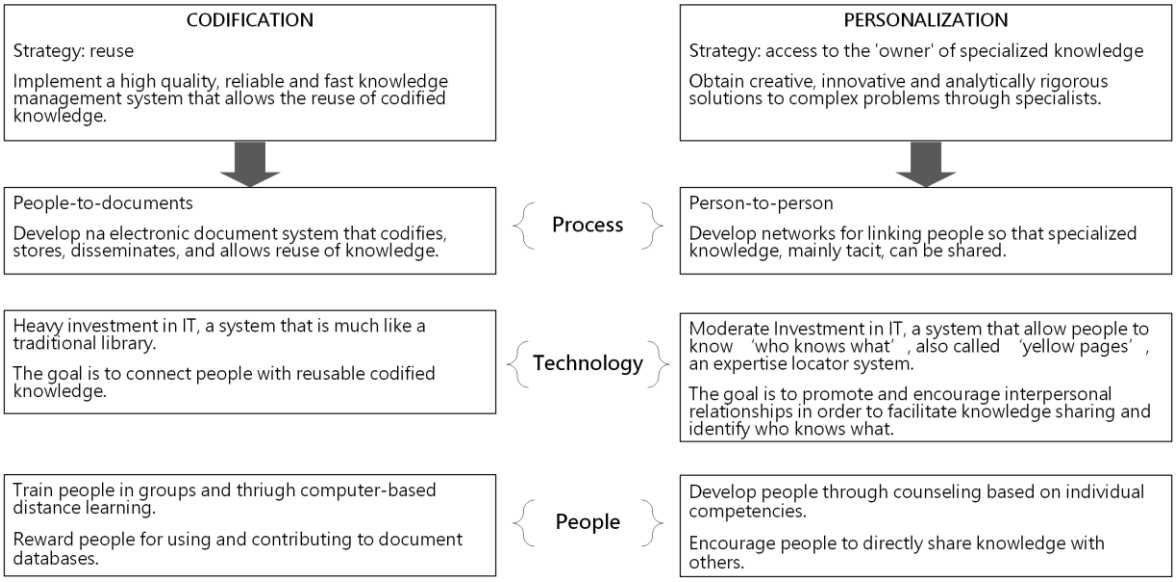


Figure I.20 - Approach strategy for codification and personalization of knowledge.
Adapted from M.T. Hansen et al. (1999)

I.2.4 Knowledge management in university-software industry collaboration relationship

Given the intensive knowledge nature of these two types of organizations, the collaborative strategy requires the integration of specialized knowledge, often multidisciplinary, and highly specialized, dispersed throughout each member of the work teams (Boyarchuk et al., 2018; Hermans & Castiaux, 2007). I.-E. Hansen et al. (2017) and Mehta et al. (2014) add that it is not enough just to save the results of collaborative projects, but rather that it is necessary to transform the results into knowledge and make it accessible. This is in order to be reusable in new and future projects, and to recognize and capitalize on the specific knowledge of each community and its diversity, so to strengthen the relationship and the social network. According to Hermans and Castiaux (2007), the knowledge obtained from a collaboration relationship can represent an excellent starting point for new collaborative projects. Gill (2002, p. 263) states that "it is the sharing of a common knowledge base that, continuously builds upon local knowledge bases which, is at the heart of a collaborative process". These facts, evidenced by the literature, indicate that possible solutions aimed at the sustainability of university-software industry collaboration relationships should be explored and evaluated from a knowledge management standpoint (Daria & Kostiantyn, 2018; Philbin, 2008).

Although knowledge management and collaboration are complementary, given that they have common, mutually interdependent purposes and practices (Qureshi, Hlupic, & Briggs, 2004), knowledge management in collaboration relationships lacks empirical studies. The few existing studies on this topic focus on outcomes or structures of success of the relationship (I.-E. Hansen et al., 2017), on reports of lessons learned (Bjørnson & Dingsøyr, 2008) or, as some authors have pointed out, identify universities as the only providers of knowledge and technology. There is a lack of evidence about the university's role as the recipient of knowledge created by the industry (Bozeman & Boardman, 2013; Jongbloed, 2015; Kutvonen et al., 2013). In addition, the scientific community has paid little attention to the role of knowledge in collaboration relationships and the consequent impact on the promotion of innovation and on society (I.-E. Hansen et al., 2017).

Thus, knowledge management assumes an important role for organizations in delivering the best performing solutions (Tippins, 2003). Particularly in the case of tacit knowledge, which requires considerable managerial resources, its value can ensure a more efficient and effective solution creation process, and the ability to manage such knowledge will define the difference between a good and a better performance (Bierly et al., 2009; I.-E. Hansen et al., 2017; Kidwell, Vander Linde, & Johnson, 2000).

I.2.4.1 Knowledge sharing in university-software industry collaboration relationship

Since the increase of knowledge is one of the principal focus of knowledge intensive organizations, such as university and software industry, knowledge sharing can be viewed as a primary process. Especially in knowledge-intensive organizations, such as university and software industry, there is an important stock of knowledge that is the sum of the different expertise of each member of their

team and of their daily activities supported by knowledge sharing (Bosua & Scheepers, 2007; Pee et al., 2010). This inventory has extraordinarily complex combinations of different layers, requiring the development of strong personal and team relationships, so that it is possible to share and leverage these competencies at a project and organizational levels (Edwards, 2003; Mehta et al., 2014; Nahapiet & Ghoshal, 1998; Shull et al., 2004). In general, specialized knowledge is tacit, which makes knowledge sharing more important in this type of environment (Ghobadi, 2015). This makes the knowledge of these organizations more dynamic, which requires that each member of the team is kept up to date, avoiding the obsolescence of their knowledge (Aurum et al., 2008; Bjørnson & Dingsøyr, 2008; Desouza, 2003a). However, organizations have been challenged in terms of effective knowledge sharing – especially tacit knowledge – and in ways to mitigate the effects of the loss of this type of knowledge.

The literature also suggests that knowledge sharing has particular influence in building and boosting collaboration within internal and external relationships (Plessis & du Plessis, 2007; Tan, 2016; Wu, Chuang, & Hsu, 2014). Knowledge sharing is associated with the collaboration process, since it is possible to leverage and create new knowledge, solutions, processes or products (Seonghee Kim & Ju, 2008; Tan, 2016). Several studies point out knowledge sharing as an important and strongly influential factor in a collaboration. Furthermore, strategies to promote the sharing of knowledge and collaboration are important requirements that contribute for the overall result being greater than the sum of its parts (Weber, Morelli, Atwood, & Proctor, 2006).

Collaboration has been considered a way to address the challenges of the 21st century, fostering the necessary innovation, growth, and productivity for all parties involved. Collaboration refers to the relationship and high level of knowledge sharing between team members (Nissen, Evald, & Clarke, 2014), and is the creation base for new knowledge (Nissen et al., 2014; Tan, 2016). Furthermore, collaboration promotes intense interaction among members of an institution, allowing for the resolution of issues or the discussion of common work tasks (Tan, 2016), improving the performance of these members, and contributing to the institution's success (Seonghee Kim & Ju, 2008).

The collaboration relationship between university and software industry has increasingly assumed an important role in the development and technological innovation (Frølund et al., 2018). This happens through knowledge sharing, which represents a fundamental resource in the achievement of innovative solutions for both parties (Ankrah & AL-Tabbaa, 2015; Melese et al., 2009). Furthermore, knowledge base built from the knowledge sharing in a collaboration relationship can represent an excellent starting point for new collaborative processes (Hermans & Castiaux, 2007). Gill (2002, p. 263) states that "it is the sharing of a common knowledge base that, continuously builds upon local knowledge bases which, is at the heart of a collaborative process".

Given that the solutions are increasingly multidisciplinary and that, for this reason, each team member has a different specialization, the knowledge sharing is increasingly fundamental process

within knowledge-intensive organizations (Lauring & Selmer, 2012). In general, specialized knowledge is tacit, which makes knowledge sharing more important in this type of environment (Ghobadi, 2015), and is often associated with the true value of this type of collaboration relationship (Edmondson et al., 2012). The best use of tacit knowledge can guarantee a process of creating more efficient and effective solutions (Bierly et al., 2009).

In nutshell, knowledge sharing is seen as leading to creation value since helps communities of people work collaboratively, builds new resources and abilities, and strengthening external collaborations between organizations. Daria and Kostiantyn (2018, p. 674) add that "the knowledge sharing is the main indicator of knowledge efficiency in organization". These facts, evidenced by the literature, indicate that possible solutions aimed at the sustainability of university-software industry collaboration relationships should be explored and evaluated from a knowledge sharing standpoint.

I.3 Objectives and research methodology

I.3.1 Objectives

The recognition of the increasing importance of the collaboration relationship between university and software industry reported in the literature and the need to better understand its management procedures, represent some of the reasons that motivated this study. Taking this into consideration, the main objective of this research is to identify and analyze a set of factors that enhance and/or facilitate the collaboration relationship between university and software industry, in a sustainable way, taking knowledge management into account. Thus, the following main research question emerges: "**How to leverage the collaboration relationship between university and software industry in a sustainable way, based on knowledge management?**"

Motivations are individual, organizational and contextual factors that encourage toward attaining a goal and play an important role in achieving results (Lee, 2000). The characteristics of the university and industry, the experience with university-industry collaboration relationships and areas of interest, are factors that can differentiate the establishment of motivation. Whereas the motivations for the participation in this kind of relationship are different for universities and industries (Ankrah & AL-Tabbaa, 2015), understanding the real meaning of each motivation is one of the important drivers for the success of the relationship. Therefore, the following specific question was formulated:

Q1: What are the main motivations that lead to the decision of establishing a collaboration relationship?

According to Wohlin (2012, p. 67), "successful collaboration doesn't just happen; it must be carefully planned and nurtured". Clauss and Kesting (2017, p. 186) suggest that the governance and management mechanisms of university-industry relationships "serve to define mutual

objectives, facilitate coordination, and reduce uncertainties and opportunism". Considering that the management mechanisms undertake an essential support role for this relationship and that they also influence both its frequency and success (Clauss & Kesting, 2017; M.-H. Huang & Chen, 2016; Muscio, 2010), the following specific question was defined:

Q2: What are the management mechanisms used in the governance of collaboration relationships?

Knowledge management assumes an important role for organizations with knowledge intensive activities. Particularly in the case of tacit knowledge, which requires considerable managerial resources, its value can ensure a more efficient and effective solution creation process. The ability to manage such knowledge will define the difference between a good and a better performance (Bierly et al., 2009; Kidwell et al., 2000). Moreover, the way by which knowledge is shared between partners and how it is managed in order to maximize the benefits for each partner is still relatively unknown (Geuna & Muscio, 2009; Hermans & Castiaux, 2007). The knowledge created and/or acquired from the knowledge shared in this relationship, enables both the university and industry to match their needs based on complementary knowledge. Thus, this represents a starting point for new projects, and work to develop effective collaboration relationships (Kaklauskas et al., 2018). Therefore, the following specific question was formulated:

Q3: What are the principles and culture of knowledge management and of knowledge sharing in these organizations?

In order to study this further, these questions were broken down as shown in Figure I.21.

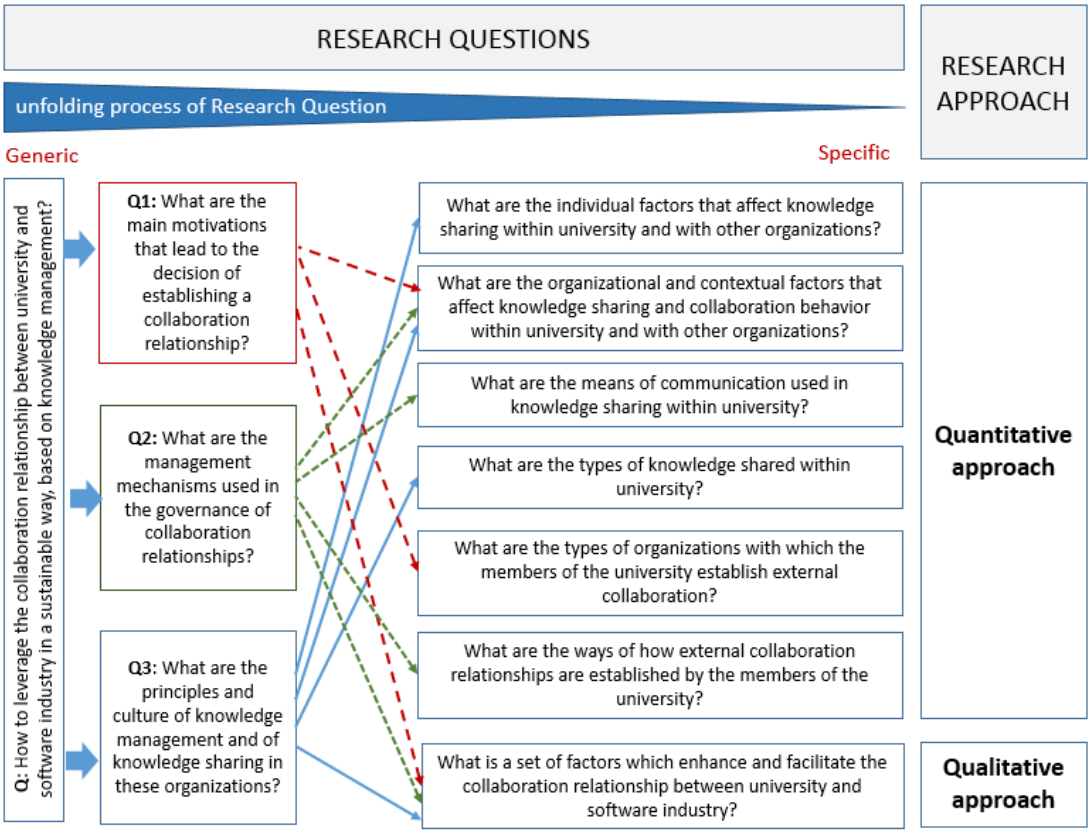


Figure I.21 - Research questions.

I.3.2 Research methodology

I.3.2.1 About Design Science Research

This research was based on the design science research (DSR) methodology, which has been primarily used in the Information Systems (IS) field (Hevner, March, Park, & Ram, 2004; Iivari, 2007). The predominance of DSR application in IS studies is mainly due to the fact that this discipline is located at the confluence between people, organizations and technologies (Hevner et al., 2004). However, in spite of its strong use in the IS field, DSR has also presented important results in studies that solve complex problems in the daily life of organizations; specifically in areas such as the collaboration relationship between university-industry (Holmström, Ketokivi, & Hameri, 2009; Rodríguez et al., 2014) and knowledge management (Baloh, Desouza, & Hackney, 2012; Markus, Majchrzak, & Gasser, 2002). DSR can "help accelerate the development of domain-independent and scalable solutions" in university-industry collaboration projects (Hevner & March, 2003, p. 113).

Hevner et al. (2004) also point out that DSR has a behavioral component - behavioral science - with the objective of developing and testing new theories that can explain or predict the behavior of people and/or organizations. Design science can also be used in the construction of innovative

devices, with the objective of understanding the limit of the capacity of people and/or organizations, to find solutions to certain problems. These authors define artifact as being a symbolic representation or a physical instance, such as a model, a method, a process, or even an information system. Peffers et al. (2007, p. 49) add that artifacts can also be social innovations or new properties added to existing resources, in other words, "any designed object with an embedded solution to an understood research problem".

The DSR is based fundamentally on the assumption of new knowledge creation, through the development of innovative artifact to solve a new observed problem (Hevner et al., 2004; Holmström et al., 2009; Vaishnavi & Kuechler, 2004). Holmström et al. (2009, p. 82) claim that the "relevance of design science research is typically not contested, because the very impetus of design science research is practical.", since it allows for the articulation between theoretical research and practical research. Hevner (2007, p. 91) concludes that DSR "is essentially pragmatic in nature", i.e. it emphasizes relevance and makes the contribution to the application environment clear. However, Hevner et al. (2004, p. 76) add that "designing useful artifacts is complex due to the need for creative advances in domain areas in which existing theory is often insufficient".

Regarding to DSR activities, Hevner (2007) determines three cycles that are part of the DSR development phases: the relevance cycle, the rigor cycle and the design cycle. Figure I.22 portrays a schematic of DSR, as well as the cycles that compose it and the way these cycles are related.

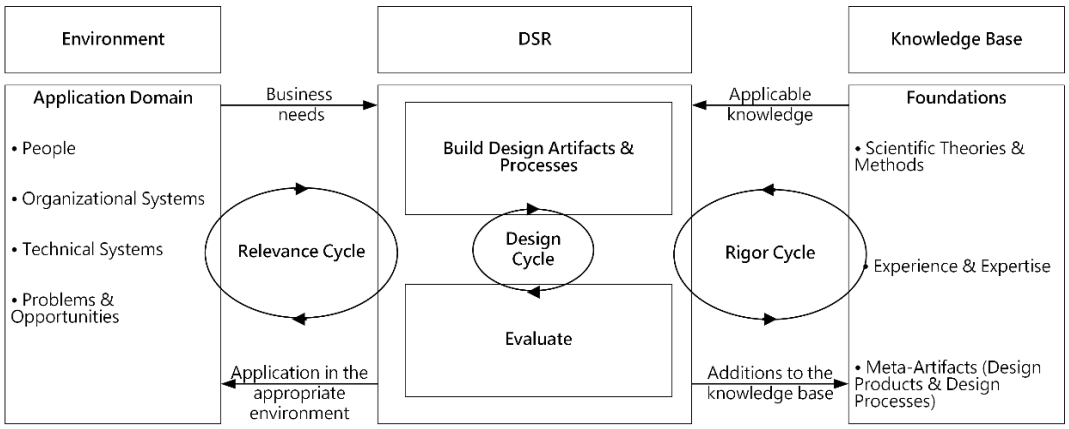


Figure I.22 - DSR cycles.
Source: Adapted from Hevner (2007) and Hevner et al. (2004)

In Hevner's view (2007), DSR involves a rigorous investigation process, with the objective of developing new artifacts, originating from an identified problem or simply from a motivation to improve the current situation. The relevance cycle starts the study with the definition of the problem, its application context and its limitations – in accordance with the existing rules and restrictions and acceptable criteria that allow for the evaluation of the results. It ends with a solution to the identified problem. The rigor cycle consists of analyzing and justifying the used theories, both in terms of the domain of the problem and in terms of the methods for the construction of the artifact; this resulting in a theoretical contribution that is added to the previously existing knowledge base. In this cycle,

an extensive review of the scientific literature is fundamental, in order to ensure that the created artifacts are effective contributions of innovation. The creation cycle concerns all the central activities that are carried out for the construction and evaluation of the created artifacts, which basically represent the research process.

The study by Iivari (2007) adds that it is possible to develop three types of knowledge during each DRS methodology phase. Descriptive knowledge (i.e. observable facts, empirical regularities, theories and hypotheses), which aims to describe, understand and explain the phenomenon or observed object; thus, contributing to suggestions for solutions to the problem that was the basis of the research. Conceptual knowledge (i.e. concepts, constructs, taxonomies, typologies and frameworks), with the structures and concepts designed for application in solving the problem. Finally, there is prescriptive knowledge, which produces alternatives to obtain the proper artifact.

I.3.2.1.1 Design Science Research in the investigation process

The present research was based on DSR, and the three constituent elements concern: (i) the environment characterized by two knowledge-intensive organizations - higher education institution and software industry - since the studied question is related to the collaboration relationship between these two types of industries; (ii) the knowledge base, which will support the theoretical foundation, both for understanding the problem domain, and for understanding the methods that will be used to address the problem and resolution of the solution; and also (iii) the research process that will be conducted, as can be seen in Figure I.23 and more detailed below.

At an early stage and in any research project involving an empirical or practical component, it is important to pay attention to the nature of the problem which was the basis for the research. Given Wieringa's approach (2009), this aspect is not discussed in the model of Hevner et al. (2004), but it constitutes as an important step in the research process. The same author, Wieringa (2009, p. 3), also points out that research may be "problem-driven", "goal-driven", "solution-driven" or "impact-driven". Considering this classification, and based on the DSR relevance cycle, the present research is at the confluence between "problem-driven" and "goal-driven". Both seek answers that can help improve a current situation, while the same may not be observed by its actors as a real problem.

Thus, with the present thesis being the purpose of looking for foundations that help answer the research question "How to leverage the collaboration relationship between university and software industry in a sustainable way?", the research process began with the literature review. This review allowed for (i) the identification of the existing theoretical framework in the problem domain, as well as (ii) the understanding of the best techniques that, within what could be done, allow a better understanding of the studied phenomenon, thus composing the **rigor cycle**. The literature review also allowed us to better understand the elements associated with the main research question,

enabling them to be deployed in more specific objectives and in the most appropriate research approaches in order to reach these objectives.

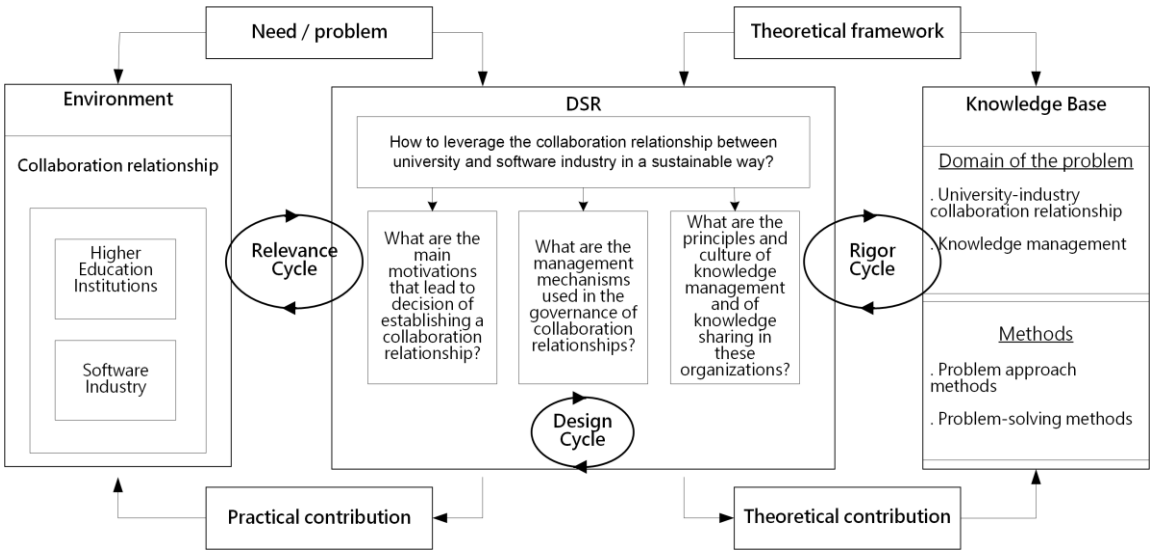


Figure I.23 - The research framework based on DSR.

Then, given the nature of the issues that determined the specific objectives of this study, a mixed research strategy was developed throughout the **design cycle.** It consisted of the approaches of collection and processing of quantitative data (questionnaire and statistical analysis) and of collection and processing of qualitative data (interview and content analysis). Figure I.24 outlines the research process, where these approaches can be observed in the research process.

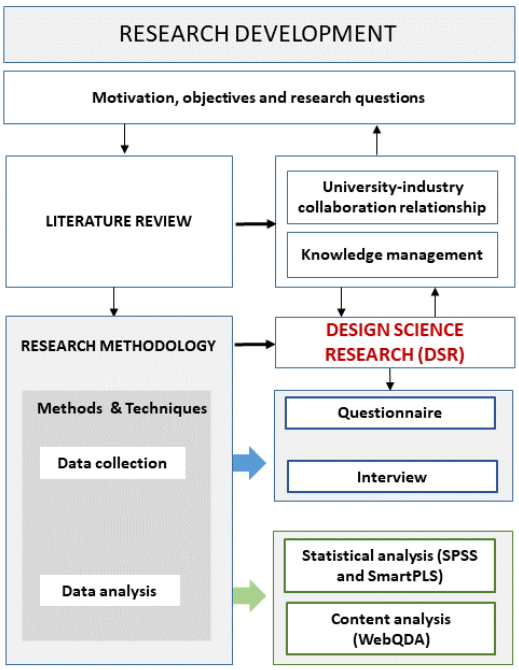


Figure I.24 - Research development supported on Design Science Research.

The research strategy followed in this project will be described further below.

I.3.2.2 Research strategy

Considering that this research is part of a multidisciplinary area, the methods used to collect quantitative and qualitative data were used in this study to answer research questions. The use of the mixed method provided a broader understanding of the research question, since it allowed access to different levels of reality - enabling a better understanding of the studied problems (Bryman, 2005; Creswell, 2009).

Next, the research strategies followed in each of the approaches (qualitative and quantitative) will be detailed in terms of data collection instruments, sample, procedure and result analysis.

I.3.2.2.1 Research strategy for the quantitative approach

Universities often play a central role in the university-industry collaboration relationships, "as they act as creators, intermediators, nodes, facilitators and resources" (Vuori & Helander, 2016, p. 952).

Considering the limited number of studies in the university's context regarding the relationship between knowledge sharing and collaborative behavior - especially within Portuguese institutions - there was a need to explore and deepen the understanding of this relationship in the context of the university that is the object of this study. Thus, this approach tried to identify elements that could help to interpret the answers given to the research questions.

Considering teachers and researchers as the main actors in the processes of knowledge creation and sharing, the present empirical study was conducted through the application of a questionnaire to this population. The decision of using the questionnaire for this study was due to the fact that this instrument is used, fundamentally, to examine the relationship between the component variables of the phenomenon to be studied in large samples (Creswell, 2009), where the focus is to test a theory and obtain a concise and limited result.

The quantitative data collection instrument - questionnaire

Based on the literature review and starting from the objective that was the basis of this study, a questionnaire was structured with closed questions around three sets of questions/information.

1. The first section covered a set of questions eliciting demographic characteristics of the respondents.
2. The second section was comprised of a set of questions with items adapted from previous studies in the context of knowledge sharing. This set of questions had the objective of measuring, through the opinion of each respondent, each of the constructs of a model, as well as to test their hypotheses (see more details of the model in the scientific work of Chapter VII). The response options for these items were presented to respondents on a

five-point Likert scale, generally used to measure attitudes (Likert, 1932). In it, '1' corresponded to the least favorable level – 'not agree at all', and '5' corresponded to the most favorable level – 'fully agree'. The option 'do not know/do not answer' was also available for all questions. All questions required mandatory response.

3. The last part of the questionnaire was composed of a set of questions aimed at collecting information regarding (i) the means of communication used in the knowledge sharing within the institution, (ii) the types of knowledge shared within the institution, (iii) the types of external organizations with which relations are established, and (iv) the way which these relationships are established. For this second group of questions a five-point Likert scale was used, where level '1' corresponded to the least favorable level – 'never' and '5' corresponded to the most favorable level – 'very often'. In this set, all questions also required mandatory response.

Table I.6 presents the questionnaire structure. The final version of the questionnaire can be consulted in Appendix I.1.

The pretest was conducted on a small scale by a panel of six professors/researchers. At the same time, they were requested to evaluate some questionnaire issues, using the form 'Survey Evaluation Sheet' (Appendix I.2). No major problems/issues that would require a major revision of the questionnaire were reported. The comments received in the evaluation process focused on the re-writing of some questions in order to clarify them.

Table I.6 - Final structure of the applied questionnaire.

Set 1 of questions - Demographic profile	1- Gender 2- Age 3- Level of education 4- Position in Department 5- Dedication 6- Scientific area 7- Years of service in current institution 8- Years of experience as professor 9- Years of experience as researcher 10- Average number of scientific conferences in which you participate annually 11- Average number of scientific articles published annually
Set 2 of questions - Measure, through the opinion of each respondent, each of the constructs of the model	1 - 4 - Intrinsic motivation 5 - 9 - Extrinsic motivation 10 - 13 - Networking 14 - 17 - Attitude toward knowledge sharing 18 - 20 - Organizational support 21 - 24 - Subjective norm 25 - 28 - Internal collaboration behavior 29 - 36 - External collaboration behavior 37 - 39 - Trust in sharing educational knowledge 40 - 44 - Educational knowledge sharing intention 45 - 47 - Trust in sharing scientific knowledge 48 - 49 - Scientific knowledge sharing intention
Set 3 of questions - Characterize knowledge sharing and collaboration practices	1 - 8 - Means of communication used in knowledge sharing within institution 9 - 12 - Types of knowledge shared within institution 13 - 16 - Types of external organizations with which respondents establish collaboration 17 - 25 - Ways of how external collaboration relationships are established

The sample

As stated before, the population of this study consisted of professors and researchers, who were members of the university that is object of study of this research. A total of 1020 professors and researchers were contacted through e-mail and requested to fill out the questionnaire. In total, 297 (29.1%) questionnaires returned, with 121 having been eliminated due to incomplete data.

As a result, 176 (17.3%) valid answers from 4 scientific areas (i.e. Life and Health, Natural and Environment, Science and Engineering, and Social and Humanities) were used in the data analysis. The sample was gender balanced (50.6% female and 49.4% male). In total, 75.5% of respondents had more than 10 years of professional experience and 66.5% had more than 10 years of affiliation with the institution.

The scientific works that make up Chapters VI, VII and VIII present a complete characterization of this sample.

The procedure for data collection

The study has been performed in the form of an online self-administered questionnaire. As the respondents were dispersed throughout different departments, schools and research units, the online survey was practical and convenient as a method of data collection. A link to a survey web platform (*LimeSurvey*) was made available through e-mail with it being carried out from March to April 2017.

The questionnaires were administered anonymously to ensure the confidentiality and the trust of the respondents, preceded by a preliminary introduction that explained the objectives of the study.

The data analysis

Regarding the statistical data analysis, after coding the response options for each question, the data was entered into a statistical package basis *IBM SPSS 24*, for descriptive analysis purposes. The descriptive data analysis was performed based on frequency, on central tendency or location, and on variability or dispersion beyond the distribution. In order to test the model, the coefficient of correlation between the various variables was calculated and the multiple linear regression was carried out (see details in Chapter VI). Subsequently, a multivariate technique was applied, structural equation modelling, by the partial least square method, using the *SmartPLS 3* software (Ringle, Wende, & Becker, 2015), as can be seen in more detail in Chapter VII.

The analysis and detailed discussion of the achieved results with the quantitative instrument can be found in Chapters VI, VII and VIII.

I.3.2.2.2 Research strategy for the qualitative approach

The qualitative approach of this research aimed to identify and analyze a set of factors which enhance and facilitate the collaboration relationship between the university and the software industry in a sustainable way, based on knowledge management. In line with the overall goal and taking into account a set of evidences reported in the literature, three specific objectives were defined, creating the three dimensions explored in this study:

a. What are the main motivations that lead to the decision of establishing a collaboration relationship?

b. What are the management mechanisms used in the governance of collaboration relationships?

c. What are the principles and culture of knowledge management and of knowledge sharing in these organizations?

The qualitative instrument, used a semi-structured interview, allowing access to the complexity and diversity of the reality of the object of study, through direct contact between the researcher and the situation in a contextualized and enriched way by the participants involved.

The qualitative data collection instrument - interview

Based on the literature review and starting from the objective that was the basis of this study, the use of a semi-structured interview was considered. This kind of instrument represents one of the most appropriate methods to explore participants' experience and reconstruct past events (Quivy & Van Campenhoudt, 1998). In order to conduct the interview, a previously prepared script was used (Berg, 2001), based on the literature review and document analysis, and structured according to the specific objectives mentioned above (Appendix II.1).

The sample

The semi-structured interview was applied to a group of participants considered relevant, since they assumed positions with decision-making powers. They were also able to provide the opportunity to obtain different and complementary visions and experiences related to collaboration activities. A sampling procedure appropriate to the objectives of the instrument in question was defined for each of the populations (university and software industry).

A non-probabilistic sample, referred to as purposive, was used for the university. Sampling decisions targeted research units (RU) that could bring greater contributions to the developing theory. Thus, four research units were chosen; RUs with an effective participation in the development and/or use of software in their activities. Five interviews were conducted over two months for the four RUs, which belonged to two different scientific areas. Participants were selected according to their role in the RU (responsible for the RU or responsible for a research group within a RU). The fact that these interviewees have an active participation in the decision-

making processes in these RUs makes it possible to classify them as privileged informants for this study. In order to anonymize the results, the interviews were coded,

The non-probabilistic technique called snowball (network or chain) was used for the industry. It uses the interviewees' contact network to indicate other contacts that have interesting characteristics to the study (Adams, Khan, Raeside, & White, 2007). The theoretical saturation criterion was used to determine the appropriate end point of the empirical data collection (Mason, 2010; Runeson & Höst, 2009). Nine interviews were conducted over a period of three months. The point of saturation appeared in the eighth interview, where it was possible to perceive that the interviewees' discourses on the relevant topics did not add new contributions. A final interview (ninth) was carried out, confirming the saturation. In order to maintain the anonymity of the interviewees, the interviews are coded similarly to the previous sample.

The characterization of the two samples (university and software industry) is described in more detail in Chapter IX of this thesis.

The procedure for data collection

All the interviews were conducted by the researcher, mainly face-to-face and audio-recorded with the consent of the interviewees. Note that only one interview was not recorded, because it did not have the interviewee's consent, because he/she did not feel comfortable issuing it. Due to the individual conditions of availability, two interviews were conducted through the *Skype* communication software and the rest of the interviews were carried out at the interviewees' premises.

At the beginning of each interview the interview protocol was presented to the interviewees (Appendix II.2) with the presentation of the subject and the purpose of the study. The confidentiality and anonymity conditions and the request for formal consent for recording and integration into the set of study interviews were also given at the start (Qu & Dumay, 2011). This first moment served as the starting point of begin the process of the trust building process between interviewer and interviewee. Also, in this initial phase, the characterization of the interview was also registered (Appendix II.3).

The data analysis

The content analysis approach was used for the analysis of the qualitative data obtained through the interviews. The content analysis aimed to broaden the knowledge of the studied context (Bardin, 2002) and to possibly elaborate an explanatory conceptual model.

In this study, the analysis took place over two main phases. In a first phase, the recorded interviews were carefully transcribed. Their repeated reading allowed us to rethink relevant topics and events that indicated responses to the study objectives. Afterward, the unit of registry was defined based

on the thematic criterion, which according to Bardin (2002) is used "to study the motives for opinions, attitudes, values, beliefs, leanings, etc.". The selection of the categories emerged from the study objectives and the evidences present in the literature. Thus, two central topics arose: (I) the collaboration relationship between the university and the software industry; and (ii) knowledge management. The *webQDA* software was used in a second phase, in order to help with the systematization process, and the interviewees' responses were categorized and codified. With the support of this software, the structure was constructed using 'tree codes' (Souza, Costa, Moreira, Souza, & Freitas, 2016), into categories and their respective subcategories, for each of the central topics.

After completing the content analysis phases based on the software, all the evidences that were found were systematized in terms of results. This was done in order to answer the starting questions that were the basis of the objectives of this study.

The scientific work in Chapter IX of this thesis presents the analysis and discussion of the results achieved through content analysis.

The structure of the thesis will be presented and justified in the following subsection that follows.

I.4 Thesis structure

The present thesis is structured into three parts, which unfold over ten chapters (Figure I.25) and appendixes. More details about each part and supporting chapters will be described below.

Part I comprises the general introduction (Chapter I) and presents a first introductory section outlining the research and its motivation (subsection I.1); the state of the art on the research focus (subsection I.2); the objectives of the research and the methodology (subsection I.3), and the present subsection with the thesis structure.

Part II is comprised of Chapter II to Chapter IX, where a set of scientific works is presented. These constitute the core of the research developed during the PhD studies, and include a total of seven articles in scientific journals and international book chapters, and one in international conference proceeding,

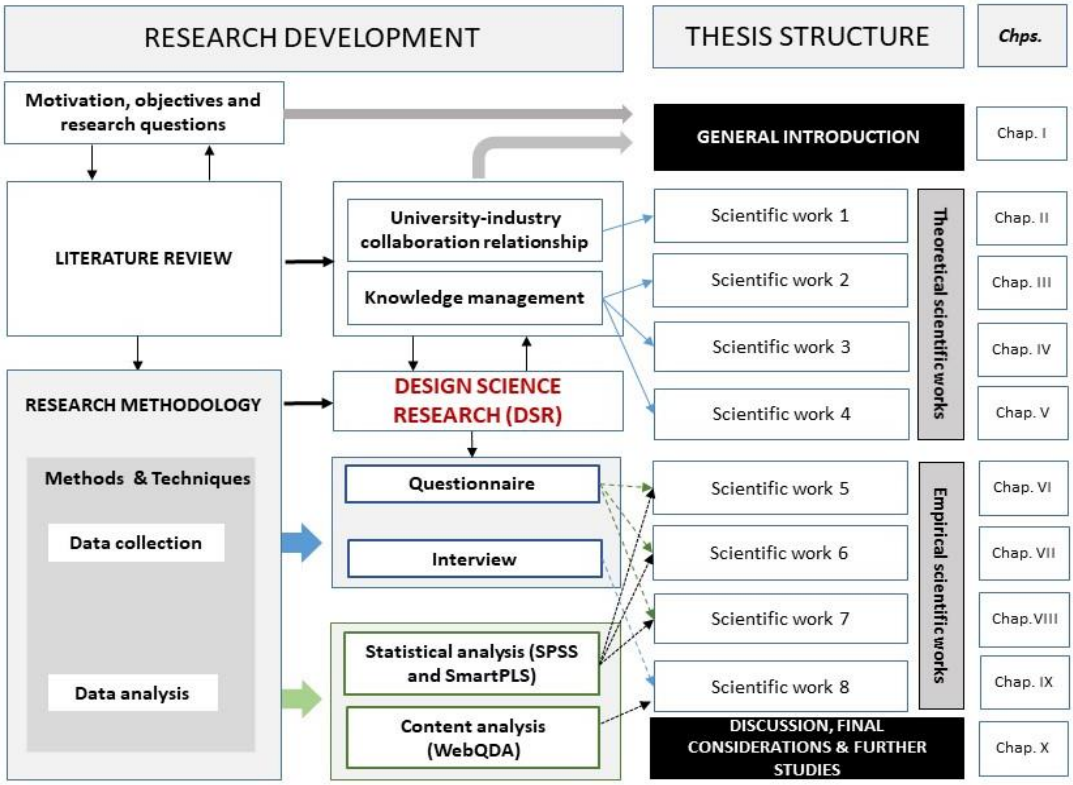


Figure I.25 - Thesis structure.

Table I.7 presents the complete reference of each of the referred documents.

Table I.7. Scientific works integrated in the thesis.

Chapter of thesis	Scientific works
II	**Chedid, M.**, & Teixeira, L. (2018). The university-industry collaboration. In M. Khosrow-Pour (Ed.), *Encyclopedia of Information Science and Technology, Fourth Edition* (pp. 3963-3975). Hershey, PA: IGI Global.
III	**Chedid, M.**, & Teixeira, L. (2017). The knowledge management culture: An exploratory study in academic context. In D. S. Deshpande, N. Bhosale, & R. J. Londhe (Eds.), *Enhancing Academic Research with Knowledge Management Principles* (pp. 29-52). Hershey, PA: IGI Global.
IV	**Chedid, M.,** & Teixeira, L. (2017). Knowledge management and software development organization: What is the challenge? In A. Bencsik (Ed.), *Knowledge Management Initiatives and Strategies in Small and Medium Enterprises* (pp. 226-246). Hershey, PA: IGI Global.
V	**Chedid, M.**, & Teixeira, L. (2018). The role of social media tools in the knowledge management in organizational context. In F. Di Virgilio (Ed.), *Social Media for Knowledge Management Applications in Modern Organizations* (pp. 31-57). Hershey, PA: IGI Global.
VI	**Chedid, M.**, Alvelos, H., & Teixeira, L. (-). Factors affecting attitude toward knowledge sharing: An empirical study on a higher education institution, *International Journal of Technology Management* (undergoing review).
VII	**Chedid, M.**, Caldeira, A., Alvelos, H., & Teixeira, L. (-). Knowledge sharing and collaborative behavior: An empirical study on a Portuguese higher education institution, *Journal of Information Science* (accepted).
VIII	**Chedid, M.**, Alvelos, H., & Teixeira, L. (2018). Characterization of knowledge sharing and collaboration practices in a Portuguese university: An empirical study (pp. 5764-74). *In 11th annual International Conference of Education, Research and Innovation: Meeting the Challenges of 21st Century Learning*, Seville, Spain.
IX	**Chedid, M.**, Carvalho, T., & Teixeira, L. (-). Collaboration relationship between University and Software Industry based on knowledge management: An empirical study in Portugal. *Journal of Knowledge Management*. (undergoing review).

The aim of the scientific work 1 described in **Chapter II** was to explore the main concepts associated with university-industry collaboration (UIC) and understand the three main drivers related to this collaboration relationship – motivation, channel of interaction and outcome. In order to achieve this goal, the literature was revised and consequently the main motivations to promote the interactions, the different channels of interaction and the expected outcomes were identified. During the review, it was possible to perceive the key role of the channels for the relationship. The proper identification and definition of channels of interaction allowed the motivations to be properly addressed and consequently achieve the outcome. Even if the motivation is well outlined, the incorrect identification of the channels can lead to failure in achieving the goals and, can consequently lead to the failure of the relationship, undermining future actions of partnership. Given the cultural and organizational differences existing between university and industry, the study also suggests that the establishment of a governance model is critical for the success of this relationship.

Chapter III (scientific work 2), based on the critical analysis of the literature, allowed for the identification that fundamental changes are needed in order to increase academic awareness about the importance of establishing a culture that, besides valuing knowledge, promotes the creation, sharing and application of knowledge more effectively. However, motivating individuals to share knowledge is not an easy task, especially when the institution does not encourage or adopt this process as the institutional culture. Given the character that distinguishes culture from academic institutions and their subcultures, there is no single model of knowledge management that adapts to all situations. The changes and their implementation must be gradual and must contemplate the unique characteristics of the academy.

Through the literature review, **Chapter IV** (scientific work 3) aimed to highlight the main challenge of knowledge management in software development companies. The current environment of software development companies is characterized by greater diversity and complexity in the developed projects. The software development process involves multidisciplinary teams and the work meetings that occur throughout a project are the source of the sharing of a large volume of knowledge, with a greater emphasis on tacit knowledge. Although the discussion of most of the authors is focused on the challenges of knowledge sharing in this context, this work emphasizes that knowledge sharing, to some extent, occurs among the members of these teams. This work points out the challenge in the implementation of mechanisms that make tacit knowledge as explicit as possible. The lack or deficiency of tacit knowledge capture and registration processes implies the waste of a valuable volume of shared knowledge, not allowing the maximization of its use in the current development project, as well as its reuse in future projects.

Chapter V (scientific work 4) was developed with the objective of reviewing and critically exploring the literature on the use of social media in the organizational context as a component of the knowledge management system. Social media has demonstrated that it is not just a 'trend' and is increasingly used by organizations as a component of knowledge management. The review

suggests that while traditional knowledge management systems are static and often act only as repositories of knowledge, social media has the potential to support the different knowledge management processes, impacting organizational culture, encouraging participation, collaboration and knowledge sharing. However, despite its recognized impact on knowledge management processes, there is still some uncertainty among academics and practitioners associated with the difficulty in understanding and measuring its real impact. This is probably due to the fact that it has not yet been fully exploited, because of its continued change and variety of platforms.

The motivation for **Chapters VI, VII and VIII** (scientific works 5, 6 and 7, respectively) comes from the difficulty that universities have had in establishing an organizational culture based on knowledge management that significantly promotes knowledge sharing and collaborative behavior among academics (teachers and researchers). The limited existence of available empirical studies that analyze this issue in higher education institution context served as the basis for these chapters. Furthermore, it is emphasized that, to date, no studies in the literature have been identified on these issues in Portuguese higher education institutions. Thus, this empirical component aimed to explore and deepen the understanding regarding the relationship between knowledge sharing and collaborative behavior within the academic-scientific community of the university that is the object of this research. This is done using a questionnaire to collect data.

According the literature, the knowledge sharing attitude is motivated and executed mainly at the individual level. The purpose of **Chapter VI** was to examine and analyze the individual factors that could affect the attitude toward knowledge sharing among professors and researchers in the specific context of a Portuguese higher education institution. The conceptual research model was developed based on the Theory of Reasoned Action and included the motivational factors (intrinsic and extrinsic motivations), and social networks as antecedents of the attitude. The result analysis, based on a multiple regression analysis, was performed using the statistic software IBM *SPSS 24*. The main results identified that intrinsic motivation and social networks positively affect the attitude toward knowledge sharing.

Chapter VII had as its main objective to examine and analyze if the knowledge sharing intention has a positive relationship with the collaborative behavior. It should be emphasized that the knowledge sharing intention can be affected by other factors - also studied in this context. In order to reach this objective, based on the Theory of Reasoned Action, first, the individual factors (i.e. intrinsic motivation, extrinsic motivation, and networking) that could positively affect the attitude toward knowledge sharing were examined and analyzed. This was followed by, how the attitude toward knowledge sharing, subjective norm and trust, affect the knowledge sharing intention; and finally, how the latter affects the internal and external collaborative behavior. Data analysis based on partial least square (PLS) was performed using the statistic software *SmartPLS*. In line with the previous study, the results indicated that intrinsic motivation and networking were the factors which positively affected the attitude toward knowledge sharing, while extrinsic motivation did not

influence it. The results' analysis also allowed for the identification of trust as the variable that more strongly affects the knowledge sharing intention - which is in accordance with other studies reported in the literature. Finally, the study identified that knowledge sharing intention has a positive influence on collaborative behavior, with this influence being stronger in the case of internal rather than external collaborative behavior.

Chapter VIII was based on the statistical analysis of the collected data referring to a set of questions of the questionnaire, aiming to explore the characterization of knowledge sharing and collaboration practices in an academic context. The analysis of the obtained results shows that in general, actions of knowledge sharing occur more frequently in the internal environment of the institution, using personal contact, phone calls, face-to-face meetings, e-mail and e-Learning tools, as the main ways of communication. The external collaboration is mainly with other higher education institutions and research units (RUs), and relationships are established through guidance and/or supervision of dissertations, internships, and projects and the participation and/or organization of conferences.

Finally, the purpose of the Chapter IX (scientific work 8) was to conduct an empirical study leading to the identification of a set of factors that can enhance the collaboration relationship between software industry and university, in a sustainable way, based on the knowledge management. In this study, the data collection took place through semi-structured interviews, and aimed to obtain and analyze perceptions and experiences of representatives of the software industry and the university. It is important to highlight that this work also aimed to fill a gap in the literature.

Finally, Part III of this thesis ends with the presentation of the general conclusions resulting from the research developed within the PhD study. Its limitations are discussed, giving hints toward further research that might improve the collaboration relationship between university and software industry.

Chapter II - The university-industry collaboration

Reference

Chedid, M., & Teixeira, L. (2018). The university-industry collaboration. In M. Khosrow-Pour (Ed.), *Encyclopedia of Information Science and Technology, Fourth Edition* (pp. 3963-3975). Hershey, PA: IGI Global. http://doi.org/10.4018/978-1-5225-2255-3.ch344

Republished in

Chedid, M., & Teixeira, L. (2019). The university-industry collaboration. In M. Khosrow-Pour (Ed.), *Advanced Methodologies and Technologies in Modern Education Delivery* (pp. 701-715). Hershey, PA: IGI Global. http://doi.org/10.4018/978-1-5225-7365-4.ch055

The university-industry collaboration

Abstract

The collaboration between academia and industry – university-industry collaboration – may occur according to different formats (multiple types) and recently has increased based on the third mission of the universities. This relationship offers advantages to both entities, addressing global challenges to their mutual benefit as well as benefits to society. Nevertheless, this relationship is complex and often appears threatening to both the university and industry through value and goals conflicts. In order to achieve success in this relationship, it is important to understand the three drivers that are part of university-industry collaboration (i.e. the motivation for collaboration, the channel of interaction and outcome, and benefits of collaboration). Their understanding allows one to mitigate barriers, overcome differences, create an environment of trust and commitment, and consequently, achieve success of the university-industry collaboration. This chapter aims to address these three main drivers of this relationship based on literature review.

Keywords

Channel of Interaction; Governance; Informal Collaboration; Motivation; Outcome; Types of UIC; University-Industry Collaboration

II.1 Introduction

The collaborations between academia and industry - University-Industry Collaboration (UIC) - may occur according to different formats (multiple types) and recently have increased based on the third mission of the universities – knowledge transfer between university and external actors. This relationship offers advantages to both entities, addressing global challenges to their mutual benefit as well as benefits to society. Both university and industry recognize the potential of UIC relationship. Nevertheless, this relationship is complex and often appear threatening to both the university and industry through value and goals conflicts. The major reason for this complexity is that the collaboration between partners with different models of organization and culture needs a considerable management effort in order to be successful.

Despite the relevance of the theme, the studies in this area neither explain the various complexities associated with this relationship, nor present recommendations of improvement for the process (Santoro & Bierly, 2006).

In order to achieve success in this relationship, it is important the understanding of three drivers which are part of UIC, i.e. the motivation for collaboration, the channel of interaction and outcome and benefits of collaboration. Their understanding allows to mitigate barriers, overcome the differences, create an environment of trust and commitment (Kauppila et al., 2015) and consequently achieve success of the UIC.

This chapter aims to address these three main drivers of this relationship based on literature review.

II.2 Background

II.2.1 The university-industry collaboration

Since the end of last century, factors such as the globalization, the growing competition and the rapid technological advances have transformed the complex business environment with impact on life cycles of processes, products and services (Kauppila et al., 2015; Mendes, Nunes, & Sequeira, 2012). This scenario forced the companies to find partners to face the new challenges, representing the University-Industry Collaboration (UIC) relationship a key resource for innovation (Lee, 2000), for promotion of technological change (Cohen, Nelson, & Walsh, 2002; Freitas, Geuna, & Rossi, 2013; Lee, 2000; Mansfield & Lee, 1996) and for promotion of higher productivity and greater economic growth (Freitas et al., 2013).

For universities, this relationship also became important, as with better awareness of the business value of its work and its research, universities have shown more interest in the marketing of their products (Santoro & Bierly, 2006). So, in addition, to contributing to the better training of their

students, the UIC can provide to universities access to expertise that they do not have and that is only possible with direct experience with companies (Ankrah & AL-Tabbaa, 2015).

In fact, both the university, and the industry recognize the potential of UIC relationship. Nevertheless, this relationship is complex and often appears threatening to both the university and industry through value and goal conflicts. The key challenge is the understanding of the organizational form of the other partner. As soon as each institution understands the needs of the other, a large number of opportunities will exist (Sherwood, Robinson, & Butts, 2011; Wallin, Isaksson, Larsson, & Elfström, 2014; Wright, 2008).

Universities and industries have different objectives, focus and ways of working, which represents some barriers to the UIC (Sherwood et al., 2011). One of the barriers faced in this relationship is the difference of views with respect to the deadline for execution of works. Universities have a long-term vision, while industries work with a short-term vision. The time frames are different (Pertuzé, Calder, Greitzer, & Lucas, 2010). Another important barrier highlighted by some authors refers to existing divergence between what is developed by the researchers in universities and the real needs or expectations of the industries (Franco & Haase, 2015) which sometimes are completely disconnected or opposed to seeking industries (Arza, 2010).

According to Santoro and Bierly (2006), academic researchers have not adequately studied many of the complexities associated with this relationship and thus have not been able to provide insightful recommendations to improve the process. Franco and Haase (2015) complement with the information that a great number of investigations is concentrated on the academic side of UIC and attention is mostly paid to the individual researchers.

Regarding the type of collaboration between university and industry, it can be established according to different approaches, having different types of classification (Figure II.26).

Generally, UIC is associated with the level of involvement of organizations and type of resources that are used, and the relationship include components such as problem solving, technology development, ideas testing or knowledge generation (Kauppila et al., 2015).

According to Nilsson et al. (2010), the different types of collaborations, sometimes occur simultaneously and in other cases one type is dependent on another.

In this sense, UIC relationships can be classified as formal or informal (Hagedoorn et al., 2000; Nilsson et al., 2010; Polt et al., 2001), and as short-term or long-term (Bruneel et al., 2010; Wallin et al., 2014). On the basis of its character the informal relationships are not much discussed or known (Hagedoorn et al., 2000), and usually do not require a formalized contract. This type of UIC relationship is, normally, a short-term relationship. On the other hand, the formal relationships require formalized agreements and generally are classified as a long-term relationship (Bruneel et

al., 2010) and therefore have a better chance for success (Lee, 2000). Verheugen and Potocnik (2005) suggests that a long-term relationship demonstrate commitment, leading to good results, mutual understanding and respect.

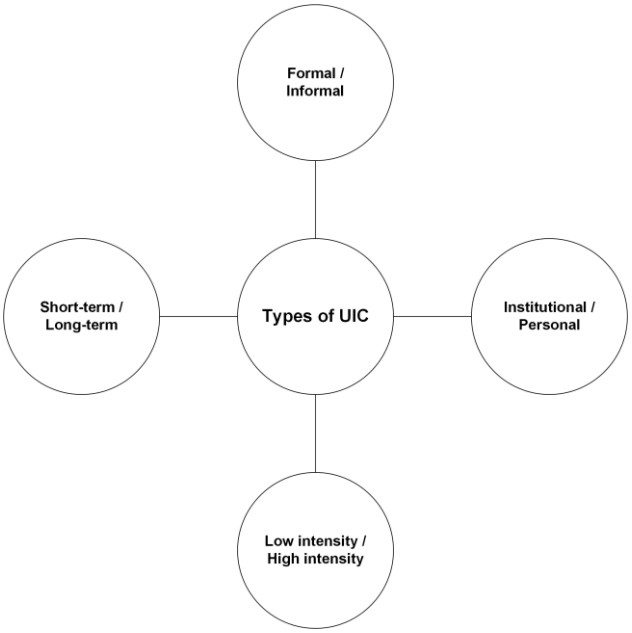


Figure II.26 - Types of university-industry collaboration.

UIC can be low intensity or high intensity (Perkmann & Walsh, 2007, 2009), being differentiated according to the intensity of contacts and activities demanded by the relationship. Finally, UIC can be institutional or personal (Freitas et al., 2013; Verheugen & Potocnik, 2005). The type of institutional relationship involves the structure of the university, while the personal mode refers to the direct contract between firms and researchers at the university.

II.2.2 The main drivers of university-industry collaboration relationship

In order to achieve success in UIC relationship, it is important the understanding of its three main drivers, i.e. the motivation for collaboration, the channel of interaction and the outcome and benefits of the collaboration. The understanding of these drivers and their proper articulation, allows to mitigate barriers, overcomes the differences, creates an environment of trust and commitment (Kauppila et al., 2015) and consequently achieve the desired success of the UIC.

According to the several literatures reviewed, the Table II.8 presents a complete information identified concerning to these three drivers – motivations, channels and outcomes – in the context of UIC. It is also identified the information of which is the focus (actor) of the articles, i.e. on the universities (U), industries (I) or both (U/I).

II.2.2.1 Motivations of interaction

The motivations are internal and external factors that stimulate to attain a goal, they are different for universities and industries (Ankrah & AL-Tabbaa, 2015) and it play an important role in the achievement of results (Lee, 2000), as well as in determining the type of channel to be used in the UIC.

Table II.8 - List of articles identified in the literature mentioning one or more drives.

Article	Actors	Motivations	Channels	Outcomes
Ankrah et al. (2013)	U/I	x	-	x
Ankrah & AL-Tabbaa (Ankrah & AL-Tabbaa, 2015)	U/I	x	x	x
Arza (2010)	U/I	x	x	x
Barnes et al. (2002)	U/I	-	x	x
Bekkers & Freitas (2008)	U/I	-	x	-
Freitas et al (2013)	I	-	x	-
Bruneel et al. (2010)	U	-	x	-
Cohen et al. (2002)	I	-	x	x
D'Este & Patel (2007)	U	-	x	-
D'Este & Perkmann (2011)	U	x	x	x
De Fuentes & Dutrénit (2012)	U/I	x	x	x
Dooley & Kirk (2007)	U/I	-	x	x
Dutrénit & Arza (2010)	U/I	-	x	x
Franco & Haase (2015)	U	x	x	-
Grimpe & Hussinger (2008)	I	-	x	-
Guimón (2013)	U	x	x	-
Hagedoorn et al. (2000)	I	x	-	x
Kneller et al. (2014)	U	-	x	x
Lee (2000)	U/I	x	-	x
Muscio & Vallanti (2014)	U	x	x	-
Nilsson et al. (2010)	U	x	x	-
Plewa et al. (2013)	U/I	-	x	-
Perkmann & Walsh (2007)	U	-	x	-
Perkmann & Walsh (2009)	U	x	x	x
Perkmann et al. (2013)	U		x	
Philbin (2008)	U/I	x	x	x
Polt et al. (2001)	U/I	x	x	-
Wallin et al. (2014)	I	x	x	x

Universities and industries seek through the UIC, to have access to resources, skills and abilities that are currently limited to one of the entities (Wallin et al., 2014; Wright, 2008). The characteristics of the university and industry, experience in this kind of relationship and areas of interest are factors that differentiate the establishment of motivation. Whereas the motivations for participation in UIC are different for universities and industries (Ankrah & AL-Tabbaa, 2015), understanding the real meaning of each motivation is one of the important drivers for the success of the relationship. (Guimón, 2013) complements stating that successful UIC needs to support the missions and motivations of each partner.

Regarding the motivation for universities collaborating with industries, the literature presents different aspects that may encourage universities to seek collaboration with industries. Based on the knowledge transfer between university and external actors known as third mission of universities, the most important one is the creation, transfer and sharing of knowledge. However, beyond the third mission, the universities look for ways to improve the training of its students, offering job opportunities to these students and to have access to expertise that they do not have and also to benefit from direct experience in companies (Ankrah & AL-Tabbaa, 2015; Lee, 2000). D'Este and Perkmann (2011) and Muscio and Vallanti (2014) also claim that, in recent years, due to cuts in government funding for research, universities have been more involved with industries, especially to get support for their research activities.

Arza (2010) summarizes and classifies the motivations of universities to collaborate with industries in two types: (i) intellectuals, regarding the exchange of information, education, ideas for new research, new publications and the consequent increase of academic productivity; and (ii) economics, relating to the funding of research.

Regarding the motivation for industries collaborating with universities, the available literature, although wide, is rather directed to developed countries. Probably, because in these countries the UIC has greater experience.

Lee (2000) lists a set of industries' motivations that appear frequently in the literature and support that the motivations for which the industries seek collaboration with university are many and complex, as industries have their own agendas for which they are willing to commit corporate resources.

Systematic review by Ankrah and AL-Tabbaa (Ankrah & AL-Tabbaa, 2015) shows motivations categorized according to Oliver's (1990) six critical determinants: necessity, reciprocity, efficiency, stability, legitimacy and asymmetry.

Arza (2010) classifies the motivations of industries to interact with universities in two types: (i) passive, using the results of the interaction for increased operational efficiency; and, (ii) proactive, exploiting the resources and expertise available in universities to develop innovative activities in industries.

II.2.2.2 Channels of interaction

Given that the UIC can promote gains for both parties involved in the relationship, it must go through an interface or tangible communication processes (Feng et al., 2015). The channels are the systems of interaction existent between the partners that allows the establishment of a relationship.

The authors in the subject consider a variety of channels of interaction may be set up (Nilsson et al., 2010; Sherwood et al., 2011), sometimes they occur simultaneously and in other cases one mechanism is dependent on another, and the emphasis in some channels depends on the motivation of each actor (Franco & Haase, 2015). Dutrénit and Arza (2010) and Arza (2010) add that some channels of interaction are more effective than others in order to achieve certain kinds of benefits. Despite the channel of interaction playing an important role of addressing motivation, it is often possible to observe that, regardless of the motivation, the well-known channels are the first to be addressed (Barnes, Pashby, & Gibbons, 2002a).

With regard to literature about channel of interaction, some studies focus on industry (Cohen et al., 2002; Freitas et al., 2013; Grimpe & Hussinger, 2008); other focus on university and industry perspectives (Ankrah & AL-Tabbaa, 2015; Arza, 2010; Bekkers & Freitas, 2008; De Fuentes & Dutrénit, 2012; Dutrénit & Arza, 2010; Polt et al., 2001) and the majority of UIC surveys are concentrated in universities.

Regarding the channel, an important point to emphasize is that university has been treated as a single unit (Bruneel et al., 2010) when in fact it is a complex organization. The report Global Connect (2007) conceptualizes it very well when affirms that university is a permeable system with multiple points of UIC. In other words, there are many doors to the university through which university partners can enter through to develop collaborative relationships. Although the relevance of the subject, most of the studies present in the literature are conducted in the perspective of the individual researcher.

Regarding to types of channels, there are multiple channels that can be used during the UIC. In this work, six groups to classify the interaction channels are identified: (i) information–including publications, conferences, informal contacts, others; (ii) R&D projects–including contract R&D, consulting, and joint R&D; (iii) licenses and patents; (iv) business–including joint or cooperative ventures, purchase of prototypes developed at science, creation of physical facilities, university spin-offs; (v) training–including supervision of PhDs and Masters theses, training of employees of enterprises, students working as trainees; and, (vi) human resources– including personnel mobility, hiring of recent graduates. Table II.9 presents compilation of the channels, based on the classification described above, that are cited in the reviewed articles that address this driver. It is also presented the information of which the actors are involved in the studies (U – University and/or I - Industry).

II.2.2.3 Outcomes of interaction

According to Ankrah and AL-Tabbaa (Ankrah & AL-Tabbaa, 2015), UIC is based on the assumptions that the benefits are greater than the (social) cost or risks associated with interaction. The capacity to generate significant outcomes, some expected and others unexpected (Lee, 2000), to the partners and society (Franco & Haase, 2015), has been one of the main factors that has

contributed to the expansion of the use of UIC. The literature presents relevant research on this topic.

Table II.9 - Channels of interaction and their actors across different studies.

Article	Actors	Information	R&D Projects	Licenses & Patents	Business	Training	Human Resources
Ankrah & AL-Tabbaa (2015)	U/I	x	x	x	x	x	x
Franco & Haase (2015)	U	x	x	x	x	x	-
Kneller et al. (2014)	U	-	x	x	x	x	x
Wallin et al. (2014)	I	x	x	-	x	x	-
Muscio & Vallanti (2014)	U	x	x	-	x	x	-
Freitas et al (2013)	I	-	x	-	-	-	x
Guimón (2013)	U	x	x	x	x	x	x
De Fuentes & Dutrénit (2012)	U/I	x	x	x	-	x	x
D'Este & Perkmann (2011)	U	-	x	x	x	-	-
Bruneel et al. (2010)	U	-	x	-	x	x	-
Dutrénit & Arza (2010)	U/I	x	x	x	x	x	x
Arza (2010)	U/I	x	x	x	x	x	-
Nilsson et al. (2010)	U	x	x	x	x	x	x
Perkmann & Walsh (2009)	U	-	x	-	-	x	-
Bekkers & Freitas (2008)	U/I	x	x	x	x	x	x
Grimpe & Hussinger (2008)	I	x	x	x	x	-	-
D'Este & Patel (2007)	U	x	x	-	x	x	-
Dooley & Kirk (2007)	U/I	x	x	x	-	-	-
Perkmann & Walsh (2007)	U	x	x	x	x	x	-
Cohen et al. (2002)	I	x	x	x	x	-	x
Polt et al. (2001)	U/I	x	x	x	x	x	x

Regarding the main outcomes promoted by the interaction, they differ between the partners of the relationship, and are strongly associated with initial motivation for interaction and with interaction channel used for this purpose (Arza, 2010). The recent systematic review by Ankrah and AL-Tabbaa (Ankrah & AL-Tabbaa, 2015) identifies an extensive list of UIC outcomes realized by universities and industries.

According to Lee (2000), the most significant outcome gathered by industries is an increased access to new university research and discoveries, and the most significant outcome by universities members is complementing their own academic research by securing funds for graduate students and lab equipment, and by seeking insights into their own research.

However, these considerable potential benefits are often not recognized in practice (Barnes et al., 2002a; Dooley & Kirk, 2007). The major reason is that collaborations between partners with different models of organization and different culture need considerable management effort in order to be successful.

For the UIC to be successful and reach mutual benefits, it is important that the channels are correctly identified in each level of the UIC (Ankrah & AL-Tabbaa, 2015), and having a clear definition of the desired and expected goals by the partners (Barnes et al., 2002a). Lee (2000) complements this reasoning, suggesting that the sustainability of the relationship is assigned to a mutual benefit.

Outcomes for universities

Several authors categorize universities benefits in two relevant outcomes: the intellectual outcomes and the economic outcomes (Arza, 2010; De Fuentes & Dutrénit, 2012; Dutrénit & Arza, 2010). In a recent survey made by Ankrah et al. (2013), social aspect is also focused and is classified in the lowest level, both for universities and industries. At the academy, the most cited social benefit is "interesting and provides personal satisfaction".

The literature points out acquisition of funds for research and lab equipment, and creation of business opportunities as main economics outcomes for universities (Ankrah & AL-Tabbaa, 2015; Ankrah et al., 2013; De Fuentes & Dutrénit, 2012; Lee, 2000). It is also possible to add the opportunity of sharing of equipment and instruments as another economic benefit (Ankrah & AL-Tabbaa, 2015; De Fuentes & Dutrénit, 2012).

As intellectual outcomes, authors refer gain of insights for further research and collaborative projects, knowledge sharing and opportunity to expose students and university to practical problems and to state-of-the-art technology (Ankrah et al., 2013; De Fuentes & Dutrénit, 2012; Lee, 2000).

It is important to point out that some authors present arguments that the UIC relationship is beneficial and advantageous to universities and there are those who consider harmful and threatening (Perkmann & Walsh, 2009). In the literature examined for this chapter it is possible to observe the conflict between the statements of different authors (Table II.10).

Outcomes for industries

Industry's partnership with universities may result in benefits to the industry to ensure competitive advantage and productivity gains with impact on financial performance (Ankrah et al., 2013; Pertuzé, Calder, Greitzer, & Lucas, 2010).

According to Ankrah et al. (2013), these collaborations give industries access to diverse resources, sometimes at prices lower than market rates, thus enabling industry to reduce their overall costs,

especially those relating to knowledge creation such as research and development. Another important point is that technological knowledge produced in the universities is the result of a dynamic development based on discussion of previous research results, including detailed documentation of trial-and-error events, which is sometimes difficult for industry to develop internally (Barnes et al., 2002a; Grimpe & Hussinger, 2008).

Table II.10 - Threats and opportunities to university across different studies.

Threats	Opportunities
Greater involvement with industry can corrupt academic research and teaching (De Fuentes & Dutrénit, 2012)	Greater involvement with industry can corrupt academic research and teaching (De Fuentes & Dutrénit, 2012)
Close collaboration facilitates interactive learning which in turn indirectly benefits scientific production by generating new ideas and motivating new research projects (Arza, 2010; Perkmann & Walsh, 2009)	Close collaboration facilitates interactive learning which in turn indirectly benefits scientific production by generating new ideas and motivating new research projects (Arza, 2010; Perkmann & Walsh, 2009)
Shift from basic research towards more applied topics and less academic freedom (D'Este & Patel, 2007; Perkmann & Walsh, 2009)	Shift from basic research towards more applied topics and less academic freedom (D'Este & Patel, 2007; Perkmann & Walsh, 2009)
Applied projects offer more learning opportunities during via highly interdependent interaction with industry (Perkmann & Walsh, 2009)	Applied projects offer more learning opportunities during via highly interdependent interaction with industry (Perkmann & Walsh, 2009)
Can reduce the openness of communications among academic research and put restriction on publishing (De Fuentes & Dutrénit, 2012)	Can reduce the openness of communications among academic research and put restriction on publishing (De Fuentes & Dutrénit, 2012)

In general, these studies categorize outcomes for industries as: (i) research and development (R&D) – acquisition of complementary or substitute R&D, innovation and new patents and processes; (ii) non R&D – technology transfer, acquisition of solution to solve production problem, acquisition of knowledge and access to qualify human resources; and (iii) quality – quality control and test of products and processes (Arza, 2010; De Fuentes & Dutrénit, 2012; Lee, 2000).

As shown above, social benefits are also classified at the lowest level by industry, being "enhanced image and reputation/credibility with the industrial community" the most cited benefit (Ankrah et al., 2013).

The UIC is based on the assumption that the benefits are greater than the costs and risks associated with the investment required (Ankrah & AL-Tabbaa, 2015). However, in general, greater investment in resources is done by industry. Then, from the company's perspective, is expected tangible benefits that include an appropriate return on investment through the value created from the technology generated (Philbin, 2008). However, in the literature reviewed for this chapter, it is possible to identify risks that offer some threat to the industry such as: (i) fundamental differences in the relative priorities, perspectives and time horizons of university and industry (Barnes et al., 2002a); (ii), gap between the knowledge produced by university researchers and what is used in practice (Arza, 2010; Franco & Haase, 2015); (iii) the loss of control of vital technology and information leakage about the firm's new technologies (Ankrah et al., 2013); (iv) other risks cited, like as financial and market risks, risk of incompetent academics in the technology transfer process, risk of incomplete transfer, and risk of non-performance of the technology (Ankrah et al., 2013).

The Figure II.27, based on the literature reviewed, presents a resume of the three drivers discussed above.

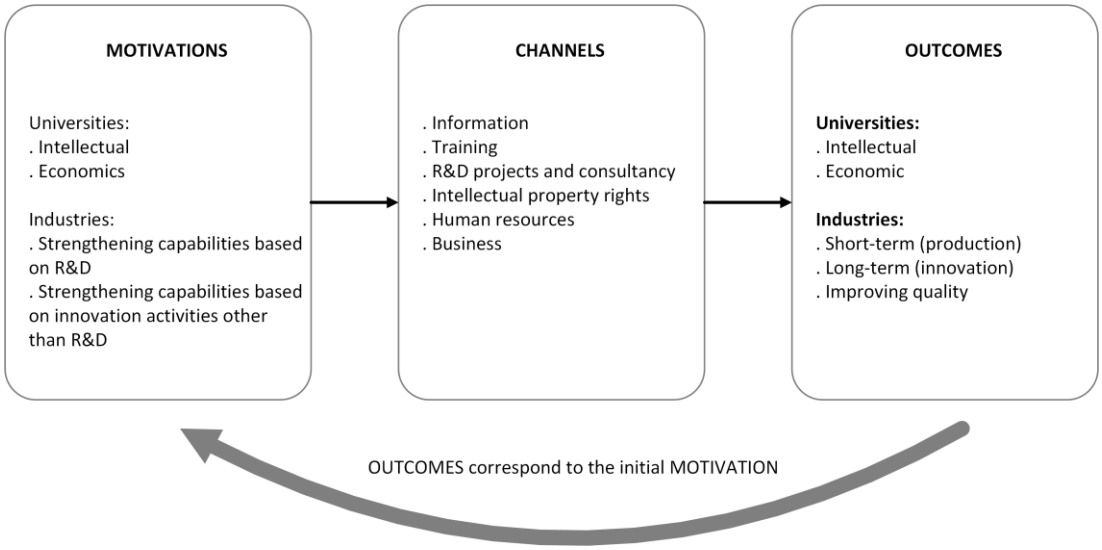


Figure II.27 - Motivations, channels of interaction, outcomes of UIC.

II.3 Future research directions

Some directions of future research in this topic could be associated with the need to understand better the UIC relationship. At first, the authors consider that although the UIC be a relationship between two organizations with fundamental differences, it is possible to identify in the literature that the major part of studies emphasizes the impact of the university on the industry. Probably caused by the fact that the authors of research articles working in universities. As an example, is mentioned the article (Cohen et al., 2002), reference too many other articles, which does not refer any impact of industry on university (Feng et al., 2015). It is expected that future researches are needed to examine the contributions and impacts of the relationship on each partner. Secondly, despite of universities are complex organizations with diversity and conflicts, many studies in UIC have treated the university as a single unit (Bruneel et al., 2010) and mostly into the individual researcher. Such differences are considered as major obstacle to successful UIC (Barnes et al., 2002a). The development of a systematic procedure of governance and management of UIC relationship is essential to its success.

Finally, it is possible identify other areas for further research: (i) development of a performance measurement system for UIC and, (ii) the shift in modern economies from manufacturing to services sector become this sector an important area for future researches.

II.4 Conclusion

The aim of this chapter was to approach and understand the three main drivers of the UIC relationship – motivation, channel of interaction and outcome - that the authors consider that may lead this relationship to success and achieve mutual benefits and therefore promote the establishment of a long-term relationship. In order to achieve this goal, the literature was revised and consequently the main motivations to promote the interactions, the different channels of interaction and the expected outcomes were identified. During the review, it was possible to perceive the key role of the channels for the relationship. The proper identification and definition of channels of interaction allow the motivations are properly addressed and consequently the outcome achieved. Even if the motivation is very well outlined, the incorrect identification of the channels will lead to failure in achieving the goals and the failure of the relationship, undermining future actions of partnership. The authors also recognize, considering the differences of culture and organizational models between the partners involved in the UIC, that it is critical for the success of this relationship the establishment of a governance model for relations of partnership between universities and industries. The industry has the opportunity to support this aspect for its large experience in developing and implementing projects. The Figure II.28 presents a framework to the understanding of the UIC relationship, based on the three main drivers described above.

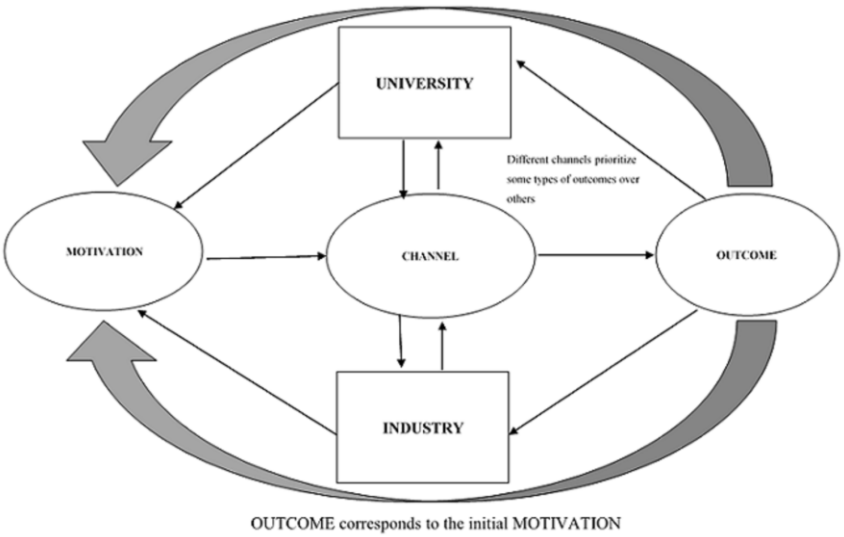


Figure II.28 - UIC framework.

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II.7 Key terms and definitions

Channel of Interaction: mechanisms of interaction existent between the partners of a relationship.

Governance: the establishment of policies, and continuous monitoring of their proper implementation to ensuring effectiveness.

Informal Collaboration: mechanism that does not involve any contractual relationship between the university and the industry.

Motivation: internal and external factors that stimulate to attain a goal.

Outcome: consequence or conclusion after a period of time, which can be one result, multiple results, or no results.

Types of UIC: organization forms of UIC relationship.

University-Industry Collaboration (UIC): bi-directional relationship between university and industry entities, established to enable the diffusion of creativity, ideas, skills and people with the aim of creating mutual value over time.

Chapter III - The knowledge management culture: An exploratory study in academic context

Reference

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The knowledge management culture: An exploratory study in academic context

Abstract

Knowledge management is defined by different authors as the process that enables the sharing, capture and application of knowledge from the individual to the group and further to organizational level. The organizational atomization observed in the academia imposes importance in paying attention to a culture that encourages knowledge management and also assigns equal importance to the cooperation and the work in team. However, due to the different levels of heterogeneity among and within these organizations there is not just one model that fits well. Through a literature review on the knowledge management in the academia, the purpose of this chapter is an exploratory study that identifies the main cultural challenges in the development and implementation of a knowledge management system in the academic context.

Keywords

Academia; Academic members; Codification approach; Knowledge-intensive organization; Knowledge management culture; Knowledge sharing; Organizational culture; Tacit knowledge

III.1 Introduction

Knowledge management (KM) has been mainly developed in the corporate knowledge perspective. Nevertheless, there are other environments within which KM should be studied, such academic context. Despite the wealth of knowledge and knowledge-intensive (KI) activities, in general, the academia does not have their knowledge properly organized and they have been paying little attention to their management, differing from the corporate sector (Ali, Gohneim, & Roubaie, 2014; Geuna & Muscio, 2009; Rowley, 2000). Geng et al. (2005) indicate that the application of KM in this context is fairly recent and that the first publication is dated in 1997.

The social academic communities are constituted by universities, public research institutes, and public research laboratories (Perkmann & Walsh, 2007).

Several authors have the opinion that the development and implementation of knowledge management processes in the academia presents often some difficulty (Petrides & Nodine, 2003; Rowley, 2000; Tippins, 2003). Although its missions are closely related to the management of knowledge (Howell & Annansingh, 2013; Tian, Nakamori, & Wierzbicki, 2009), and the existence of some important facilitator elements (e.g. large experience and expertise in creating and developing knowledge, and the horizontal and academic structure organizational).

In a similar way to the other KI organizations, academia is exposed to marketplace pressures (Rowley, 2000), which makes as critical as in the corporate sector the use of mechanisms of KM (Howell & Annansingh, 2013; Kidwell, Vander Linde, & Johnson, 2000). However, academia faces some difficulties in establishing an organizational culture that focuses on KM and significantly boosts the sharing of scientific knowledge.

The academic environment has certain characteristics that dominate their culture and that need to be understood. According to Tippins (2003), the academic environment is characterized by a group of individual experts in different and diverse areas of knowledge. This environment of diversity propitiates the development of sub-cultures (Howell & Annansingh, 2013) transforming these communities in complex social organizations composed by diverse cultures, predominating the academic freedom and autonomy (Sporn, 1996), where close control can induce negative reactions (Starbuck, 1992).

Knowledge in academic context is created by different forms and is related to the experience and competence of their teachers and researchers, without any coordination or management in line with a specific strategy. Geuna and Muscio (2009, p. 99) add that “the characteristics of individual researchers have a stronger impact than the characteristics of their departments or universities”. According to Tian et al. (2009), basically, in the creation process of new knowledge academics reach required knowledge from three dimensions (scientific, social, and creative) and can be

supported from four knowledge sources (supervisor or professor adviser, colleagues, self-study, and outside scholars).

The created knowledge becomes explicit through articles, patents, books, conferences, classes, etc. In the meantime, part of this created knowledge is kept in the tacit form.

An effective KM in academic context is possible. However, the organizational atomization observed in the universities imposes importance in paying attention to a culture that encourages KM and also assigns equal importance to the cooperation and the teamwork (Bjørnson & Dingsøyr, 2008; Howell & Annansingh, 2013; Sporn, 1996).

Thus, in order to provide knowledge-intensive inputs to companies, government and to society (Schmitz, Teza, Dandolini, & Souza, 2014), as pointed out by Kidwell et al. (2000), the academia has to move from the old culture that considers, “What is in it for me?” to a new one “What is in it for our customer?”.

From a critical analysis derived from the literature on the KM in the academia, the purpose of this chapter is an exploratory study that identifies the main cultural challenges in the development and implementation of knowledge management processes in the academic context. The chapter also aims to address some further research directions.

In this chapter the authors address the non-profit academies, since the non-profit institutions tend to reflect more similar characteristics to business organizations (Kezar, 2001).

III.2 Background

III.2.1 About knowledge management

The advancement of an economy based on knowledge has increased the visibility and importance of organizations that create and disseminate knowledge. Through knowledge, organizations can disrupt limitations, enhancing development and create new opportunities (Pekka-Economou & Hadjidema, 2011).

Even though knowledge and information are far from identical, the concept of knowledge has varied considerably, and is often used as something similar to information (Kakabadse, Kakabadse, & Kouzmin, 2003; Mårtensson, 2000) or is used interchangeably (Stenmark, 2001).

There is not a common knowledge definition accepted and, as such, knowledge is defined according to the context in which it is discussed (Gloet & Terziovski, 2004; Stenmark, 2001; Stoyanov, 2014). Rowley (2007) agrees that knowledge is an elusive concept which is difficult to define.

Regardless of the concept, knowledge always brings their respective truths and beliefs, judgments and expectations, methodologies, and know-how (Prieto, Revilla, & Rodríguez-Prado, 2009; Reimer & Karagiannis, 2006).

Knowledge-intensive (KI) can be applied to organizations in which knowledge has more importance than other inputs (Starbuck, 1992), work is mainly of intellectual nature (Alvesson, 2001), and consequently where knowledge workers are the major part of team work (Drucker, 1994; Tzortzaki & Mihiotis, 2014). Generally, KI organization has the capacity to solve complex problems through creative and innovative solutions (Wong, 2005). Social norms of openness and teamwork, where cooperation is fundamental, are key cultural characteristics in this type of organization (Starbuck, 1992). Alvesson (2001) adds that KI organization can also produce good results with the help of outstanding expertise.

The KM is crucial in organizing processes and can representing many gains for the KI organization. However, Rowley (2000) highlights that an effective KM process may require significant changes in culture and values, and in organizational structure.

III.2.1.1 Types of knowledge

The different dimensions focused by the authors in different fields of study result in various classifications and distinctions of knowledge. Alavi and Leidner (Alavi & Leidner, 2001) summarize the various views of knowledge under different perspectives and present knowledge taxonomies. Johannessen's (2008) study offers a schematic depiction of different knowledge distinctions, and Kakabadse et al. (Kakabadse et al., 2003) answer the question "What is knowledge?" presenting a table of taxonomies that addresses types and forms of knowledge and level of embodiments.

However, the major part of authors adopts the classical division introduced by the Hungarian chemist and philosopher Polanyi (1966), and widely spread by Nonaka et al. (1996): knowledge can be explicit or tacit.

Explicit knowledge (EK) is a type of knowledge that can be easily codified, articulated, documented and archived, and usually, it is stored and expressed in the form of texts, data, scientific expressions, maps, manuals and books, websites, etc. (Alavi & Leidner, 2001; Iacono, Nito, Esposito, Martinez, & Moschera, 2014; Nonaka & Konno, 1998; Polanyi, 1966; Santoro & Bierly, 2006; Seidler-de Alwis & Hartmann, 2008).

Tacit knowledge (TK) is the basis of knowledge creation, it is complex and not codified, and presents some difficulties in its reproduction in document or database. Smith (2001) reports that 90 percent of the knowledge in any organization is TK and it is embedded and synthesized in peoples' heads.

In general, the literature mentions the existence of two dimensions of TK: (i) technical and (ii) cognitive (Alavi & Leidner, 2001; Nonaka & Konno, 1998). The technical dimension is often referred to as expertise, and consist of informal personal skills, and crafts that apply to a specific context. The cognitive dimension refers to mental models, beliefs, ideals, values and paradigms, which are deeply ingrained in people. Nonaka and Konno (1998) suggest that while difficult to articulate, this cognitive dimension of TK shapes the way each one person perceives the world.

Some authors even differentiated the knowledge between individual and organizational (Birasnav & Rangnekar, 2010) assuming that the individual resides entirely in the mind of each person, while the organizational exists in explicit and tacit forms and may be resident in people, groups, documents, processes, policies, physical contexts or in data basis.

III.2.1.2 Knowledge management

After the information management, a neutral and normative system in the organizations (Gloet & Terziovski, 2004), the KM emerges as a distinct area of study, establishing as a significant source of competitive advantage and as one of the most important resources in the capacity of progress of modern organizations (Mårtensson, 2000; Pekka-Economou & Hadjidema, 2011).

Prusak (2001) indicates that the first conference devoted to KM occurred in Boston in 1993. Strongly influenced by Nonaka and Takeuchi's book (Chen, 2006), the KM expanded rapidly in various fields such as psychology, management science, sociology, strategy, production engineering, etc. This wide diversity of areas transforms KM in a complex and multi-faceted concept (Alavi & Leidner, 2001), reflecting the wide range of definitions, leading in the absence of a standard and universally accepted definition (Chen, 2006; Kakabadse et al., 2003; Sadeghi & Salemi, 2013). In a recent article, Girard and Girard (2015) listed more than a hundred KM definitions from twenty-three distinct domains. It is important to note that, in general, such definitions bring with them the concepts of the domains in which they are applied.

Although the absence of consensus regarding the definition of KM, the Davenport et al.'s (1998) definition is one of the most cited in the literature: "KM is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives".

Knowledge management is based on three main pillars: (i) technology, (ii) people, and (iii) process (Kalkan, 2008; Prieto et al., 2009). Considering that a knowledge management system is not an automatic data processing system (Tuomi, 1999), the focus should not be on one element, and is certainly a combination of all three the best approach (Bjørnson & Dingsøyr, 2008).

III.2.1.3 Knowledge management culture

The organizational culture of each organization affects the implementation and sustainability of KM. According to Davenport et al. (1998), in order to create a favorable environment for a successful KM, a discussion that considers its relation to the culture of the organization (Figure III.29), is appropriate.

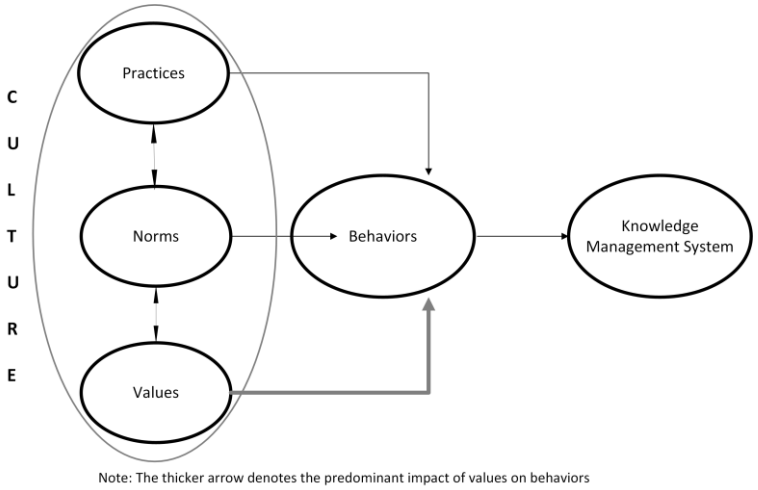

Figure III.29 - Elements of culture.
Adapted from (De Long & Fahey, 2000)

Organizational culture is created and maintained through different interactions between team members, teams, organizations, etc., and reflects the behavior that is characterized by the values, norms and practices commonly accepted by the members of the organization (De Long & Fahey, 2000; Jolaee, Md Nor, Khani, & Md Yusoff, 2014; Omerzel, Biloslavo, & Trnavcevic, 2011). De Long and Fahey (2000) alert that at the deepest level, culture consists of values that are often difficult to change, but in the meantime should never be underestimated.

For De Long and Fahey (2000), organizational culture is recognized as a major barrier to leveraging knowledge. They identify four ways which organizational culture influences the behaviors in knowledge management process: (i) shapes assumptions about what knowledge is and which knowledge is worth managing; (ii) mediates the relationships between levels of knowledge; (iii) creates the context for social interaction; (iv) shapes the processes by which new knowledge is created, legitimated, and distributed in organizations.

III.2.2 The culture of knowledge management in the academic context

The academic institutions are social communities constituted by universities, public research institutes, and public research laboratories (Perkmann & Walsh, 2007). Many of them are a conglomerate of autonomous subunits, composed by a group of individual experts, with loose links and a high degree of specialization in the disciplines, which are organized in different domains of

knowledge (Sporn, 1996; Tippins, 2003). These individual experts are simultaneously developers, users, and bearers of knowledge (Omerzel et al., 2011).

Due to its missions closely related to the KM (Table III.11), academic institutions have a cultural, social and technological structure highly favorable to the practices of KM (Howell & Annansingh, 2013; Tian et al., 2009), and a significant experience and expertise in creation, sharing and dissemination of knowledge, especially explicit knowledge (Rowley, 2000). The academia has been recognized as knowledge-intensive organizations (Ali et al., 2014; Fullwood, Rowley, & Delbridge, 2013; Howell & Annansingh, 2013).

Table III.11 - The Academia's missions.

Missions		Knowledge Management Process
1º Mission	Education	Preservation and sharing of knowledge
2º Mission	Research	Knowledge creation
3º Mission	Service to society	Knowledge transfer to the different stakeholders

However, in the Kerr's (1987) opinion, currently, academia faces the greatest critical age as a result of the confrontation between accumulated heritage and modern imperatives of society. Different society drivers of change (e.g. radical shift from an industrial to a knowledge society, market pressures from industry, lifelong learning, new technologies, etc.) and the pressure to reach different sources of funding in the research process, bring new challenges to the academia (Franco & Haase, 2015; Geuna & Muscio, 2009; Kerr, 1987; Kezar, 2001; Pekka-Economou & Hadjidema, 2011).

This context makes as critical as in the corporate sector the use of mechanisms of KM in the academia (Howell & Annansingh, 2013; Kidwell et al., 2000). Alexandropoulou et al. (2008) add that the possibility of consolidation of the three academic missions can be one of the main benefits of KM.

Several authors have the opinion that knowledge in the academic context is not so completely organized and the implementation of a KM is often difficult (Petrides & Nodine, 2003; Rowley, 2000; Tippins, 2003). Due to the distinct nature of academia, its organizational culture has been recognized as one of the main barriers in the implementation of KM (Dill, 1982; Rowley, 2000; Tan, 2016).

Although their members are involved in innovation processes and are considered as agents of change, several attempts to change the organizational culture in the academia have been frustrated as a result of unique features that are associated with the set of long history and traditions (Kezar, 2001; Poole & Iqbal, 2011).

III.2.2.1 Knowledge and knowledge management in the academic context

Throughout their history, the academia has played a crucial role in creating and disseminating knowledge. In continuation of their history, the third mission reinforces the importance of the academic knowledge and establishes strong incentives for development a more efficient way of transferring the knowledge from academia to the business world.

The academic knowledge includes professional knowledge, teaching skills, and research capabilities (Omerzel et al., 2011). In general, it is in the basis of technological development and in the products and processes in most industries (OECD, 1996). The academic knowledge has been acknowledged as a key resource for innovation, for promotion of technological change and for fostering of higher productivity and greater economic growth (Cohen, Nelson, & Walsh, 2002; Freitas, Geuna, & Rossi, 2013; Lee, 2000; Mansfield & Lee, 1996; Polt, Rammer, Gassler, Schibany, & Schartinger, 2001).

However, Mansfield (1995) notes that many of the innovations is based on academic research but it is not invented at academia. In many situations, academia just provides a source of knowledge and skills that makes innovation happen (Wallin, Isaksson, Larsson, & Elfström, 2014; Wright, 2008).

Academic knowledge management is a set of processes that provides academia the most effective way to create and organize knowledge, share this knowledge and foster its application (Geng et al., 2005), which supports the achievement of the goals related to their missions.

Knowledge management in this context is particularly appropriate and may have a significance equal to or even greater than in the corporate sector (Gill, 2009; Howell & Annansingh, 2013; Kidwell et al., 2000; Petrides & Nodine, 2003). Tian et al. (2009, p. 84) consider that “knowledge as the cornerstone for scientific creation itself is the most important factor to effective KM implementation”.

Despite the existence of important facilitator elements for implementing knowledge management processes in academic context, the practice is very recent and has still received scant attention and little research has been conducted on this topic (Fullwood et al., 2013; Geng et al., 2005; Geuna & Muscio, 2009; Tan, 2016; Tian, Nakamori, Xiang, & Futatsugi, 2006). In most cases corresponding to the individual initiatives, without any kind of coordination or management with specific purpose or limited to some applications of information technology (Gill, 2009). D’Este and Patel (2007) reported that often, the experience and expertise of individual academics have a stronger impact than the characteristics of their departments or universities.

The nature of diversity across different disciplines often implies difficulties in identifying which knowledge is critical to manage, representing some constraints in development and implementation of academic knowledge management (Townley, 2003). However, on the other hand, KM processes

offer a great opportunity for the creation and organization of interdisciplinary knowledge (Rowley, 2000; Tippins, 2003).

The corporate and academic knowledge creation processes present a significant difference between them. The knowledge created within academia has mostly individual motivation and is related to the experience and expertise of its researchers (Tian et al., 2006), and some academics which wishing to ensure the academic freedom are reluctant to the knowledge management process (Townley, 2003). Unlike the corporate process, in which the knowledge creation is a mission of the group, and is embedded in work process, systems and infrastructure (Howell & Annansingh, 2013; Tian et al., 2009). Organizational culture will play a determining role in the knowledge sharing behavior among academic members (Howell & Annansingh, 2013; Mansor, Mustaffa, & Salleh, 2015).

Basically, according to Tian et al. (2009), in the creation process of new knowledge, academics required knowledge from three dimensions - scientific, social, and creative - and can be supported from four knowledge sources - supervisor or professor adviser, colleagues, self-study, and outside scholars (Figure III.30). Probably due to the individual motivation in the knowledge creation process, academic members prioritize self-study as the principal knowledge source (Tian et al., 2009), assigning a secondary place to cooperation (Tian et al., 2006).

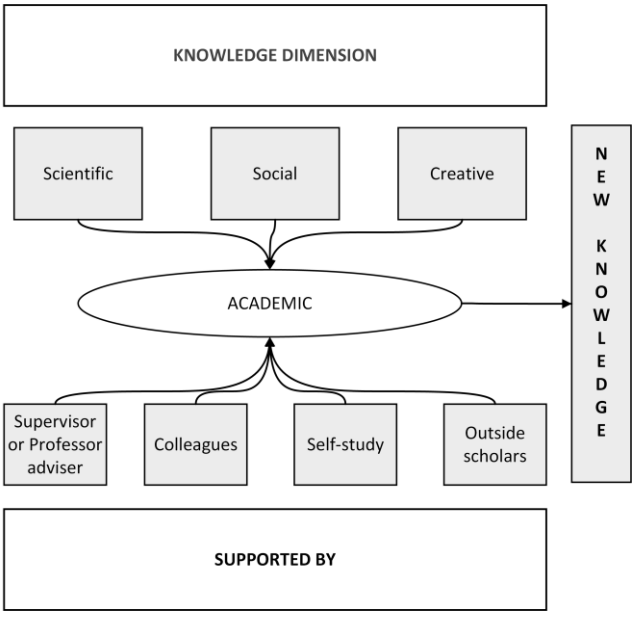

Figure III.30 - Academic knowledge creation.

In general, the sharing of knowledge occurs through papers, books, researches, classes, conferences, etc. (Mansor et al., 2015). These mechanisms of sharing often privilege the EK, whereas for TK the option is informal communication or remain as grey literature (Freitas et al., 2013; Grimpe & Hussinger, 2008; Nilsson, Rickne, & Bengtsson, 2010). For this reason, perhaps, is assigned to informal communication relevant importance in the creation of scientific knowledge.

Polt et al. (2001) argue that the involvement of academic members with industries (and vice versa) contributes to the sharing and creation of EK and TK.

The TK possessed by academic members constitutes the main part of academia's intellectual capital, and usually this knowledge is primarily shared externally where academics consider there are clear rewards (Howell & Annansingh, 2013). Kezar (2001) alerts to the risk of substantial loss of TK in this decade when is expected a volume of about 40% of retirements within the academia. The exit of any academic member may correspond to loss of important knowledge for the academia.

In addition to considerable improvements in the sharing of explicit and tacit knowledges, which intensifies knowledge creation process, KM environment offers a varied number of benefits that ranges from knowledge refinement to greater collaborative opportunities.

Different authors indicate several other benefits that can be achieved through the implementation of KM. In their work, Kidwell et al. (2000) relate relevant number of applications of KM and respective potential benefits in the various activities of the academia: the research process, curriculum development, alumni services, administrative services, and strategic planning. Steyn (2004), in his study, also presents several benefits that may be reached with the application of KM.

The Table III.12 summarizes the main potential benefits to be achieved with the implementation of KM described by several authors in the reviewed literature.

Table III.12 - Benefits of implementation of knowledge management.

Benefits	Authors
Recognition of knowledge as organizational intellectual capital	Rowley (2000)
Improve the quality of teaching and research	Gill (2009); Kidwell et al. (2000); Steyn (2004)
Closing gaps between senior and new academic members	Gill (2009); Kidwell et al. (2000); Steyn (2004)
Locating experts ("yellow pages") – facilitating attempts to find experts on specific subjects	Gill (2009); Kidwell et al. (2000); Steyn (2004)
Develop an environment where more experts would be more interest to work - recognition for its excellent research facilities, resources and programs, etc.	Gill (2009)
Document management, improving responsiveness by monitoring and including lessons learnt	Gill (2009); Kidwell et al. (2000); Steyn (2004)

III.2.2.2 Organizational culture in the academic context

Academia, as a complex social organization, have distinctive characteristics that dominate their culture, and that characterizes it as being different from other organizations. These characteristics highlight the complexity and fragmentation existing within the academia (Sporn, 1996), with their organization in different domains of knowledge, through systems such as scientific, pedagogical, research, and cooperation.

The various communities that constitute an academic institution assume a common culture with symbolic context based on the history and traditions, hindering the establishment of a culture with rational process of management and strategic vision (Dill, 1982).

Kerr (1987) observes that unlike other sectors, academia has not been subject to any greater challenge of technological change, and in his view, "the academics continues to operate largely as individual craftsmen" (p. 184). However, in Kezar's (2001) opinion, factors such as technological advances, distance education, and constraints of funds for research, will impact the culture over time.

Sporn (1996) identifies in her study some characteristics that dominate the culture of academic institutions:

- Goals are ambivalent: different objectives and standards, many of which cannot be measured very well;
- Large extent "people-oriented": necessity in recognizing different stakeholders in order to fulfill their missions;
- Problematic standards for goal attainment: it is hard to define segmented and routinized procedures, due to the need to develop and employ an array of standards in relation to the variety of outcomes (Bartell, 2003);
- Difficulty in establishing a coordinated initiative for governing and managing due to the involvement and different interests of academic members: close control can induce exits (Starbuck, 1992);
- Academia are vulnerable to its environment: changes in political, economic, social, and technological conditions can strongly affect universities. These changes affect the academia more than the other institutions (Kerr, 1987).

Academia faces another problem related to the existence of diverse subcultures within the institution.

The organization based on different areas of knowledge associated with inviolable values, like freedom and autonomy, is propitious for the formation of different subcultures that overlaps the main culture (Howell & Annansingh, 2013; Sporn, 1996). These subcultures often exert strong influence on the way of action of each member the organization. According to Howell and Annansingh (2013), subculture is a set of meanings shared by a group which shapes the way that these members teach, engage in research or interact with colleagues and students.

In general, subcultures are related with the culture of the academic profession at large, and the culture of academic discipline (Dill, 1982; Fullwood et al., 2013; Poole & Iqbal, 2011). The current high degree of specialization in the disciplines lead to the exacerbation of existence of subcultures. This specialization, according to Dill (1982, p. 312), may result in "declining involvement in institutional requirements, and a lessening of social ties with disciplinary and institutional colleagues".

Sporn (1996) notes that the challenge is to integrate all activities of the subcultures so that they can be used on an institutional level. The encouragement to a higher level of social interactions can lead to the unification of the various subcultures of the different units around the academic culture (Bartell, 2003; Dill, 1982).

III.2.2.3 Knowledge management culture in the academic context

In their article Kidwell et al. (2000, p. 28) raises the question: "Are the concepts of knowledge management applicable to colleges and universities?". Although the existence of important facilitator elements for implementing KM in academic context, Kidwell et al. (2000) conclude that the existing examples are the exception rather than the rule. In general, academia has an individualistic culture (Fullwood et al., 2013) that do not maintain norms, values and practices, focusing on KM, or have a complex one (Rowley, 2000).

Academic culture presents some specific characteristics, which usually act as barriers or obstacles that difficult the development of a sustainable KM culture. In the Table III.13, the authors summarize these unique characteristics described by several authors in the literature on the topic.

Table III.13 - Factors that act as barriers or obstacles and affect knowledge management culture.

Barriers and Obstacles	Authors
Decentralized nature of departments and disciplines. Loyalty to discipline rather than organization.	Fullwood et al., (2013); Townley (2003)
Inadequate management competencies to prepare the organization for KM. Lack of strategy, policies and work process. Lack of leadership.	Howell & Annansingh, (2013); Petrides & Nodine (2003); Tan (2016); Tian et al. (2009)
Academia are knowledge-intensive institutions, however do not share and leverage their knowledge to realize their goals as corporate organizations.	Howell & Annansingh, (2013); Petrides & Nodine (2003); Tan (2016); Tian et al. (2009)
Environment characterized by lack of effective environment of communication that enables the sharing of knowledge, with few areas of collective work, where the few existing meetings are administrative, and with closed, separated and unlinked groups. Lack of social interaction.	Omerzel et al. (2011); Tan (2016); Tippins (2003)
Individualistic organizational model with absence of a knowledge sharing culture offers very little chance for collaboration and cooperation. Mechanisms of sharing such as conference and publications act more as competition than rather cooperation. Cooperation is a weak point.	Howell & Annansingh (2013); Tian et al. (2009)
The institutions do not clearly recognize or reward knowledge sharing. The majority of knowledge sharing is done externally, where there are clear rewards.	Howell & Annansingh (2013); Tian et al. (2016)
Knowledge is often not stored in the correct format to facilitate sharing. Many knowledge repositories often use different software, are poorly organized and the relationship between them is not well or clearly defined.	Petrides & Nodine (2003); Rowley (2000)

Knowledge management culture must be part of the institutional vision and mission and shall be in line with its goals and strategy. The cultural factors will strongly affect KM practices.

The adoption of a wide approach to the KM by the academia, can lead to effective cultural change that enables the development and implementation of KM. This approach requires understanding the unique characteristics of academia, incorporation of the main principles, and then proceeding the necessary cultural changes (Gill, 2009; Kezar, 2001). However, Rowley (2000, p. 331) alerts that "culture change is likely to be a slow and painful process".

Another important factor in the academia that affect the development and implementation of a sustainable culture of knowledge management that prioritizes the sharing of knowledge is related to the distinctive personal characteristics and behaviors of their members (Table III.14).

Table III.14 - Academic characteristics and behaviors that affect knowledge management culture.

Academic Characteristics and Behaviors	Authors
Most likely individualistic, independent, and autonomous. In general, they are not aware of valuable expertise within the academia that can contribute to their work, preferring acquire knowledge through other mechanisms, such as internet and personal networks.	Alexandropoulou et al. (2008); Howell & Annansingh (2013); Kim & Ju (2008); Petrides & Nodine (2003); Rowley (2000); Starbuck (1992)
Knowledge as private intellectual capital, and in some cases, the perception is that any attempt to exploit this capital would be against their work ethic. Knowledge is retained in individuals' heads or personal files. Lack of trust.	Alexandropoulou et al. (2008); Kim & Ju (2008); Omerzel et al. (2011); Tan (2016); Tippins (2003); Townley (2003); Weber, Morelli, Atwood, & Proctor (2006)
Knowledge creation more interesting than knowledge sharing, due to the fact of absence of system that protect their intellectual assets.	Alexandropoulou et al. (2008); Kim & Ju (2008)
Objective distance from the work of their peers, focusing on individual goals rather than working toward common goals.	Kim & Ju (2008); Tippins (2003)
Typified by lack of flexibility, tending be conservative, and hesitant in accept maturing technologies or rapid changes. Slowness in adopting many principles taught in the classroom.	Kezar (2001); Kim & Ju (2008); Tippins (2003); Townley (2003)
Perception of little benefits and rewards in sharing knowledge within the academia. Academics see their community as mainly existing outside the institution.	Howell & Annansingh (2013); Mansor et al. (2015; Tan (2016)

Usually, academic members consider knowledge as their private property that is not freely shared (Omerzel et al., 2011; Tan, 2016; Tippins, 2003). Considering that knowledge increases in value and importance when shared (Tippins, 2003), this individualistic characteristic is not suitable with the knowledge sharing process. This shall become the main challenge of the implementation of a knowledge management culture in the academia. In addition to the factors listed in Table III.14, Tippins (2003) discusses the fact that academic members also tend not to share knowledge due to the individual different skill levels among them. They wonder about the absorptive capacity of certain types of knowledge by the other members.

Knowledge is dynamic and its evolution, or creation of a new one, depends on the sharing of knowledge and experience. In a context where there is not a culture that promotes and encourages KM, the process of sharing is not so easy, and consequently knowledge is often lost (Omerzel et al., 2011). That strengthens the hypothesis that Gill (2009) calls the "erosion" of knowledge. Howell and

Annansingh (2013) highlight that often knowledge sharing in the academia involves breaking down barriers and knowledge silos.

The lack of social interaction in the academic context influences effectiveness of the creation of social networks. In Gill's (2009) opinion, networking is not just an activity related to knowledge sharing but also about leverage of knowledge. Some studies have shown that direct contact and oral communication processes may foster the acquisition of the major part of knowledge through face-to-face meetings or telephone conversations (Davenport & Prusak, 1998). Like in the corporate sector, academia should encourage and promote cooperation, collaboration and teamwork.

The environment of competition rather than cooperation is unfruitful, and often discourages or demotivates people. According to the studies, the environment of cooperation has not been recognized or emphasized enough (Tian et al., 2006). Thus, for a successful knowledge management process in academia, it should be strongly considered promoting a cooperative environment. Petrides and Nodine (2003, p. 18) are the opinion that "knowledge management is more likely to take root in communities that need to share knowledge to realize their goals".

III.3 Future research and directions

After the review of relevant literature on knowledge management culture focusing on the academic context, the authors point the following further research opportunities:

- First of all, the authors would like to highlight that the majority of studies reviewed were focused on academics' views. It would be interesting other studies that focus on additional views.

- Organizational strategy and knowledge management culture are key factors to the development of initiatives that foster the knowledge sharing environment. Future case studies with empirical validation of models are needed to examine which elements in organizational strategy and knowledge management culture are suitable to the academia achieve their strategic goals.

- Most of knowledge in the academia is shared in the explicit form. However, apart from this EK there is evidence that the major part of TK is not registered or is not properly registered. There is scant evidence in the literature on how to deal with TK or the real necessity of its management. Since the academia missions are related to KM and their intensive TK nature, makes essential the development of research that address this question.

- Finally, due to the globalization process of academia, one area that needs further research is related to the development of KM models in the academic context that address aspects

of the dispersion and/or concentration of knowledge and check the impact of cultural differences between different academic members.

III.4 Conclusion

In this chapter, based on the critical analysis of literature, it was possible to perceive that the current context of increasing organizational atomization and external vulnerability, assigns an increasingly importance to the role of culture in the KM. Thus, the chapter's authors have the opinion that there is an urgent need for greater awareness on the part of the academia on the importance of establishing a culture that values knowledge and promotes the creation, sharing and application of knowledge in the most effective way.

Given the distinctive nature of the culture of academic institutions and their subcultures there is no single model that fits all situations. There is a need of changes and definition of strategies that can provide directions to the academia to choose, implement, and overcome resistance to a new culture of KM. The change and its implementation should be gradual and should contemplate the unique characteristics of the academia. The cultural change is a difficult element and lengthy process for the institutions like academia. According to Towley (2003, p. 11), "fundamental changes in organization, like KM, are evolutionary and take time to develop".

Despite the type of approach, depending on the strategy to be defined by the institution, explicit knowledge already has over the years a strong trend of shares and coding actions. A greater effort should be conducted in the sharing of tacit knowledge and in the identification of specific knowledge experts. However, motivating individuals to share knowledge is not an easy task, especially where the institution does not encourage and adopt this process as institutional culture. The authors of the chapter tend to agree with Gill's (2009, p. 609) opinion that "a successful organizational shift in culture definitely signals the success of a KM process".

III.5 References

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III.6 Key terms and definitions

Academia: A community constituted by universities and public research institutes or laboratories. The academia offers teaching, research, and service to the community in various areas of knowledge.

Academic Members: Researchers, teachers and student incorporated in an academic institution.

Codification Approach: A "people-to-document" approach, which knowledge is carefully codified and stored in databases where it can be accessed and used easily by anyone in the organization. Knowledge is extracted from the person who developed it, made independent of that person and reused for various purposes.

Knowledge-Intensive Organization: A kind of organization that it is characterized by a high proportion of highly qualified workers, due to access to and manipulation of large quantities of knowledge.

Knowledge Management Culture: A culture that is affected by the organizational culture, but refers to particular values, norms and practices pertaining to knowledge management processes.

Knowledge Sharing: Sharing and transfer are interchangeable in the literature, and commonly appear with the same sense. It is a key process related to the knowledge- intensive context. Knowledge sharing promotes the creation of new theories and ideas, and establishment of new research principles.

Organizational Culture: The pattern of shared practices, norms, and values of an organization that shapes its functioning and the behavior of their members.

Tacit Knowledge: Type of knowledge that is complex, not codified, and presents some difficulty in its reproduction in a document or in a database. It can be got from experience, perceptions and individual values and depends on the context in which is inserted.

Chapter IV - Knowledge management and software development organization: What is the challenge?

Reference

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Knowledge management and software development organization: What is the challenge?

Abstract

Software development organization (SDO) is a kind of knowledge-intensive business and their large majority is small and medium enterprise (SME) facing similar challenges of large ones. The diversity and complexity of the SDO environment makes knowledge the fundamental element in the software development process, which strengthens the importance of an effective knowledge management process. The software development process involves multidisciplinary teams, and the various working meetings that occur during a project are conducive to generate and share a lot of knowledge, in particular tacit knowledge. The use of a knowledge management process that enables to manage tacit knowledge will define the difference between a good SDO performance and the best SDO performance. This chapter aims to present an exploratory study based on literature review, with the aim of identifying the main challenge of knowledge management in the SDO context. The authors also aim to address some new research directions.

Keywords

Codification approach; Explicit knowledge; Knowledge capture; Knowledge sharing; Knowledge-intensive organization; Multidisciplinary team; Personalization approach; Tacit knowledge

IV.1 Introduction

As a knowledge-intensive organization, the most valuable asset of a software development organization (SDO) is the knowledge of its employees (Lee-Kelley, Blackman, & Hurst, 2007; Walz, Elam, & Curtis, 1993). Consequently, knowledge management assumes a vital role in the software development process of any SDO.

Knowledge has become one of the most valuable resources for businesses, representing an important driver of strategic capability and competitive advantage (Johannenssen, Olsen, & Olaisen, 1999; Kasemsap, 2015). Nahapiet and Ghoshal (1998) added that the advantage obtained by the organizations depends largely on the ability of creating and sharing knowledge.

According to the classical division introduced by the Hungarian chemist and philosopher Polanyi (1966) and widely spread by Nonaka et al. (1996), knowledge can be explicit or tacit.

Explicit knowledge is a type of knowledge that can be easily codified, articulated, documented and archived. While tacit knowledge although being at the base of the creation of the knowledge, is complex, it is not easy to be codified, and presents some difficulty in its reproduction in a document or in a database.

Knowledge management is the process that enables the sharing, capture and application of knowledge from the individual to the group and further to organizational level (Rasmussen & Nielsen, 2011).

The current SDO environment is characterized by increased diversity and complexity in software development projects. Due to this environment, software development process involves multidisciplinary teams (Huzita et al., 2012) once a member of a team no longer has all the necessary knowledge (Desouza, 2003; Walz et al., 1993). The several working meetings that occur throughout a project are conducive to generate and share a lot of tacit knowledge.

But in the meantime, despite the importance of tacit knowledge generated in the software development process, several authors (e.g. Huzita et al., 2012; Johnson & Donnelly, 2013) pointed to the fact that due to lack of proper mechanisms that allow sharing, identification and capture of this type of knowledge, most of them is wasted resulting in unavailability for future uses or projects (Johnson & Donnelly, 2013). However, what is the challenge of the knowledge management in SDO? According to some authors, it is possible to suggest that the main challenge of the SDO is developing mechanisms to make the tacit knowledge more explicit as possible (Johnson & Donnelly, 2013; Shull et al., 2002).

Through a literature review on the knowledge management in SDO, the purpose of this chapter is to present an exploratory study that describes the main findings that may respond to the aforementioned question. The chapter also aims to address some further research directions.

This chapter is organized as follows. In the next section, the authors briefly introduce SDO and knowledge management. The following section, based on the literature reviewed, provides a critical discussion of the knowledge management in software development environment. Following this section, the authors discuss about the main challenges of knowledge management in the SDO context. Finally, in the remainder sections, the authors point future research directions, and conclude.

IV.2 Background

IV.2.1 Theoretical foundations on software development organization and knowledge management

In this section, the chapter outlines a brief theoretical foundation of the study. The first part covers the SDO. The second part discusses knowledge management and its processes.

IV.2.1.1 Software development organization

SDO is a kind of business typically based on knowledge-intensive activity (Aurum, Daneshgar, & Ward, 2008; Lee-Kelley et al., 2007; Mehta, Hall, & Byrd, 2014; Walz et al., 1993) where knowledge is the raw material (Walz et al., 1993) and the intellectual capital constitutes the major asset (Huzita et al., 2012; Peters, 1992). Due to this characteristic, according to Becerra-Fernandez and Sabherwal (2010) this kind of organization is valued at three to eight times its financial capital. Applying the "Tobin's q ratio" – relationship between a company's market value and its physical assets – Swart and Kinnie (2003) compared that whereas for the SDO the ratio is of 7.00, for the traditional companies the ratio is of nearly 1.00. Currently, SDO are distinguished as a business in increasing economic importance (Dubé & Robey, 1999; Segelod & Jordan, 2004).

The large majority of SDO is characterized as small and medium enterprise (SME) (Richardson & Von Wangenheim, 2007; Savolainen & Ahonen, 2015) and works in scenery of shortage of resources. However, small and medium SDO face similar challenges of large ones (Richardson & Von Wangenheim, 2007).

In the modern society, the software is constantly present and is widely used in several areas (Aurum et al., 2008) that makes the current environment of SDO diverse and complex (Huzita et al., 2012), causing to the SDO pressure for higher-performing products, and more frequent faster releases (Dubé & Robey, 1999).

Software development process is differently at every organization (Bogue, 2006) and represents a

set of activities that occurs by processing of large amount of knowledge from different areas (Robillard, 1999), and that occurs in teams (Ryan & O'Connor, 2013). Each team member has a different expertise (Pee, Kankanhalli, & Kim, 2010) and makes a large number of decisions (Shull et al., 2002), that requires development of strong personal and team relationships (Nahapiet & Ghoshal, 1998).

The term knowledge-worker was first used by Peter Drucker in his 1959 book, "Landmarks of Tomorrow" (Drucker, 1994), and includes all these members of software development teams (Ryan & O'Connor, 2013). According to Lee-Kelley et al. (2007), the term is also frequently used to define "any employee possessing specialist knowledge or know-how who is involved in consultancy based on their specialist knowledge or know-how, or research and development work for new products, services or processes" (2007, p. 205).

In the meantime, despite this environment and the evolution of new software development organizational arrangements (e.g. outsourcing, global software development, and open source) Aurum et al. (2008) considered that software development still needs to achieve a higher level of maturity.

IV.2.1.2 Knowledge management

There is not common knowledge definition accepted and so knowledge is defined according to the context in which it is discussed (Girard & Girard, 2015; Gloet & Terziovski, 2004; Stenmark, 2001; Stoyanov, 2014). In Rowley's (2007) opinion, there is agreement among several authors that knowledge is an elusive concept which is difficult to define. However, regardless of the concept, knowledge always brings their respective truths and beliefs, judgments and expectations, methodologies, and know-how (Prieto, Revilla, & Rodríguez-Prado, 2009).

According to the classical division introduced by the Hungarian chemist and philosopher Polanyi (1966), and widely spread by Nonaka et al. (1996) knowledge can be explicit or tacit.

Explicit knowledge is a type of knowledge that can be easily codified, articulated, documented and archived, and usually, it is stored and expressed in the form of text, data, scientific formulae, maps, manuals and books, websites, etc. (Alavi & Leidner, 2001; Iacono, Nito, Esposito, Martinez, & Moschera, 2014; Nonaka & Konno, 1998; Polanyi, 1966; Santoro & Bierly, 2006; Seidler-de Alwis & Hartmann, 2008).

Tacit knowledge is the basis of knowledge creation, it is complex and not codified, and presents some difficulty in its reproduction in document or database. Smith (2001) reported that ninety percent of the knowledge in any organization is tacit knowledge and it is embedded and synthesized in peoples' heads.

In general, the literature mentions the existence of two dimensions of tacit knowledge: (i) technical and (ii) cognitive (Alavi & Leidner, 2001; Nonaka & Konno, 1998). The technical dimension is often referred to as expertise and consist of informal personal skills and crafts that apply to a specific context.

The cognitive dimension refers of mental models, beliefs, ideals, values and paradigms, which are deeply ingrained in people. Nonaka and Konno (1998) suggested that while difficult to articulate, this cognitive dimension of tacit knowledge shapes the way each one person perceives the world. In the Figure IV.31, based on Nonaka (2010), the authors summarized explicit and tacit knowledge.

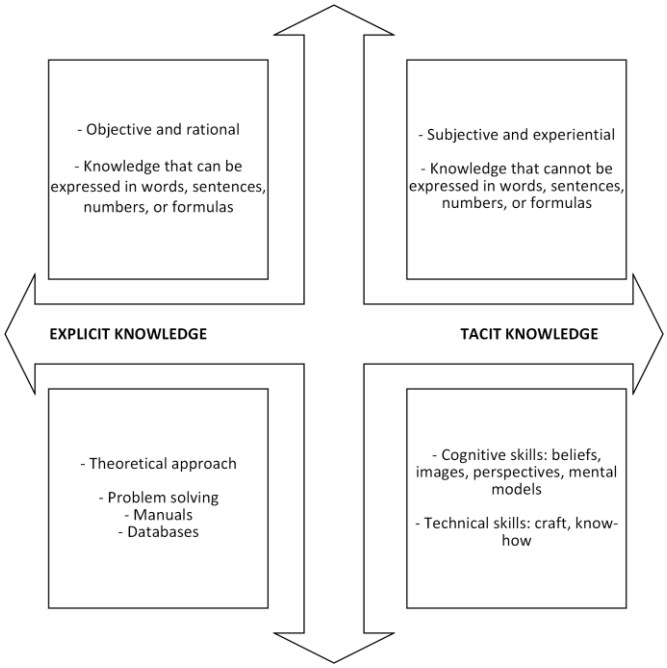

Figure IV.31 - Explicit and tacit knowledge.
Adapted from Nonaka (2010)

After the information management, a neutral and normative system in the organizations (Gloet & Terziovski, 2004), knowledge management emerges as a distinct area of study, establishing as a significant source of competitive advantage and as one of the most important resources in the capacity of progress of modern organizations (Mårtensson, 2000; Pekka-Economou & Hadjidema, 2011). Several authors consider that new knowledge and innovation are heavily dependent on knowledge management practices (Gloet, 2006; Inkinen, 2016). Knowledge management practices act as a key driver of innovation performance.

Knowledge management expanded rapidly in various fields such as psychology, management science, sociology, strategy, production engineering, etc. This wide diversity of areas transforms knowledge management in a complex and multi-faceted concept (Alavi & Leidner, 2001), reflecting the wide range of definitions, leading in the absence of a standard and universally accepted definition (Chen, 2006; Kakabadse, Kakabadse, & Kouzmin, 2003; Sadeghi & Salemi, 2013).

Although the absence of consensus regarding the knowledge management definition, the Davenport and Prusak's (1998) definition is one of the most cited in the literature (Metaxiotis, Ergazakis, & Psarras, 2005): "knowledge management is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives." Knowledge management is based on three main pillars (Figure IV.32):

1. Technology;

2. People; and

3. Process (Kalkan, 2008; Prieto et al., 2009).

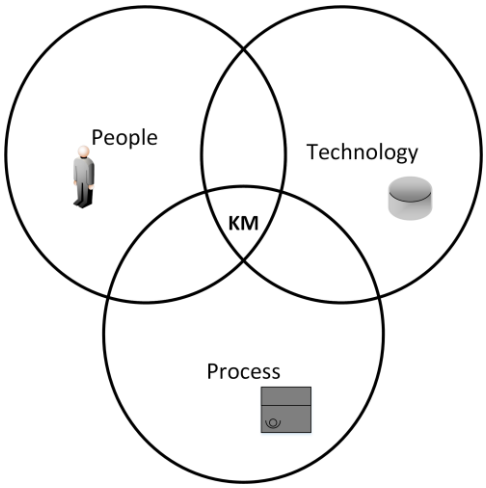

Figure IV.32 – Knowledge management main pillars.

The great discussion has been about which of these pillars is the main facilitator for the knowledge management. Considering that a knowledge management system is not an automatic data processing system (Tuomi, 1999), the three mentioned pillars are important for a successful knowledge management and the focus should not be on any one element.

The strategy for developing a successful knowledge management involves a range of enabling conditions (Prieto et al., 2009) which would need to be managed to support different types of knowledge processes. In her article, Mårtensson (2000) presented a set of critical elements to develop and implement a knowledge management system, and she pointed out that in order to reach success the strategy must be taken into account both the creation and the leverage of knowledge.

As a result of the wide range of knowledge management definitions, the literature presents different sets of processes that comprise a complete knowledge management system. In general, each process is involved in creation, sharing or change of the state of knowledge. For example, Alavi

and Leidner (2001) considered the processes of creating, storing/retrieving, transferring, and applying knowledge. In the standpoint of Grover and Davenport (2001), the processes are generation, codification, transfer, and realization. Nielsen (2006) identified eight key processes: creation, acquisition, capture, assembly, sharing, integration, leverage, and exploitation of (new) knowledge. Hoffman et al. (2008) indicated the processes of capture, learning, discovery, knowledge, and application. In the Nonaka et al.' (1996) opinion, the processes are socialization, externalization, combination and internalization.

In this chapter the authors consider three processes based on Rasmussen and Nielsen (2011):

1. Knowledge sharing and transfer;
2. Knowledge capture;
3. Knowledge application.

Knowledge sharing and transfer

As in the Kang et al.'s (2010) statement, knowledge by itself is not a useful resource that creates value and competitive advantage until it can be shared and transferred. Knowledge emerges from sharing knowledge in a social context (Jakubik, 2008) resulting of interactions between people.

Several times in the literature the terms sharing, and transfer are interchangeable and appear with the same sense, or with other denominations (e.g. disseminate, distribute, exchange, translation) to identify the migration process of knowledge of a situation to another, i.e. between or within people, organizations or countries (Huzita et al., 2012).

The term sharing of knowledge has a tendency to refer more to exchanges of knowledge between people, while the transferring of knowledge expression is used more often in exchanges between units of the same organization or between other organizations (Argote & Ingram, 2000; Paulin & Suneson, 2012). The chapter's authors also suggest that sharing of knowledge is also associated to tacit knowledge and transferring of knowledge is used in the situation of explicit knowledge (Johannenssen et al., 1999).

The successful sharing and transfer of knowledge is an important factor in knowledge management performance (Wang & Noe, 2010).

Knowledge capture

Knowledge needs to be captured, stored and then disseminated (Huzita et al., 2012). The knowledge capture is a key process of preserving and formalizing knowledge (Becerra-Fernandez & Sabherwal, 2010) and the result is the inclusion of the knowledge into the stock of knowledge. The process of capture has various methods and the selected method depends on the type of

knowledge. The process of capture must be disposed of properly, responding to the challenge of capturing only the relevant and valuable knowledge (Nielsen, 2006). Once captured, knowledge should be continuously evaluated to ensure their quality and relevance.

Although the knowledge capture is one of the primaries aims of knowledge management, Hoffman et al. (2008) highlighted that some organizations have failed by applying weak methods for this process.

Knowledge application

This is the process of knowledge management that justifies the existence all of others. It makes no sense to create knowledge, capture it, share it and download it, if not be disseminated and applied. Starbuck (1992) argued that merely storing knowledge does not preserve it.

The importance of applied knowledge is due to be specialized knowledge (Drucker, 1994). The ability to disseminate and apply knowledge enables the opportunity of competitive advantage and becomes more important than the ability to create new knowledge (Alavi & Leidner, 2001; Nielsen, 2006).

New knowledge is disseminated through several channels available among the members of a social system (Graham et al., 2006) promoting their application (Becerra-Fernandez & Sabherwal, 2010). Social system is considered a set of interactions between people who have connection between themselves and that belong to the same context (Figure IV.33).

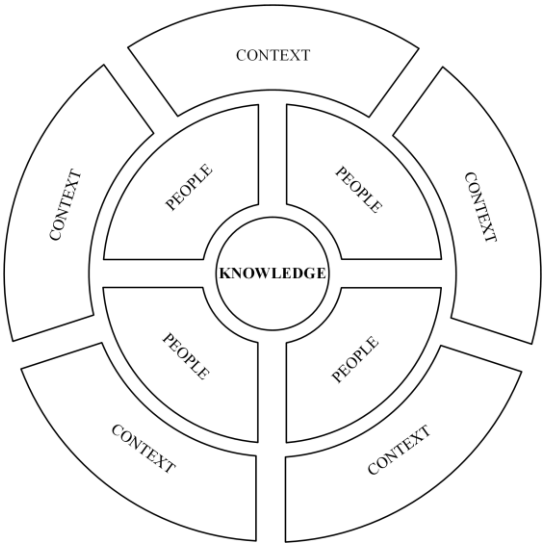

Figure IV.33 – Social system.

IV.2.2 Knowledge management in software development environment

The current environment of SDO is of increasing diversity and complexity. Software development process is differently at every organization and may work just for a specific environment and situation (Bogue, 2006). Recently this situation has been exacerbated by the evolution of new software development organizational arrangements (e.g. outsourcing, global software development, and open source). Bresnen et al. (2003) highlighted that the need to carry out short-term projects has also caused restrictions of opportunities for innovations in the software development process.

Software development is a highly knowledge-intensive activity (Desouza, 2003) that processes large amount of knowledge from various domains (Robillard, 1999). Knowledge management assumes an important role for any SDO in providing solutions, and improving of performance (Fehér & Gábor, 2006; Meehan & Richardson, 2002; Rus & Lindvall, 2002).

According its organizational culture, and business strategy, SDO must define a strategic approach to managing knowledge (Aurum et al., 2008). Researchers have suggested some approaches, however several of them point to the codification and personalization strategies (Desouza, 2003; Fehér & Gábor, 2006; M.T. Hansen, Nohria, & Tierney, 1999). Fehér and Gábor (2006) reinforced that typical knowledge-intensive organization, like SDO, must choose between codification and personalization strategies.

Codification strategy centers on the technology and explicit knowledge. Knowledge is codified and stored in databases, and it becomes available to be accessed and used easily by everybody (Fehér & Gábor, 2006; M.T. Hansen et al., 1999). M.T. Hansen et al. (1999, p. 2) called it “people-to-documents” strategy.

In contrast, personalization strategy is called people-to-people approach (Desouza, 2003) where tacit knowledge is the focus (Fehér & Gábor, 2006). Knowledge is shared through face-to-face interactions like brainstorming sessions, meetings and conversations, where expertise and experience have important role (Desouza, 2003; Fehér & Gábor, 2006; M.T. Hansen et al., 1999). According to M.T. Hansen et al. (1999), the most important in this strategy is a system that allows people to find the right people, in other words, a system that maps who holds the knowledge which is not fully documented in the organization. Several authors (Becerra-Fernandez & Sabherwal, 2010; Bjørnson & Dingsøyr, 2008; Erden, von Krogh, & Nonaka, 2008; Grover & Davenport, 2001) named this system as “yellow pages”.

In Robillard’s view “before the development of a software the knowledge has to be described and organized in a specific knowledge structure” (1999, p. 87) and he added that “software development is the processing of knowledge in a very focused way” (1999, p. 92). Robillard (1999) called knowledge-crystallization the process of transformation knowledge into a language that can be read and executed by the computer (Figure IV.34).

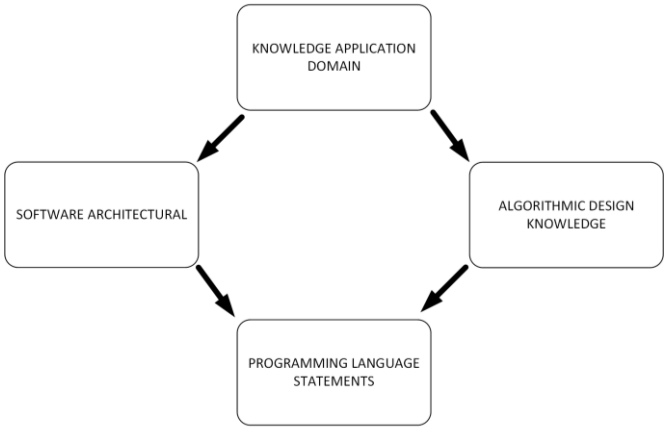

Figure IV.34 – Knowledge-crystallization.
Based on Robillard (1999)

As a function of the SDO environment characteristics, Edwards (2003) argued that knowledge management in SDO is somewhat distance from mainstream. Bresnen et al. (2003) considered that knowledge management in context like existing in SDO faces many challenges due to discontinuities in methods of organization and flows of personnel, materials and information.

Due to the fact that just one person does not have the domain all the knowledge necessary for a project (Desouza, 2003; Walz et al., 1993) these activities are developed by multidisciplinary teams (Huzita et al., 2012). However, the composition of teams changes very quickly (Edwards, 2003) as a result of the different nature of projects.

It is important to point out that SDO is a knowledge-intensive organization. According to Starbuck (1992), knowledge-intensive organizations have a stock of expertise (knowledge) which is the sum of different expertise of each team member (Pee et al., 2010). This stock has unusually complex combination of different layers (Edwards, 2003), and requires development of strong personal and team relationships (Mehta et al., 2014; Nahapiet & Ghoshal, 1998), in order to share and to leverage the expertise at the project and organization level (Shull et al., 2004).

These social interactions involve both explicit and tacit knowledge and play an important role in sharing and creation of knowledge. These social processes in interaction with other specific mechanisms, including technology, make the knowledge more dynamic (Aurum et al., 2008; Bjørnson & Dingsøyr, 2008), requiring each team member keep up to date thus avoiding obsolescence of knowledge (Desouza, 2003).

However, the performance of the development team is affected by a number of important organizational and structural factors that act either as barriers or as facilitators for the full use of knowledge management (Bresnen et al., 2003; Ryan & O'Connor, 2013). Among the barriers or facilitators pointed out by the authors of the reviewed articles, the process of communication seems to be the most relevant, since it is the most cited (Table IV.15). The communication barrier is

exacerbated by the utilization of multidisciplinary teams and also when occurring geographical dispersion of the sites which may difficult the actions like face-to-face (Bresnen et al., 2003), reduce the absorptive capacity (Mehta et al., 2014), introduce cultural diversity and background within the team (Schilling & Klamma, 2010) and hinder the establishment of a common vocabulary and meanings in the process of sharing (Barksdale & McCrickard, 2012).

Table IV.15 - Barrier/facilitator.

Barrier / Facilitator	Issue	Reference
Organizational structure	Economies of scale in the use of certain mechanisms	(1)
Cultural context and climate for change	Continuing support across the organization whole	(1)
Skill and capabilities	Motivation and personal skills in development social contacts and informal networks	(1); (2); (5)
Communications, networks and information flows	Geographical dispersion of sites; common vocabulary and meanings	(1); (2); (3); (4); (5)
Technological mechanisms	Incentives and resources to use and up-date information	(1); (2)
Objectives and outputs	Clear set out	(1); (5)

Legend: (1) Bresnen et al. (2003); (2) Mehta et al. (2014); (3) Barksdale and McCrickard (2012); (4) Schilling and Klamma (2010); (5) Ryan and O'Connor (2013)

This context associated with difficulty in developing and establishing stable routines, become critical success factors an effective knowledge sharing process (Aurum et al., 2008) based on a supportive culture of sharing (Edwards, 2003).

However, some authors (e.g. Aurum et al., 2008) and practioners have the opinion that the tools, techniques and methodologies currently employed by SDO are inadequate to implement an effective knowledge management model.

IV.2.2.1 Knowledge sharing in software development environment

As previously noted by the authors, in the wide literature on knowledge management is difficult to find a consensus that distinguish clearly sharing and transferring knowledge. The same is true in the software development domain with several authors diverging with regard to terminology and assumptions.

Knowledge sharing is a key process regarding to the knowledge-intensive context in general, and in particular within teams of software development (Ghobadi, 2015; Ryan & O'Connor, 2013). Considering that each team member has a different expertise (Pee et al., 2010) and that expert knowledge is mostly tacit (Ryan & O'Connor, 2013), knowledge sharing assumes increased importance in software development environment.

The Table IV.16 presents some relevant situations that reinforce the importance of knowledge sharing in software development environment pointed out by the authors in the literature examined.

The knowledge sharing process is not as simple and straightforward as it may seem. The process can present a number of challenges that depends on the context it happens. Shull et al. (2004) added that this situation can have impacts on the success of reuse of knowledge.

Table IV.16 - The importance of knowledge sharing in SDO Situation.

Situation	Reference
Basis of the knowledge is often an individual	Edwards (2003)
Different projects – different teams	(Edwards, 2003)
Rapid turnover of staff	Edwards (2003) and Lee-Kelley et al. (2007)
Influence software development and ultimately overall	Lee-Kelley et al. (2007)
Eliciting both explicit and tacit knowledges	Ryan and O'Connor (2013)
Knowledge-intensive nature	Mehta et al. (2014)
Iterative development cycles	Ghobadi (2015)
Overcome the cultural and social challenges	Ghobadi (2015)

Due to the importance and complexity of knowledge sharing, Ghobadi (2015) enhanced the great and necessary effort of coordination and communication in all of software development stages.

Software is developed in teams where knowledge emerges in a social context from sharing of knowledge, resultant of several interactions within members of the team and stakeholders. The social context has an important role (Bresnen et al., 2003) in the knowledge sharing process, it is complex (Ryan & O'Connor, 2013), and needs to be encouraged and facilitated through all levels of the organization.

The social context is also very important for tacit to tacit exchange and may take place within and outside the organizations (Bresnen et al., 2003; Prieto et al., 2009).

Effectiveness and efficiency levels of team and consequently of organization is influenced by the extent knowledge that is shared and captured (Barksdale & McCrickard, 2012; Wang & Noe, 2010).

In recent literature review article Ghobadi (2015) has identified forty-four knowledge sharing drivers in software development teams and categorized them into four categories: people-related, structure- related, task-related, and technology-related. Nearly half of the drivers identified (twenty-one) were categorized as people-related. As people, Ghobadi (2015) considered users, managements, developers and other key stakeholders of the project.

Despite the software developers believe in the importance of knowledge sharing (Aurum et al., 2008), that process within software development team can be challenging. Knowledge sharing involves both explicit and tacit knowledge, although knowledge in software development process is almost all tacit. Tacit knowledge is an important factor in SDO and may be situated and embedded within a social group or individuals, and context.

With the challenges of knowledge sharing in software development environment, Edwards (2003) argued that the effective process is possible and that a combination of technology, people and

process-based solutions is best approach. Edwards complemented saying that the most important aspect is to develop the overall culture that encourages knowledge sharing.

IV.2.2.2 Tacit knowledge in software development environment

According to Lethbridge et al. (2005), people create software, people maintain software, people evolve software. Faced with this statement, and considering that people are rich in tacit knowledge, it is possible to complement the Segelod and Jordan's opinion (2004) and suggest that software is essentially tacit knowledge in codified form. The best use of tacit knowledge can ensure a more efficient and effective solution creation process (Bierly, Damanpour, & Santoro, 2009), having an important role in a SDO's performance (Ryan & O'Connor, 2013).

Although several researchers across several schools highlight the necessity to focus also on tacit knowledge and not exclusively on explicit knowledge (Bjørnson & Dingsøyr, 2008; Leonard & Sensiper, 1998; Rus & Lindvall, 2002), the debate is still too focused on explicit knowledge with few references on tacit knowledge (Seidler-de Alwis & Hartmann, 2008). Clark et al. (2015) alerted to the fact that massive investments that organizations have been made in systems foster the capture of explicit knowledge but shift the focus away from tacit knowledge.

Tacit knowledge is often fundamental for the interpretation of the explicit knowledge. Explicit knowledge without tacit insight quickly loses its meaning (Seidler-de Alwis & Hartmann, 2008; Shull et al., 2004), that is to say that this type of knowledge is inseparable from tacit knowledge. In general, both types of knowledge are not completely distinct and depending on the context or a specific situation each shared knowledge presents different degrees of tacitness and explicitness (Ambrosini & Bowman, 2001; Wong & Radcliffe, 2000). Wong and Radcliffe (2000) named "knowledge spectrum" the different composition of tacit and explicit knowledge of each shared knowledge, i.e. the different knowledges have different degrees of composition of both knowledges. In a similar way, Ambrosini and Bowman (2001) presented which they call "degree of tacitness", where knowledge can encompass a range of different levels of tacitness, and this range may be from deeply ingrained tacit to completely explicit. The Figure IV.35 shows the two models so that they can be compared.

Tacit knowledge can be shared in a number of ways, including coexistence, interactions between groups, oral communication and informal contact. According to Webber (1993), conversation is the best way for discovering what the group know, sharing what they know, and create new knowledge. Several studies have demonstrated that the contacts of the type face-to-face and informal conversations are responsible for the acquisition of up to two-thirds of knowledge, arising only a third from documents (Davenport & Prusak, 1998).

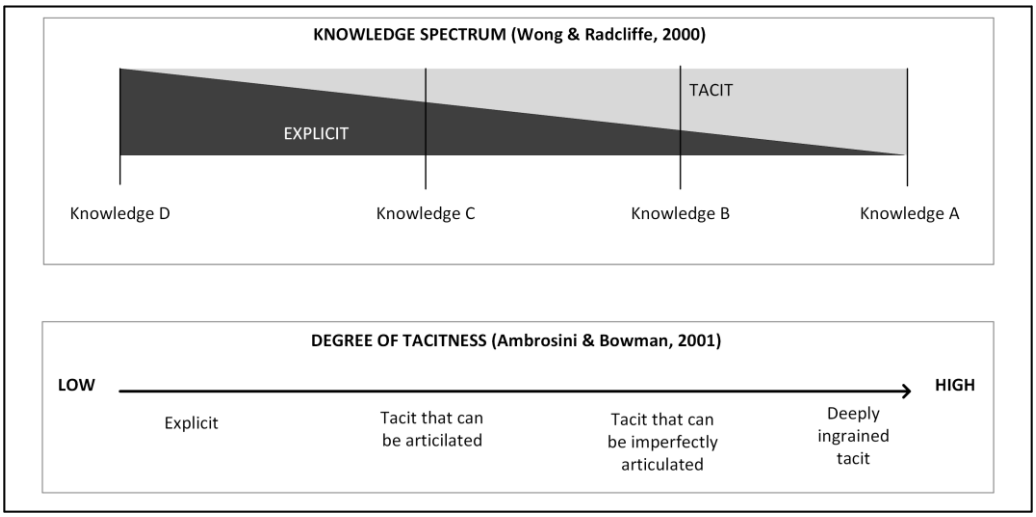

Figure IV.35 - Knowledge spectrum and degree of tacitness.

If on the one hand the multidisciplinary teams are an advantage for developing higher performance products and faster releases (Dubé & Robey, 1999), on the other hand the type of team presents barriers in the effectively sharing knowledge within the team (Barksdale & McCrickard, 2012).

Desouza (2003) in his article indicated three key issues that may inhibit knowledge sharing of tacit knowledge in development teams (Table IV.17).

Table IV.17 - Barriers on sharing tacit knowledge.

Issues		Remedies
Resistance to be known as an expert	Once titled an expert works to one's disadvantage and hampers rather than advances one's career	Organization must encourage a knowledge-sharing culture by clearly defining incentives
Required knowledge cannot be captured and categorized	Knowledge is highly tacit in nature, much of which cannot be articulated well or be put in explicit format, the cost of doing so on average outweighs perceived benefits	KMS should encourage dialogue between individuals rather than just point to repositories
Richness of alternative knowledge exchange mediums	A key for exchange of TK (socialization), knowledge shared surpasses knowledge in information systems	Information technology is only one means to foster knowledge and may not be a true indicator of knowledge-sharing behavior

The Agile Manifesto emphasize the importance of tacit knowledge sharing through social interaction (Ryan & O'Connor, 2013), reinforcing that the face-to-face communication is the most effective way for software development team.

Patton (2002) considered that although close collaboration is exhausting, when team finish the development process, the team's tacit knowledge is 'irreplaceable'. Ryan and O'Connor (2013) defined team tacit knowledge as "the aggregation of articulable tacit, individual, goal driven, expert knowledge to the team-level, where different members of the team possess different aspects of tacit knowledge" (2013, p. 1616). In the Ryan and O'Connor's (2013) opinion the team's

relationships are more associated with team performance than technical factors on successful projects.

Currently, the evolution of new software development organizational arrangements, and digital communication replacing face-to-face communication have challenged the stakeholders to effective transfer of tacit knowledge as well as forms of mitigate the effects of loss of this kind of knowledge. In Clark et al.'s opinion, "there is a lack of the role tacit knowledge plays in teams collaborating digitally" (2015, p. 113). In general, existing literature addresses tacit knowledge utilization in traditional contexts.

IV.3 What is the challenge?

Software is developed from intensive and interactive processes within the team members and knowledge sharing is a key process in its development. Segelod and Jordan considered that software "is an intangible product consisting of nothing but pure knowledge in codified form" (2004, p. 240).

The gathering of people around a software development has the potential of sharing and leveraging different knowledges from different sources and stakeholders. The expected result is the creation of new knowledge that should be more than just the sum of the individual knowledge of each team member. The capture of new knowledge will enable its reuse with saving time, effort and cost (M.T. Hansen et al., 1999; Smith, 2001) and consequently reaching efficiency gains in future projects of development (Huzita et al., 2012; Wang & Noe, 2010).

Every form of organization has an informal organization within the formal one (Al-Rawas & Easterbrook, 1996). Knowledge can be taken during the development process but also in an informal contact (Segelod & Jordan, 2004), so it is important to encourage informal communications between different members of the team and different stakeholders.

The various working meetings that occur throughout a project are conducive to generate and share a lot of tacit knowledge. This tacit knowledge is the product of events such: discussions - whose outcome involved individuals accepting new knowledge or revising beliefs (Walz et al., 1993), parallel conversations, questions, doodles and notes on paper work, notes on blackboards, and experiences from previous projects. According to Kidwell et al. (2000), the ability to manage tacit knowledge defines the difference between a good performer and the best performer. Venkitachalam and Busch (2012) added that the desirable is discuss a way of use of tacit knowledge consistently and efficiently, so that fosters better results in SDO.

However, despite the important and large volume of tacit knowledge generated in the software development process, even if unconsciously, it is common overlook it (Shull et al., 2004). Several authors point to the fact that due to lack of proper mechanisms that allow sharing, identification and

capture of this type of knowledge, most of them is wasted resulting in unavailability for future uses or projects (Al-Rawas & Easterbrook, 1996; Clark et al., 2015; Huzita et al., 2012; Johnson & Donnelly, 2013). Johnson and Donnelly (2013, p. 729) added “much of what we learn by dint of hard work is left on the room floor”.

Based on the literature review and on the above discussion, it is possible to suggest that the main challenge of the SDO is the development of approaches and tools that make the tacit knowledge more explicit as possible (Johnson & Donnelly, 2013; Shull et al., 2002). Facing to the impossibility to codify the relevant tacit knowledge completely, these mechanisms should address ways of personalizing them for future use.

IV.4 Future research directions

After the literature review, the authors point to three possible future research directions within the domain of this chapter.

The several models of knowledge management system are limited to capture just the shared documented knowledge, neglecting undocumented face-to-face knowledge sharing (Wang & Noe, 2010). However, the intensive tacit knowledge nature of the software development process makes essential the development of research in models of knowledge management that address means of conversion of tacit knowledge into explicit or that enable register them.

Based on the new organizational SDO formats and in the practice of utilization multidisciplinary teams of software developers, future researches will benefit with a focus on understanding how cultural and background differences among the several stakeholders involved in software development may affect the ability to share and capture the tacit knowledge.

And finally, the literature concerned to the knowledge management in SDO environment is wide, which has led to increased interest in systematic reviews (Bjørnson & Dingsøyr, 2008). The revisions are important works due to the taxonomy developed, but not aims to evaluate and test the various investigated proposals. The case studies with empirical validation of models and not only with the assessment of technologies becomes a relevant direction.

IV.5 Conclusion

In this chapter, the aim was to highlight through the reviewed literature in the context of SDO the main challenge of knowledge management in this kind of organization.

During the review, it was possible to perceive that knowledge management in context of SDO is extremely complex, it is somewhat distanced from mainstream of knowledge management (Edwards, 2003), and still requires some special attention (Bjørnson & Dingsøyr, 2008). Although most authors (Bresnen et al., 2003; Ghobadi, 2015; Ryan & O’Connor, 2013; Shull et al., 2004)

focus on the challenge in knowledge sharing, some opinions among them are divergent. For example, Shull et al. (2004) argued that there is a need for a wide range of mechanisms to permit knowledge sharing in SDO. While in Bresnen et al.'s (2003) view, interpersonal and social aspects, rather than technological or procedural mechanisms, are critical factors of a successful knowledge sharing.

The chapter's authors have the opinion that somehow knowledge sharing occurs within software development team. Actually, quite encouraged by the formation and use of multidisciplinary teams in the software development process. Multidisciplinary teams have different cultures and expertise and consequently are rich in tacit knowledge. In order to find ways to reach the goal, several formal and informal meetings occur during development process. These meetings are conducive to generating and sharing a lot of tacit knowledge that team members share their perceptions, interpretations, intuitions and judgments within the group (Erden et al., 2008).

The authors also point out that the most of SDO are SME with structures more open and informal with short communications lines (Nonaka et al., 1996), that provide team members close interpersonal relationships with higher degree of trust (Erden et al., 2008). That context is extremely favorable to knowledge sharing activities. On the other hand, according to Erden et al. (2008), most SME lack the understanding of key knowledge management concepts and are slow in implementing knowledge management practices.

That context associated to the growing need to develop software in increasingly shorter periods leads each team member and also the organizations focus on solving the immediate problem and, consequently, the necessary knowledge to do so, implying in the waste of a large amount of tacit knowledge. In the Koskinen's (2001) opinion the utilization of tacit knowledge happens mainly unconsciously. The authors of the chapter tend to agree with Shull et al.'s (2004) opinion that tacit knowledge is overlooked in the context of the SDO. The process of capture or register of tacit knowledge will enable its use and reuse, in an efficient and effective manner, in the current development project and in the future.

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IV.7 Key terms and definitions

Codification Approach: A "people-to-document" approach, which knowledge is carefully codified and stored in databases where it can be accessed and used easily by anyone in the organization. Knowledge is extracted from the person who developed it, made independent of that person and reused for various purposes.

Explicit Knowledge: Knowledge that can be easily expressed in words, numbers, and symbols and stored in books, computers, etc.

Knowledge Capture: A fundamental process of preservation and formalization of knowledge.

Knowledge Sharing: Sharing and transfer are interchangeable, and commonly appear with the same sense in the literature. It is a key process regarding to the knowledge-intensive context in general and in particular within teams of software development.

Knowledge-Intensive Organization: A kind of organization that it is characterized by a high proportion of highly qualified workers, due to access to and manipulation of large quantities of knowledge.

Multidisciplinary Team: A group composed of members with varied but complimentary experience, qualifications, and skills that contribute to the achievement of specific objectives.

Personalization Approach: A “person-to-person” approach that involves ensuring that tacit knowledge is registered. The exchange is achieved by creating networks and encouraging face-to-face communication between individuals and teams by means of informal conferences, workshops, communities of practice, brainstorming and one-to-one sessions.

Tacit Knowledge: Knowledge that is complex, not codified, and presents some difficulty in its reproduction in a document or in a database. It can be got from experience, perceptions and individual values and depends on the context in which is inserted.

Chapter V - The role of social media tools in the knowledge management in organizational context

Reference

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The role of social media tools in the knowledge management in organizational context

Abstract

The advancement of the economy based on knowledge makes knowledge management critical for organizations. The traditional knowledge management systems have presented some shortcomings on their implementation and management. Social media have demonstrated that are not just a buzzword and have been used increasingly by the organizations as a knowledge management component. This chapter was developed aiming at exploring and critically reviewing the literature of social media use in organizational context as a knowledge management component. The review suggests that, while traditional knowledge management systems are static and often act just as knowledge repositories, social media have the potential for supporting different knowledge management processes that will impact on the organizational culture by encouraging on participation, collaboration and knowledge sharing. Despite their recognized impact on knowledge management processes, some uncertainty remains amongst researchers and practitioners and is associated to the difficulty in understanding and measuring their real impact.

Keywords

Knowledge capture; Knowledge management; Knowledge management 2.0; Knowledge sharing; Social media; Social networks; Tacit knowledge; Web 2.0

V.1 Introduction

In the last twenty years knowledge management emerges as a distinct area of study, consolidating as a significant source of competitive advantage and as one of the most important resources in the capacity of progress of modern organizations (Mårtensson, 2000; Pekka-Economou & Hadjidema, 2011). The ability to define, implement and manage business opportunities depends largely on the availability and quality of knowledge.

To meet the challenge of capturing, organizing and disseminating knowledge, the organizations have undertaken heavy investments in technology, however, with "significant failure rates" (Malhotra, 2005, p. 8). In general, the system was not appropriated, or the organization was not prepared for the required cultural change.

Despite the wide agreement that knowledge management occurs within a social context, some authors have the opinion that organizations have been focused primarily on the technology and little on people and process (Kakabadse et al., 2003), and most of the solutions were centralized within the organization with lack of interactivity (Panahi, Watson, & Partridge, 2012).

Social media became a global phenomenon (Schlagwein & Hu, 2016) and have been used increasingly by the organizations. There are several examples of social media use in line with different organization objectives across countries and different types of industries. According to Von Krogh (2012, p. 154), “the increased use of social software by firms is often the result of a strategic imperative for more openness toward the outside”, including, for example, universities, suppliers, customers, and users.

Social media, also called social software, has become in a driving force by exploiting the collective intelligence (Chatti, Klamma, Jarke, & Naeve, 2007). Social media are a set of features, grouped into software applications, which enables to recreate online various types of social interactions that are possible to find in physical environments.

The strategically chosen social media can be internal or external to organization and its use can have as objective to achieve internal or external goals. Schlagwein and Hu (2016, p. 3) add that “technologically different social media tools might achieve the same organizational purpose, or technologically similar social media tools might achieve very different organizational purposes”. These purposes can be such as to improve productivity, increase the interaction between departments and team workers, create a channel with consumers or enhance the management of knowledge.

Truly, almost none of the social media acts alone. The combination of different tools in an appropriate measure can produce excellent results for organizations. However, often identifying the

perfect match of tools can be somewhat difficult due to the dynamism and versatility of social media tools (Schlagwein & Hu, 2016).

Social media are very close in its principle and attributes to knowledge management (M. Levy, 2009), providing inexpensive alternatives and solutions that can overcome many failures of traditional knowledge management models (von Krogh, 2012). These tools have also shown to be an efficient mechanism in supporting knowledge sharing, particularly tacit knowledge, helping organizations to capture knowledge based on the knowledge from different stakeholders (Al Saifi, Dillon, & McQeen, 2016; Clark et al., 2015; Costa et al., 2009; Panahi et al., 2012; Paroutis & Al Saleh, 2009; Tee & Karney, 2010). Based on the crowd-wisdom, the social media enable to keep knowledge relevant and up-to-date (Chatti et al., 2007).

According to Kane et al. (2014, p. 276) "the impact of social media on and for organizations, represents an important area for information systems research".

Given that knowledge management is critical for organizations and social media tools have the potential to be enablers for knowledge management processes, through a literature review, the chapter's authors aim to explore and contribute to understanding the possible impacts and consequences in the use of these tools in knowledge management in organizational context, and highlight the factors that can be determining to the eventual success of a knowledge management based on social media. The chapter also aims to address some further research directions.

This chapter is to be understood as being exploratory in its nature and is organized as follows. In the next section, the authors through the theoretical background introduce social media and knowledge management. The following section, based on the literature reviewed, provides a critical discussion of the role of social media in the knowledge management processes. Following this section, the authors discuss about the main benefits and threats of social media in the knowledge management context. Conclusion and directions for future research are in the final part of this chapter.

V.2 Background

Initially, it is important to make a brief theoretical background of the study. In this section, the authors provide an overview of social media tools and traditional knowledge management.

V.2.1 Social media tools

Social media have demonstrated that is not just a buzzword. After influencing how organizations and society operate (Ford & Mason, 2013b), social media in the organization have been boosting collaboration and participation among knowledge workers, helping to create a social network in which people are more connected and knowledge can flow more efficiently between participants (Gaál et al., 2015; M. Levy, 2009).

Kaplan and Haenlein (2010, p. 59) argue that in the literature "there seems to be very limited understanding of what the term "social media" exactly means", and what exactly should be included under this term (Kaplan & Haenlein, 2010). Practitioners and researchers have used the term social media interchangeably and as synonym for Web 2.0 (Kaplan & Haenlein, 2010; O'Reilly, 2007). This situation causes some confusion, so it is necessary to clarify the terms. The term Web 2.0 is credited to O´Reilly (Paroutis & Al Saleh, 2009) and it refers to a set of technology of online tools that supports social interaction among users. Social media are the platforms created using the Web 2.0 technologies being, according to Kaplan and Haenlein (2010, p. 61), defined as "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content". Also, De Wever et al. (2007, p. 512) define social media as "software that enables communication through digital technologies during which people connect, converse, collaborate, manage content and form online networks in a social and bottom-up fashion".

Harrysson et al. (2016) state that, based on their survey "The evolution of social technologies" carried out among 2750 global executives over each year from 2005 to 2015, since the beginning of the social-technology era, organizations have recognized potential of social media in strengthen lines of company communication and collaboration, and to boost knowledge sharing. In their article, Kane et al. (2014) support that the adoption of social media by organizations has just begun. Interestingly though, a more recent survey of McKinsey&Company (Bughin, 2015) points out that organizational use of social media grew rapidly, but currently growth is flattening.

The availability of popular, and free, open source software, that are simpler, smarter and more flexible has fostered the increased use of social media (Avram, 2006; Leonardi, Huysman, & Steinfield, 2013).

Social media are based on integration between people and comprise a set of technological tools that support organizational purpose enabling people to connect, communicate, and collaborate by self-organizing social networks and engaging in conversational interactions and social feedback (Hemsley & Mason, 2011; Schlagwein & Hu, 2016; Sigala & Chalkiti, 2015).

According to Levy (2009), the decision to use social media tools by the organizations is taken based on two dimensions: technology adoption (software infrastructure or software application), and user orientation (use by and for organizational members, or use by organization facing stakeholders - customers, partners and suppliers). These tools typically consist in: blogs and micro-blogs, discussion forums, social networks or relationship maps, document or media sharing, and wikis (Ford & Mason, 2013b; Hemsley & Mason, 2011).

At the strategic level, according to the Harrysson et al.'s survey (2016), around 30% of the organizations use social tools for strategy development, and 25% of organizations make decisions and setting strategic priorities from bottom up. The survey results also point to the fact that,

according to the 47% of surveyed executives, the strategy of priorities from the bottom up would intensify over the next three to five years, with organizations using mainly social networks that have their use expanded and become better integrated.

However, organizations do not work the same way the Internet community does, and a model that is working out there could fail in the organizational context. Consequently, social media use in organizations faces two main barriers. The first on the part of organizations that are concerned about the risks and consequences of a potential misuse, and the second on the part of workers and managers that are not motivated or are not aware of the benefits of using these tools for work purposes (Gaál et al., 2015).

The same social media tool can be used for very different organizational purposes (Schlagwein & Hu, 2016). However, this versatile characteristic brings a challenge. According to McAfee (2006) the challenge lies in ability of each organization to exploit these tools, and he adds that the significant difference in organizations' abilities that will make all the difference.

Due to the combination of their main characteristics, such as user-generated content, peer to peer communication, networking, multimedia oriented, and user friendly (Panahi et al., 2012), these tools represent a successful mechanism that enables knowledge sharing and knowledge creation, keeps people connected, can supply endless reusable knowledge, or even facilitates to access expert's knowledge (Bharati, Zhang, & Chaudhury, 2015).

V.2.2 Traditional knowledge management

After the information management, a neutral and normative system in the organizations (Gloet & Terziovski, 2004), knowledge management emerges as a distinct area of study, establishing as a significant source of competitive advantage and as one of the most important resources in the capacity of progress of organizations in today’s hypercompetitive and globalized marketplace (Ford & Mason, 2013b; Mårtensson, 2000; Pekka-Economou & Hadjidema, 2011).

The advancement of an economy based on knowledge has increased the visibility and importance of organizations that create and disseminate knowledge. Through knowledge, organizations can disrupt limitations, enhancing development and create new opportunities (Pekka-Economou & Hadjidema, 2011). Several authors consider that new knowledge and innovation are heavily dependent on knowledge management practices (Gaál et al., 2015; Gloet, 2006; Inkinen, 2016), thus constituting knowledge management practices as a key driver of innovation performance.

According to the classical division introduced by Polanyi (1966a), and widely spread by Nonaka et al. (1995) knowledge can be explicit or tacit.

Explicit knowledge is a type of knowledge that can be easily codified, articulated, documented and archived, and usually, it is stored and expressed in the form of text, data, scientific formulae, maps,

manuals and books, websites, etc. (Alavi & Leidner, 2001; Iacono, Nito, Esposito, Martinez, & Moschera, 2014; Nonaka & Konno, 1998; Polanyi, 1966a; Santoro & Bierly, 2006; Seidler-de Alwis & Hartmann, 2008).

Tacit knowledge is the basis of knowledge creation, it is complex and not codified, and presents some difficulty in its reproduction in document or database. Smith (2001) reported that ninety percent of the knowledge in any organization is tacit knowledge and it is embedded and synthesized in peoples' heads.

Among several authors knowledge management is a multidimensional concept (e.g. Gaál et al., 2015). In the present chapter the authors adopt the Davenport and Prusak's (1998) definition, that is one of the most cited in the literature: "knowledge management is concerned with the exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives."

Knowledge management is based on three main pillars (technology, people and process), and occurs within a social context (Kalkan, 2008; Prieto et al., 2009) (Figure V.36).

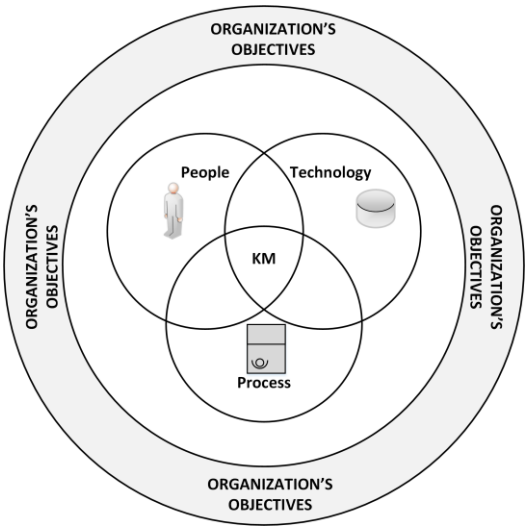

Figure V.36 - Knowledge management pillars.

With substantial investments in highly structured technological solutions, organizations have been carried to focus primarily on the technology and little on people and process (Kakabadse et al., 2003), not enabling the interactivity and opportunity of the people in influencing (McAfee, 2006; Panahi et al., 2012). According to Sultan (2013, p. 162) "working people are more likely to seek work-related advice from fellow workers than from a knowledge-based system".

Technologies are not creator of knowledge but are considered as one of the key enablers in the knowledge management process (Malhotra, 2005).

Knowledge management describes the processes of sharing and transfer, capture, and application of organizational knowledge to improve organizations' competitiveness.

Kang et al.'s (2010) state that knowledge by itself is not a useful resource that creates value and competitive advantage until it can be shared and transferred. Knowledge emerges from sharing knowledge in a social context (Jakubik, 2008) resulting of interactions between people. However, several authors (e.g. Ford & Mason, 2013b; Sigala & Chalkiti, 2015; von Krogh, 2012) identify the knowledge sharing process, a weak point of traditional models of knowledge management.

The successful sharing and transfer of knowledge is an important factor in knowledge management performance (Gaál et al., 2015; Wang & Noe, 2010), and according to Gaál et al. (Gaál et al., 2015, p. 185) "actually, the organizations are faced with the challenge how to get people to share their knowledge". Faced with this challenge, organizations have been forced to improve their knowledge sharing practices and to adopt new technologies.

Knowledge needs to be captured, stored and then disseminated (Huzita et al., 2012). The knowledge capture is a key process of preserving and formalizing knowledge (Becerra-Fernandez & Sabherwal, 2010) and the result is the inclusion of the knowledge into the stock of knowledge. The process of capture has various methods and the selected method depends on the type of knowledge. The process of capture must be disposed of properly, responding to the challenge of capturing only the relevant and valuable knowledge (Nielsen, 2006). Once captured, knowledge should be continuously evaluated to ensure their quality and relevance.

Knowledge application is the process management that justifies the existence all of other processes. It makes no sense to create knowledge, capture it, share it and download it, if not be disseminated and applied. Starbuck (1992) argued that merely storing knowledge does not preserve it.

New knowledge is disseminated through several channels available among the members of a social system (Graham et al., 2006) promoting their application (Becerra-Fernandez & Sabherwal, 2010). Social system is considered a set of interactions between people who have connection between themselves and that belong to the same context (Figure V.37).

Traditional knowledge management are complex environments which have as organizational purposes to capture knowledge through documents repositories, share that knowledge with groupware tools, and make it accessible via corporate portals (von Krogh, 2012). These solutions often require an effort of investment and presents some difficulty in its application (Sultan, 2013).

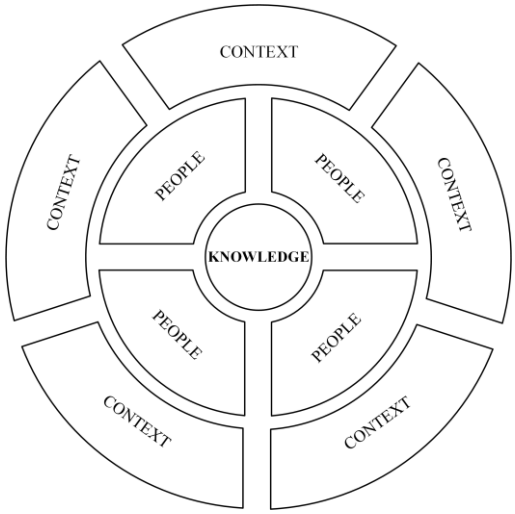

Figure V.37 – Social system.

In general, traditional knowledge management system consist in a collection of knowledge management technologies (Figure V.38), which support the knowledge management processes, and a set of communication media widely diffused in the organizations, such as e-mail, person-to-person instant messaging, and telephone (McAfee, 2006; von Krogh, 2012). The usage of communication media use, according to McAfee (2006, p. 22), enable that digital knowledge "can be created and distributed by anyone, but the degree of commonality of this knowledge is low", i.e. it's only viewable by the few people who are part of the subject.

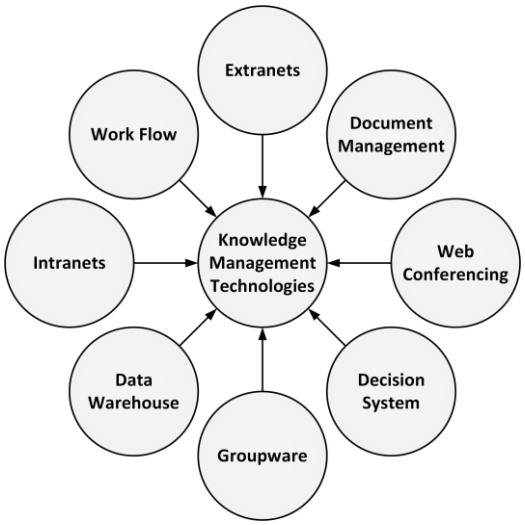

Figure V.38 – Knowledge management technologies.

V.3 The role of social media tools in the knowledge management in organizational context

V.3.1 Knowledge management 2.0

The expression “knowledge management 2.0” refers to the knowledge management system that enables self-organization of people, by utilization of appropriate social media tools (Becerra-Fernandez & Sabherwal, 2010; Levy, 2009). In contrast to the traditional knowledge management models, knowledge management 2.0 is characterized by the content that is generated in decentralized and distributed way and in a bottom-up condition, from workers (internal social media use) and stakeholders (external social media use) (Avram, 2006; Schlagwein & Hu, 2016; von Krogh, 2012). Ford and Mason (2013a, p. 8) highlight that "the two types may have different risks, costs, and benefits for organizations".

As well as with the knowledge management, the use of social media by organizations has become a global phenomenon (Schlagwein & Hu, 2016). Bharati et al. (2015) cite in their study that, based on the 2011 McKinsey’s survey, around 70% of the organizations use social media tools to increase speed to access knowledge.

The social media tools, that organizations can buy or develop, are close to some principles of knowledge management (Ford & Mason, 2013b; Levy, 2009; McAfee, 2006; von Krogh, 2012), since both involve people using technology to capture or acquire knowledge, create knowledge, and share this knowledge (Bradley & McDonald, 2011).

According to von Krogh (2012) social media have three aspects of relevance to knowledge management: (i) it is founded on socially oriented principles; (ii) it consists of a series of intuitive and easy to use applications (e.g. blogs and wikis); (iii) it is based on infrastructures (e.g. open platforms and enabling services) that make possible to reach considerable economies of scale.

The significant difference consists in the centralization and controlled attitude of knowledge management, in contrast to the uncontrolled and decentralized one of social tools (Levy, 2009).

The traditional knowledge management systems are technology-centric with a rigid and hierarchic knowledge structure. However, Malhotra (2000) in his work “Knowledge management and new organization forms: a framework for business model innovation” points to the fact that knowledge management technologies, in itself, do not assure knowledge creation and knowledge evolution. In this era characterized by discontinuous change, there is an increasing importance of the “human function of ensuring the reality check - by means of repetitive questioning, interpretation and revision of the assumptions underlying the knowledge system” (Malhotra, 2000, p. 11).

Social media technologies are people-centric with priority to the relationship and collaborative knowledge management processes (Sigala & Chalkiti, 2015). This second generation of knowledge

management solutions puts technology in the background and focuses on people, promoting the participation of knowledge workers, who will be more willing to share and innovate by using tools they already know and like (Levy, 2009).

Figure V.39 illustrates the difference between these two approaches.

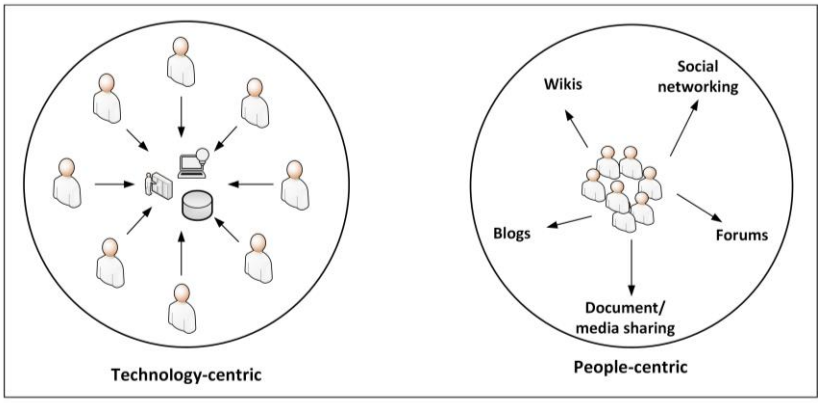

Figure V.39 – Technology-centric and People-centric approaches.

McAfee (2006) alerts to the fact that social technologies are not incompatible with traditional knowledge management systems. Existing channels and platforms can be enhanced, improving and reducing gaps in processes and technologies, by adoption of social tools that provide the essential ingredients needed to succeed in the organizations. These ingredients are summarized in an acronym formulated by McAfee (2006) (see Figure V.40).

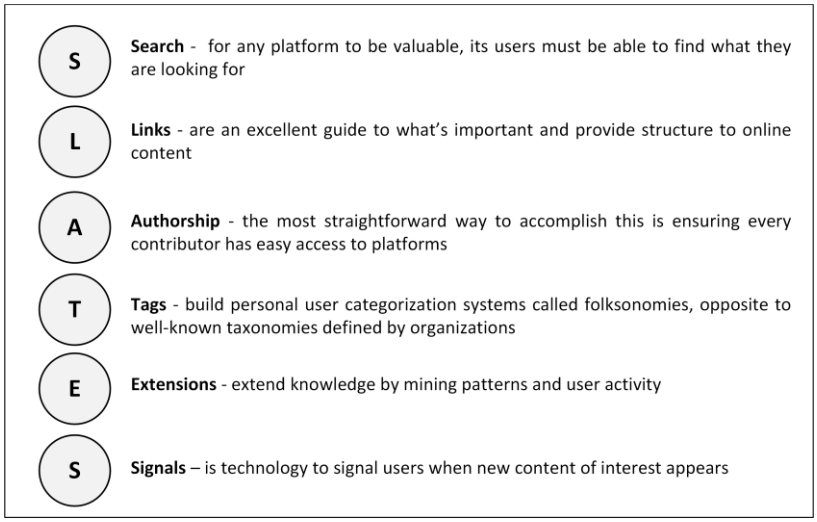

Figure V.40 – SLATES infrastructure – Based on McAfee (2006).

Knowledge management 2.0, with structures more open and informal with short communication lines, arises to answer the request for effective ways to support knowledge sharing, and collaborative work. Organizations have been looking for secure, flexible environments where workers can add, organize, share and socialize knowledge through close interpersonal

relationships with higher degree of trust. Social media tools seem to be suited to increase knowledge sharing and improve organizational competences.

V.3.2 Social media as a knowledge management component

The usage of social media as a component of the knowledge management system has a great potential to leverage the existing knowledge management initiatives in organizations (Ford & Mason, 2013a; Richter, Stocker, Müller, & Avram, 2011), and to foster and to support the human participation in the processes. It is important that organizations embrace them and consciously utilize them to support their knowledge management initiatives (Levy, 2009; von Krogh, 2012).

The social media use as a knowledge management component can facilitate communication and collaboration between users within and outside an organization (Bharati et al., 2015), enabling users to easily share what they have learned, created and experienced, creating opportunities and conditions that promote the flow of tacit knowledge (Panahi et al., 2012), as well as allowing the storage of knowledge directly on social media or the use of social media to post links to knowledge management system (Schlagwein & Hu, 2016).

The Figure V.41 represents a conceptual model of tacit knowledge sharing in social media according Panahi et al. (2012).

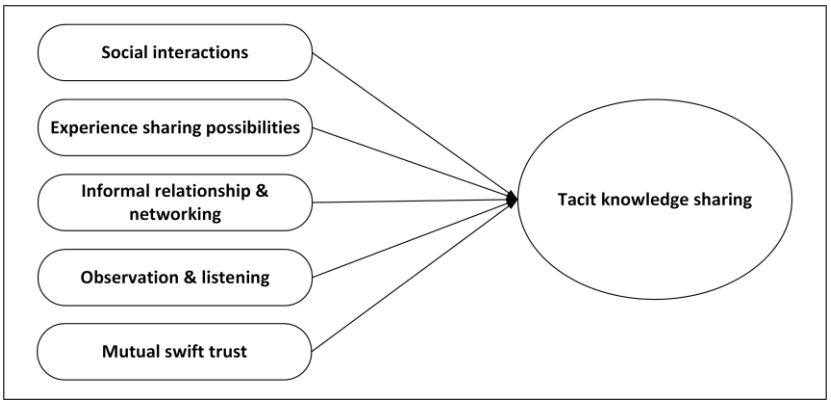

Figure V.41 – Tacit knowledge sharing in social media from Panahi et al. (2012).

Citing Bebensee et al. (2011), von Krogh (2012) argues that social media have three layers of relevance to knowledge management, namely, they are based on socially oriented principles, the tools are intuitive to understand and easy to use, and they are infrastructures as open platforms that achieve considerable economics scale. Dave and Koskela (2009) add two other relevant aspects. They mention search capabilities, that make easy to retrieve knowledge, and anytime/anywhere and widespread availability.

The knowledge management evolution is characterized by the adoption of appropriate social media tools including, among others, wikis, blogs and social networks. The use of one or a combination of these tools as a knowledge management component has been providing to the organizations a

new knowledge environment (Hemsley & Mason, 2011) with enhancement of organizational knowledge management and collaborative sharing of knowledge (Bharati et al., 2015; O'Reilly, 2007; von Krogh, 2012).

The paradigm shift taking place in the new forms of interaction and knowledge sharing requires that organizations will adopt more flexibility in roles and control, with greater individual responsibilities (Ford & Mason, 2013a). Social media tools can facilitate this shift, supporting and providing fundamental changes in traditional knowledge management processes (Bharati et al., 2015; Richter et al., 2011).

Social media embodied with a business mindset can move organizational knowledge management, with impacts within and outside the organizations (Dave & Koskela, 2009), towards to a more flexible structure, thereby leading to fundamental change in such a way that enables interactions among individuals with rich and diverse types and contents knowledge (Richter et al., 2011; Sigala & Chalkiti, 2015). This change enables self-organization of workers, promote social interactions, networking and different ways of knowledge sharing (Bharati et al., 2015; Dave & Koskela, 2009; Sigala & Chalkiti, 2015), in particular regarding the tacit knowledge (Dave & Koskela, 2009).

Sigala and Chalkiti (2015) suggest that according the existing literature, social media can support all the four circles of the SECI model (Nonaka et al., 1996) by empowering people to create and renew knowledge in a dynamic, conversational and flexible way (Figure V.42). The SECI model is based on the assumption that the creation and expansion of organizational knowledge occur by the continuing interaction between tacit and explicit knowledge resulting from the interactions between groups or individuals.

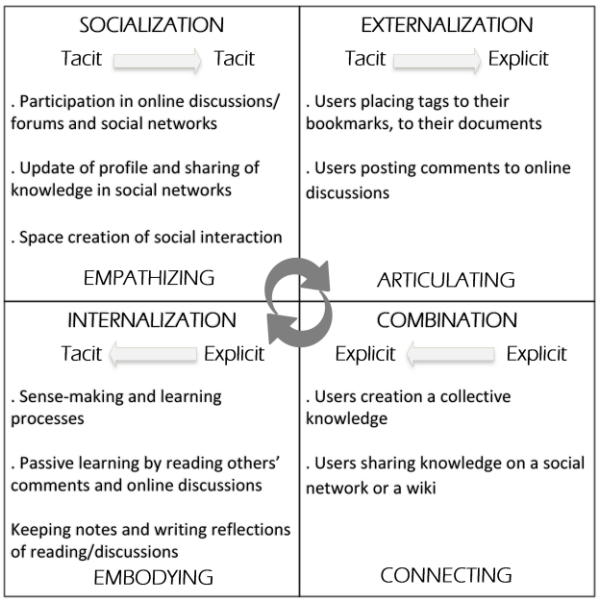

Figure V.42 – Knowledge conversion circles enabled by social media – based on Nonaka et al. (2000) and adapted from Sigala and Chalkiti (2015).

Although their significant impact, some organizations remain uncertain of their usage (Ford & Mason, 2013a). This uncertainty, according to several authors (Kane et al., 2014; Richter et al., 2011; Schlagwein & Hu, 2016), is associated to the difficulty amongst researchers and practitioners in understanding the real impact of the social media adoption in the organizations. In recent study Schlagwein and Hu (2016) discuss about this issue and identify three social media characteristics that can hinder this understanding. Social media are continuously in development, encompass a wide range of different tools and content, and the same social media tool at the same time can be used for very different organizational purposes or different social media tools might achieve the same organizational purpose (Schlagwein & Hu, 2016).

Based on the literature reviewed, the Table V.18 presents several empirical studies about the usage of social media in the knowledge management context.

Table V.18 - Social media in knowledge management context.

Author	Study	Method
Al Saifi et al. (2016)	This paper explores the relationship between face-to-face social networks and knowledge sharing. The results reveal that face to face social networks facilitate knowledge sharing in diverse ways.	Semi-structured interview
Schlagwein & Hu (2016)	This study examines the relation between social media use and the absorptive capacity of organizations.	Semi-structured interview
Bharati et al. (2015)	This study highlights both the potential and limitations of social media in promoting organizational knowledge management.	Case study
Gaál et al. (2015)	This research investigates how internal or external social media technologies are being used for knowledge sharing during work or for professional development.	Survey
Sigala & Chalkiti (2015)	The study investigates the relation between social media use and employee creativity by adopting a knowledge management approach in order to consider the influence of social networks and interactions on individuals' creativity.	Case study
Soto-Acosta et al. (2014)	This paper extends previous studies on the use of internet technologies and knowledge management by analyzing factors affecting knowledge sharing through Web 2.0 technologies within small and medium-sized enterprises.	Survey
Giuffrida & Dittrich (2013)	This paper reviews and map empirical studies on the usage of social software in Software Engineering projects and in distributed teams. Social software is reported as being chiefly used as a support for collaborative work, fostering awareness, knowledge management and coordination among team members.	Systematic mapping study
Bebensee et al. (2011)	This article aims at identifying Web 2.0 applications for bolstering up organizations' knowledge management practices.	Case study
García et al. (2011)	The aim of this work is to provide a set of guidelines to develop knowledge-based Process Asset Libraries to store software engineering best practices, implemented as a Wiki.	Fieldwork case study
Richter et al. (2011)	This study analyzed social software adoption in 23 companies and derived six main goals of corporate social software adoption. These goals were compared with the goals of knowledge management projects and initiatives, as identified in a series of well-known knowledge management studies.	Case study
Costa et al. (2009)	This case study describes the effects of using a Web Based Social Network approach to Knowledge Management in a Brazilian software development organization.	Case study
Dave & Koskela (2009)	This paper discusses a range of solutions and presents a case study where a collaborative knowledge management solution is implemented across a multi-functional construction company.	Case study
Paroutis & Al Saleh (2009)	The purpose of this paper is to investigate the key determinants of knowledge sharing and collaboration using Web 2.0 technologies by exploring the reasons for and barriers to employees' active participation in its various platforms.	Case study design

V.3.3 Benefits of using social media as knowledge management component

Considering that organizations do not have the mass of people as the Web does (Levy, 2009), the collaborative use of social media by organizations assumes an important role in the development of a collective intelligence knowledge environment which can represent a competitive advantage (Charband & Navimipour, 2016; Hemsley & Mason, 2011).

Knowledge management 2.0 with structures more open and informal with short communication lines, can provide workers close interpersonal relationships with higher degree of trust. This context is extremely favorable to knowledge sharing activities (Al Saifi et al., 2016).

Social media enable that knowledge becomes more articulated and explicit through discussions within workers and different stakeholders with creation of particular knowledge outputs as well as products and services (Schlagwein & Hu, 2016), overcoming many of failings of traditional knowledge management solutions (Chatti et al., 2007).

Leonardi et al. (2013) highlight that social media are distinguished with respect to other communication technologies since maintain the visibility and persistence of communicative actions, expanding the environment whom workers can learn. Social media also promotes the knowledge reuse, or as Schlagwein and Hu (2016, p. 19) say “may prevent that organization from forgetting what it already knows”, with workers taking advantage of past experiences and learning from what others already know within and outside organization. As well as, compared to traditional knowledge management systems, social media enable easily that knowledge be edited, updated and searched, what encourages workers to participate in creation and use of relevant knowledge, fostering and enriching the individual and collective processes of cognitive interactions. (Harrysson et al., 2016; Schlagwein & Hu, 2016; Sultan, 2013).

McAfee (2006, p. 26) address another important issue related to the integration capability of social media in large organizations, that makes organizations "in some ways more searchable, analyzable and navigable than smaller ones". The workers are able to find knowledge more readily and to identify experts on various topics.

Due to their characteristics, social media also emerge as an opportunity for the small and medium enterprises. These organizations work in a scenery of shortage of resources, and in the knowledge era they will be competitive if they take advantage of their peculiarities and peculiarities of their environment (Starbuck, 1992). Social media can meet the knowledge management needs of these type of organizations (Sultan, 2013).

Richter et al. (2011) in their study “Knowledge management goals revisited - A cross-sectional analysis of social software adoption in corporate environments” identify the main benefits that organizations expect to reach with the adoption of social media (Table V.19).

Social media have also shown to be an important and efficient mechanism in supporting tacit knowledge sharing, helping organizations to capture knowledge based on the knowledge from different stakeholders (Al Saifi et al., 2016; Clark et al., 2015; Costa et al., 2009; Tee & Karney, 2010). With the creation of social interactive and collaborative spaces - so-called Ba by Nonaka et al. (2000), provided by these technologies, the individual and collective cognitive processes are facilitated (Sigala & Chalkiti, 2015), occurring great opportunity for effective flow of tacit knowledge between workers or communities of experts (Chatti et al., 2007; Panahi et al., 2012).

Table V.19 - Main goals for the adoption of social media - adapted from Richter et al. (2011).

Main goal	Characteristics of the goal
Efficient, goal-oriented employee communication and avoidance of information overload	Implementation of open communication channels, support of employees' goal orientation by enhancing communication, improvement of employee- to-employee communication, prevention and control of information overload, decrease of e-mail usage
Efficient knowledge transfer	Preservation and restoration of internal knowledge, breaking up of knowledge silos, facilitation of intra-organizational knowledge transfer, better access to best practices
The establishment of networks of experts	Improvement of networking among employees and identification of experts, connecting people with similar contexts, development of expert communities (e.g. yellow pages), support for wisdom of crowds
Participation of employees and creation of open corporate culture	Sustainable involvement of employees i.e. each employee should be able to contribute actively, prevent employee anonymity within the organization, improve exchange and discussion among the employees to get better insights to support the corporate culture, development of a creative climate, openness of corporate culture allowing employees to participate more
Increased awareness and transparency	Provide better visibility to common tasks and competences, more transparency within decisions and processes, employees and management are aware of each other, cross-cutting issues can be revealed
Support for the innovation potential and secure the future viability of the enterprise	Innovation can be communicated faster and will be better understood, innovation can be started from inside and outside, new systems guarantee future-orientation and flexibility, sustainability is demonstrated by including the younger generations

V.3.4 Threats of using social media as knowledge management component

The flexibility seems to be the watchword of social media. The new forms of communication and knowledge sharing, arising from the adoption of social media as a knowledge management component, require greater flexibility by organizations with impact on organizational culture of control and management.

However, Richter et al. (2011, p. 8) highlight that "flexibility in use does not come without threats".

Based on the literature reviewed, the chapter's authors identify some threats related with knowledge protection, knowledge quality, and management approach.

Knowledge protection

The advent of social media as a knowledge management component may represent large efficiency gains, and knowledge sharing within and across organization boundaries (von Krogh, 2012) stands out as one of the most significant benefit. However, knowledge sharing achieved with the use of social media can turn into a relevant threat for the organizations.

Due to the ease with that knowledge can be disseminated and shared, result of social media characteristics, such as speed of knowledge distribution, blurry audience, and easily collectible (Ford & Mason, 2013b; Richter et al., 2011), and the way that organization perceive knowledge in this new environment, social media could represent as a knowledge protection threat (Ford & Mason, 2013b).

This threat may mean potential loss in the organization's value resulting from disclosure of critical knowledge assets (Ford & Mason, 2013b; von Krogh, 2012), misuse of knowledge (Ford & Mason, 2013b), or risk of exposure of existing gaps in organizational knowledge (von Krogh, 2012).

The philosophy of traditional knowledge management concerning the notion of knowledge protection seems to be conflicting with knowledge management 2.0's philosophy. Restrictive rules and monitoring at the individual level may be impractical and counterproductive (von Krogh, 2012), and can seriously inhibit or even stop spontaneous workers' interactions and collaborations.

Knowledge quality

The quality of knowledge created in this new environment derived of the adoption of social media is often questioned in the literature (von Krogh, 2012). Whereas knowledge quality is essential to manage business opportunities, this issue may be also viewed as a possible threat.

The environment that enables quality of knowledge should be rich and diverse in sources of knowledge in order to benefit knowledge creation, thus avoiding the influence of existing biases within and among of small groups of workers (Kane, 2015). McAfee (2006) also alerts for the fact of that, due to the versatility of social media, despite the correct use of them by the workers, the knowledge reached by the organization may not being the intended.

Another issue which arises when talking about quality of knowledge is the overload of knowledge that results from the diversity in the knowledge sharing process fostered by the social media use in knowledge management. It will therefore be fundamental for the organizations to ensure the increased efficiency and effectivity at knowledge sharing (Charband & Navimipour, 2016; Richter et al., 2011).

The overload knowledge effect may cause some difficulty to workers in processing a vast quantity of knowledge (Kane et al., 2014) or in differentiating the relevant knowledge (Kane et al., 2014; Leonardi et al., 2013). Which, according to Leonardi et al. (2013, p. 12), "could force workers to become even more insulated and in-group focused than they were before of social media use".

The business emphasis of knowledge management plays a central role in bridging the threat of knowledge quality in the social media use (Bharati et al., 2015; Dave & Koskela, 2009).

Management approach

Ford and Mason (2013b) highlight that the adoption of social media causes emergence of some tensions between these technologies and knowledge management initiatives arise. The tensions arise from the necessity to redefine previously accepted organizational mechanisms (e.g. roles, control) that become difficult to maintain in what is emerging as a dynamic, complex knowledge environment (Ford & Mason, 2013a, 2013b). The formality will not disappear entirely, however management style will play an important role in this process, and their involvement in the adoption and utilization of social media as a component of knowledge management practices will be crucial (Bharati et al., 2015). The management should clearly support the adoption of new technologies, explicit expectations about the outcomes (Paroutis & Al Saleh, 2009), and embrace social media as a part of organization's knowledge strategic component (von Krogh, 2012).

In the literature several authors point out some issues that the management faces when organizations adopt social media. For example, McAfee (2006) has the opinion that knowledge workers, in general, are busy, do not help to development social media platforms, and just use them as user. Ford and Mason (2013a) comment that when organization supports empowerment and engagement, these initiatives may fail if they are seen as attempts to control the knowledge and to make workers expendable. According to Sultan (2013, p. 164) "a large proportion of the content created on social media platforms is the contribution of a small proportion of the people who use those tools", making it necessary to encourage as many of workers as possible to engage and contribute to knowledge creation process in a collaborative manner (Al Saifi et al., 2016; Richards, 2007).

V.4 Future research directions

The adoption of social media by organizations has increased quickly and the implementation approaches vary from organization to organization (Bharati et al., 2015; Richter et al., 2011; von Krogh, 2012). The research opportunities are vast on the usage impact of these tools for knowledge management into organizations. It is possible to find in the existing literature studies which are devoted to the opportunities or needs of research on this subject (e.g. Kane et al., 2014; Leonardi et al., 2013; von Krogh, 2012).

The chapter's authors highlight some questions which should be addressed in future research:

- First of all, does exist difference among the types of organization that social media is more suitable than traditional knowledge management?
- How does organization balance the social media and traditional knowledge management uses to enable knowledge processes?

- How does organization protect their knowledge exploiting the benefits and mitigating the threats?

- It seems to be consensus among authors that capture and sharing of knowledge may become easier with social media use. What are the best practices to boost them?

- Finally, due to the phenomenon of globalization of organizations, would be interesting further researches on the identification of the impact of cultural differences on social media adoption.

V.5 Conclusion

This chapter was developed aiming at exploring and critically reviewing the literature of social media use in organizational context as a knowledge management component and highlight which roles that these tools have played enabling and improving the development of knowledge management in the organizations.

In the extensive literature the term ‘easy’ is the most commonly used by different authors in relation to social media (e.g. Avram, 2006; Leonardi et al., 2013; Levy, 2009; von Krogh, 2012). However, the abilities to exploit these tools will make significant difference among organizations.

Despite some authors claim that social media oriented to knowledge management will require much less of the ‘management’ component, the chapter's authors have the opinion that the adoption of these tools often requires management actions more intense than in the traditional knowledge management, since the workers are used to use social media in a very spontaneous way and in accordance with their interests. According to Gaál et al. (2015, p. 196), “it is recommended for management to support introducing social media tools, establish the terms and conditions of usage, communicate the benefits and provide the necessary trainings”.

The review suggests that, while traditional knowledge management systems are static and often act just as knowledge repositories, social media have the potential for supporting different knowledge management processes that will impact on the organizational culture by encouraging on participation, collaboration and knowledge sharing. This impact provides capabilities, which are difficult in traditional model that can make knowledge management processes, mainly knowledge creation and sharing, more effectively and efficiently.

Social media, probably due to its continuous change and variety of platforms, have not yet been fully exploited, but it seems be clear their potential as a significant component of knowledge management system.

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V.7 Key terms and definitions

Knowledge Capture: A fundamental process of preservation and formalization of knowledge.

Knowledge Management: The exploitation and development of the knowledge assets of an organization with a view to furthering the organization's objectives.

Knowledge Management 2.0: Knowledge management system that enables self-organization of people, by utilization of appropriate social media tools, such as wikis, blogs and social networks.

Knowledge Sharing: Sharing and transfer interchangeable, and commonly appear with the same sense in the literature. Knowledge sharing promotes the creation of new theories and ideas, and establishment of new research principles. It is a key driver of innovation process.

Social Media: A set of features, grouped into software applications and websites, which enables people and organizations to recreate online various types of social interactions that enable to create and share content.

Social Networks: Web sites that enable users to articulate a network of connections of people with whom they wish to share access to profile information, news, or other forms of content.

Tacit Knowledge: Knowledge that is complex, not codified, and presents some difficulty in its reproduction in a document or in a database. It can be get from experience, perceptions and individual values, and depends on the context in which is inserted.

Web 2.0: The second generation of the World Wide Web, that emphasizes the concept of exchange of information and collaboration through the Internet sites and virtual services. The idea is that the online environment becomes more dynamic and, in this way, users to collaborate to organize content.

Chapter VI - Factors affecting attitude toward knowledge sharing: An empirical study on a higher education institution

Reference

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Factors affecting attitude toward knowledge sharing: An empirical study on a higher education institution

Abstract

Higher education institutions are currently under pressure, driven by the knowledge society and the internationalization of institutions. Therefore, a positive attitude toward the knowledge sharing, on behalf of higher education institutions and their main actors, is required. Considering that the knowledge sharing attitude is motivated and executed mainly at the individual level, this study examines the relationship between individual factors and the attitude toward knowledge sharing among professors and researchers. The results identified that intrinsic motivation and social networks positively affect the attitude toward knowledge sharing. In practice, this work can help the institution defining strategies and developing future actions in order to promote a knowledge sharing culture supported through an empirical study. In a theoretical perspective, this study contributes to the knowledge's increase in the area, since little is known about the attitudes regarding knowledge sharing in higher education institutions.

Keywords

Higher education institution; Knowledge sharing attitude; Intrinsic motivation; Extrinsic motivation; Social networks

VI.I Introduction

Knowledge has become one of the most valuable drivers for exploiting core competencies and achieving sustained competitive advantage (Lin, 2007a). The advantage obtained by the organizations depends largely on the ability of creating and sharing knowledge (Nahapiet & Ghoshal, 1998). Several studies have shown the existence of different factors that can affect people's attitude toward knowledge sharing (Seonghee Kim & Ju, 2008), such as organizational, technology, and individual (Lin, 2007b; Patel & Ragsdell, 2011; Tohidinia & Mosakhani, 2010).

Higher education institutions are knowledge intensive organizations (Howell & Annansingh, 2013), where knowledge is their input and output (O. F. Ali, Gohneim, & Roubaie, 2014), which requires an attitude toward knowledge sharing. However, in spite of knowledge sharing being one of their core missions (Fullwood, Rowley, & Delbridge, 2013), the studies show that knowledge sharing does not emerge strongly within higher education institutions (Ramayah, Yeap, & Ignatius, 2013). Their idiosyncratic characteristics, such as individualistic culture, knowledge as proprietary and source of differentiation, the specific needs of every researcher, and academic freedom (Tian, Nakamori, & Wierzbicki, 2009; Tippins, 2003), make values and practices associated with knowledge sharing complex within this context (Rowley, 2000).

There is a limited previous research in higher education institutions context (O. F. Ali et al., 2014; Fullwood et al., 2013), unlike the organizational environment, where there is an extensive reference of researches on knowledge sharing. The small number of existing studies in this context shows little empirical research into knowledge sharing and factors that can affect it (O. F. Ali et al., 2014; Fullwood et al., 2013), and little is known about the attitudes regarding knowledge sharing (Seonghee Kim & Ju, 2008). Interestingly, the main studies on knowledge sharing in higher education institution context have been carried out in UK and Asian countries (Tohidinia & Mosakhani, 2010). Clearly, only few studies have been conducted in Europe, and in particular in Portuguese institutions.

Whereas, due to their characteristics, higher education institutions are endowed with relatively high level of individuality, this study examines and analyses the relationship between individual factors (i.e. intrinsic motivation, extrinsic motivation, and social networks) and the attitude toward knowledge sharing among the members (professors and researchers) of a Portuguese higher education institution.

VI.2 Literature review and research context

VI.2.1 Knowledge sharing

As suggest by Kang et al. (2010), knowledge by itself is not a useful resource that creates value, exploits core competencies, and achieves sustained competitive advantages until it can be shared.

Within the overall knowledge management context, knowledge sharing is a critical area that needs an appropriate attention from organizations. Knowledge sharing refers to the process of making individual knowledge, ideas, experiences, or technologies available through the conversion into a form that can be understood and used by other individuals or communities according to their real knowledge needs (Seonghee Kim & Ju, 2008; Smith, 2001; Tan, 2016). Van de Ven and Johnson (2006, p. 804) argue that users of knowledge "selectively interpret and use knowledge as it serves their own purposes, fits their unique situations, and reflects their relations with their practicing community". Good knowledge sharing process is one of the keys to create a knowledge base allowing the effective knowledge reuse (Bierly, Damanpour, & Santoro, 2009; Stoyanov, 2014).

Knowledge sharing process is associated to collaboration, since that can help to leverage and to create new knowledge, solutions, process, or products (Seonghee Kim & Ju, 2008; Tan, 2016).

Knowledge sharing can occur via written form, or in a social context through networking with other experts, or documenting, organizing and capturing knowledge from others (Wang & Noe, 2010).

VI.2.1.1 Knowledge sharing in higher education institutions

Higher education institutions, throughout their history, have played a crucial role in creating and disseminating knowledge (Chedid & Teixeira, 2017). They are consisted by a group of individual experts, which are simultaneously developers, users, and bearers of knowledge (Omerzel, Biloslavo, & Trnavcevic, 2011), with a high degree of specialization in certain disciplines, which are organized in different scientific domains (Tippins, 2003).

According to some authors (Fullwood et al., 2013), there are three knowledge domains in higher education institution: (i) organizational knowledge - documents, processes, procedures, strategies, etc.; (ii) teaching knowledge – teaching and learning resources and practice; and (iii) scientific knowledge – research information and activities. Considering that the aim of this study is to understand the attitudes of professors and researchers toward knowledge sharing, the organizational knowledge is excluded from the study and it is concentrated in teaching and scientific knowledges.

Higher education institutions have been experienced intensified pressure (Omerzel et al., 2011), influenced by the knowledge society and the globalization, with more interconnected entities and where knowledge, creativity and innovation are the essential elements for competitiveness, which requires the development of a positive attitude toward the management of knowledge.

Knowledge sharing emerges as the most important knowledge management process that higher education institutions should look forward to (Tan, 2016). However, despite Fullwood et al. (2013) arguing that there is an implicit knowledge sharing culture in these institutions, this "culture is individualistic in nature and to some extent self-serving" (p.131). This individualistic characteristic is

not suitable for the knowledge sharing process, since knowledge increases in value and importance when shared and used (Bierly et al., 2009; Tippins, 2003). Based on several authors, Howell and Annansingh (2013, p. 32) add that "while in the corporate sector, managing and sharing knowledge is considered a key to achieve and maintaining a competitive advantage, in higher education institutions this has primarily been ignored".

Previous studies highlight some issues that can inhibit knowledge sharing in this context. Despite the existence of an implicit knowledge sharing culture in these institutions, the prime loyalty of academic members is in to the discipline (Fullwood et al., 2013; Seonghee Kim & Ju, 2008), which inhibits the existence of any universal culture that influence their degree of engagement in knowledge sharing activities (D'Este & Patel, 2007). Some studies present the evidence that higher education members put more emphasis on their individual achievements (Jolaee, Md Nor, Khani, & Md Yusoff, 2014; Seonghee Kim & Ju, 2008) and they consider knowledge as proprietary and something that should not be shared freely (Tippins, 2003). Howell and Annansingh (2013) add that formal knowledge sharing mechanisms such as conferences and publications are more recognized as a mean for competition rather than collaboration.

VI.2.2 Factors that affect knowledge sharing

The knowledge sharing literature has been identifying a wide range of factors that affect and impact the success or failure of the initiatives for sharing of knowledge (A. A. Ali & Dominic, 2018; Tohidinia & Mosakhani, 2010; Wang & Noe, 2010). In general, these factors are summarized into three perspectives: (i) organizational; (ii) technological and; (iii) individual/personal.

Regarding the organizational perspective, Wang and Noe (2010) list a range of issues that affect knowledge sharing, such as culture and climate, management support, reward and incentives, and structure. Among the organizational issues, Tohidinia and Mosakhani (2010), highlight the important role of a proper organizational climate and they consider that the its lack of support might render useless the attempts of establishing knowledge sharing processes.

Other authors place emphasis on the technological perspective considering it as one of the decisive factors in knowledge sharing (Tohidinia & Mosakhani, 2010). The use of infrastructures such as groupware, online databases, intranet, and virtual communities (A. A. Ali & Dominic, 2018; Lin, 2007b), enables individuals to directly or indirectly share knowledge with others (Bock, Zmud, Kim, & Lee, 2005), and supports and makes available incentives and resources to use and up-date knowledge (Cabrera, Collins, & Salgado, 2006). However, Desouza (2003) holds the view that technology is only one mean to foster knowledge and may not be a true indicator of knowledge sharing behavior, since shared knowledge can be accessed by others even those not making contributions or usage of this knowledge (Cabrera et al., 2006; Lin, 2007b; Wang & Noe, 2010).

Finally, based on the point of view of Nonaka et al. (2000) which knowledge is personal and is related to human action, and that knowledge sharing is a very individualistic behavior (Bock & Kim, 2001), the individual perspective assumes a key factor that can affect attitude toward knowledge sharing (Bock et al., 2005; Tohidinia & Mosakhani, 2010). As suggested by Ajzen and Fishbein (1977, p. 889) "attitudes are held with respect to some aspect of the individual's world".

Despite been knowledge intensive organizations (Howell & Annansingh, 2013), which requires an attitude toward knowledge sharing, the high education institutions are characterized by a relatively high level of individuality and the cult of the individual expert (Omerzel et al., 2011), where their members are "motivated" to use knowledge as source of personal advantage rather than as an organizational resource (Lin, 2007b). The individual characteristics of their members have a stronger impact than the characteristics of their departments or institutions (D'Este & Patel, 2007).

Table VI.20 shows an overview of factors affecting attitude toward knowledge sharing found in the literature review.

Table VI.20 - Factors affecting attitude toward knowledge sharing.

Author	Factors	Method/Sample	Findings	
			Affecting	Not affecting
Bock and Kim (2001)	Individual	467 questionnaires of employees of 4 large, public organizations in Korea	Expected associations and contributions	Expect rewards
Bock et al. (2005)	Individual and subjective norm	154 questionnaires of managers from 27 Korean organizations	Reciprocal relationships and subjective norm	Extrinsic rewards and sense self-worth
Lin (2007a)	Motivational (Intrinsic and Extrinsic)	172 questionnaires of employees from 50 large organizations in Taiwan	Reciprocal benefits, self-efficacy, and enjoyment in helping others	Rewards
Yang and Chen (2007)	Cultural, structural, human, technical	256 questionnaires from people of different positions, departments, and industries in Taiwan	Structural, human, and technical	Cultural
Seonghee Kim and Ju (2008)	Relational and structural	70 questionnaires of faculty members at a private university in South Korea	Perception and reward systems	Trust, openness, collaboration, and communication channels
Tohidinia and Mosakhani (2010)	Individual	502 questionnaires from 10 Iranian oil companies	Knowledge self-efficacy and reciprocal relationships	Extrinsic rewards
Fullwood et al. (2013)	Individual, organizational, and technological	230 questionnaires from 11 UK universities	Reciprocal relationships, and rewards	Leadership, organizational structural and technology
Ramayah et al. (2013)	Individual and subjective norm	447 questionnaires of academic members from 10 public universities in Malaysia	Extrinsic rewards, reciprocal relationships, sense of self-worth, and subjective norm	-
Jolaee et al. (2014)	Individual and social networks	117 questionnaires from 3 social science faculties in Malaysia	Social networks and self-efficacy	Extrinsic rewards
Tan (2016)	Individual, organizational, technological, and communication	421 questionnaires from 5 research universities in Malaysia	Trust, rewards, culture, system quality, openness, and face-to-face communication	Self-efficacy, reciprocal benefits, management support, and system infrastructure

Individual factors

Knowledge sharing is a type of action that depends on experience, values, motivation, and beliefs of the individual (Lin, 2007b). There seems to be a consensus among several authors that knowledge hoarding is a natural tendency rather than sharing (e.g. Bock & Kim, 2001; Bock et al., 2005; Cabrera et al., 2006; Howell & Annansingh, 2013). Individuals tend to hoard knowledge for various reasons (Bock et al., 2005). In order to change this behaviour, it will be necessary a strong personal motivation which promotes an individual attitude to share knowledge (Howell & Annansingh, 2013; Rutten, Blaas-Franken, & Martin, 2016). Motivation means being energized or activated toward an end, and "orientation of motivation concerns the underlying attitudes and goals that give rise to action" (Ryan & Deci, 2000, p. 54). Lin (2007a) states in her study that intrinsic motivation (knowledge self-efficacy and enjoyment in helping others) and extrinsic motivation (expected organizational rewards and reciprocal benefits) influence individual attitudes to engage, or not, in knowledge sharing activities.

Intrinsic motivation behaviour is based in the individuals' needs to be competent and autonomous (Deci & Ryan, 1985). Intrinsic motivation will occur only for activities that hold intrinsic interest for an individual, that is, activities which are performed out of interest and satisfy individuals' needs for competence (self-efficacy) and autonomy (self-determining) (Deci, Olafsen, & Ryan, 2017). Studies have shown the role of intrinsic motivational factors in explaining individual behaviour in several domains (Deci & Ryan, 1985), and Lin (2007a) demonstrates that individuals' enjoyment in helping others significantly influences their attitude toward knowledge sharing (Lin, 2007a).

The extrinsic motivation contrasts with the intrinsic motivation, since its fundamental goal is to receive organizational rewards or reciprocal benefits (Lin, 2007a). As suggested by Deci and Ryan (1985, p. 35), extrinsic motivation "refers to behaviour where the reason for doing it is something other than an interest in the activity itself". Although, extrinsic motivation is considered as a pale and impoverished form of motivation (Ryan & Deci, 2000), many extrinsically motivated attitudes and behaviors, are important in the social world (Deci & Ryan, 1985). Organizational rewards are incentive systems which can motivate individuals to share their knowledge (Nonaka et al., 2000; Yang & Chen, 2007). However, monetary compensation is not the only incentive for extrinsically motivating an individual behaviour or attitude, being enhanced reputation, learning opportunities, and career advancement are also relevant issues (Yang & Chen, 2007).

Soonhee Kim and Lee (2006) additionally identify social networks as an important individual factor that can influence knowledge sharing within communities and summarize that both formal and informal relationships and contacts are considered essential for knowledge sharing.

Individuals do not work, learn, or share knowledge in isolation (Wang & Noe, 2010). Social networks are circles in which individuals interact and connect with each other in different contexts, developing relationships and, in turn, sharing knowledge (Al Saifi, Dillon, & McQeen, 2016; Avram,

2006). Those social networks are supposed to enhance and encourage knowledge sharing (Du Chatenier, Verstegen, Biemans, Mulder, & Omta, 2009), and to affect the extent of knowledge sharing (Al Saifi et al., 2016), establishing an essential context to make knowledge sharing efficient and effective (Avram, 2006). Nahapiet and Ghoshal (1998) suggest that members of higher education institutions have been recognized the important role of social networks in promoting early access to new knowledge, facilitating its sharing and development, and often accelerating the progress of science.

As in this context knowledge sharing attitude is motivated and executed mainly at the individual level, this study examines the relationship among individual factors and the attitude toward knowledge sharing among the members of a Portuguese higher education institution. Attitude is expected to be responsible for a member's sharing of knowledge among colleagues and others.

VI.3 Research model

Since the focus of this study is on attitude toward knowledge sharing, the conceptual research model is developed based on the theory of reasoned action formulated by Fishbein e Ajzen (1975). This theory posits that an individual intention is a key determiner of behaviour, and it has been one of the most used to investigate the behaviour concerning to knowledge sharing (Wang & Noe, 2010). However, Wang and Noe (2010) state that few studies have examined their antecedents, and Lin (2007a, p. 136) alerts to the "need to include other components to provide a broader view and a better explanation of human behaviours". Thus, this study applies a framework (Figure VI.43) which conceptually follows the theory of reasoned action and includes the motivational factors (intrinsic and extrinsic motivations), and social networks applied by Jolaee et al. (2014) and Soonhee Kim and Lee (2006), as antecedents of the attitude.

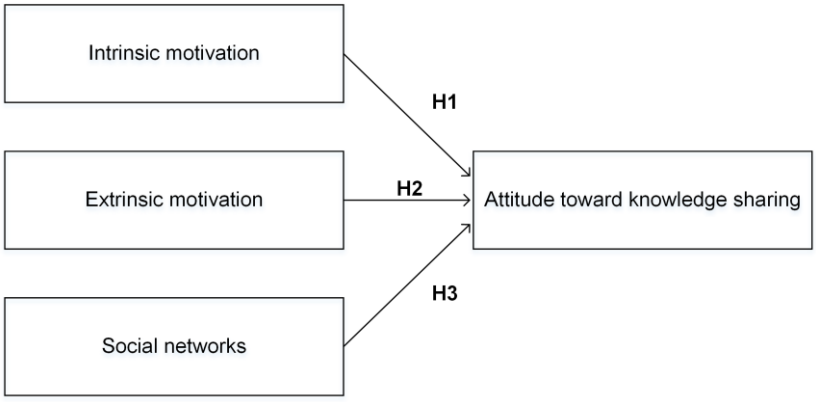

Figure VI.43 - Research model for interpreting the hypotheses.

Each construct, involved in the basis of research hypotheses and the design of the questionnaire, are then presented below.

Intrinsic motivation

This study proposes that knowledge self-efficacy, and enjoyment in helping others, as intrinsic factors that motivate towards knowledge sharing in higher education institutions. According to social cognitive theory, knowledge self-produced factors influence an individual's attitude and behaviour (Bock & Kim, 2001), whereas enjoyment in helping others derives from the concept of altruism (Lin, 2007a). For this reason, the following hypothesis is presented:

H1. Intrinsic motivation positively affects attitude toward knowledge sharing.

Extrinsic motivation

Reciprocal behaviour in a higher education institution context can provide a sense of mutual collaboration, inspiring knowledge owners to improve their relationships with each other, which can ensure ongoing knowledge sharing (Lin, 2007a). Supposing that individuals believe they can receive rewards or reciprocal benefits by sharing knowledge, and therefore they will develop more positive attitude toward knowledge sharing, the following hypothesis is proposed.

H2. Extrinsic motivation positively affects attitude toward knowledge sharing.

Social networks

Knowledge sharing depends on personal networks and the willingness of individuals to participate in the process (Cormican & Dooley, 2007). According to the Soonhee Kim and Lee's (2006, p. 377) survey, "employees with strong social networks report high levels of knowledge sharing than employees who did not". Riege (2005) considers the lack of social networks as one of knowledge sharing barriers. Therefore, the following hypothesis is proposed:

H3. Social networks positively affect attitude toward knowledge sharing.

In order to test the model with the collected data, the correlation coefficients between all the variables were calculated, and a result of the linear regression was performed:

Attitude toward knowledge sharing = f (Intrinsic motivation, Extrinsic motivation, Social networks)

VI.4 Material and methods

VI.4.1 Data collection

The study has been performed in the form of an online self-administered questionnaire from March to April 2017. Link to a survey platform was made available by e-mail. As the respondents were dispersed in departments, schools and research units, the online survey was practical and convenient as a method of data collection. The questionnaires were administered anonymously to

ensure confidentiality and the confidence of the respondents, preceded by a preliminary introduction that explained the objectives of the study.

The questionnaire was divided in three sections. The first section covered a set of questions eliciting demographic characteristics of the respondents. The second section comprised a set of questions which variables items were adapted from previous studies in the knowledge sharing context, namely from Bock et al. (2005), Lin (2007a), Soonhee Kim and Lee (2006) and Jolaee et al. (2014). This set of questions had the objective to measure, through the opinion of each respondent, three independent variables (intrinsic motivation, extrinsic motivation, and social networks), and one dependent variable (attitude toward knowledge sharing) (see Table 2). The response options for these items were presented to respondents on a five-point Likert scale, generally used to measure attitudes (Likert, 1932), where '1' corresponded to the least favorable level – 'not agree at all', and '5' corresponded to the most favorable level – 'fully agree'. For all the questions was also available the option 'do not know/do not answer'. The set of questions presented in the last section of the questionnaire were not used in present study.

The questionnaire was submitted to a pre-test before the launch. According to Adams et al. (2007, p. 136), "this is done to ensure that the questionnaire is clear to respondents and can be completed in the way you wish". The pre-test was conducted on a small scale by a panel of six professors / researchers. At the same time, they were requested to evaluate some questionnaire issues. No major problems were reported that would require a major revision of the questionnaire. The comments received in the evaluation process focused on the writing of some questions and the formatting of the questionnaire. Subsequently, adaptations were made in accordance with the comments, thus improving the questionnaire understanding.

VI.4.2 Sample

The population for this study consists of professors and researchers from a public higher education institution in Portugal. This higher education institution (created in 1973) quickly became one of the most dynamic and innovative universities in Portugal. This institution is ranked for the sixth time in a row (2017) among the 100 best institutions of higher education in the world under 50 years old, in the Times Higher Education ranking. It is the only one of the youngest Portuguese higher education institutions to integrate the world's top 100. It is one of the six largest institution in Portugal, with the higher concentration into a single campus, and it is organized in departments through a matrix structure. This institution is organized into 16 different departments, 4 polytechnic schools, and 18 research centers, according to a wide range of fields. It has about 15,000 students on undergraduate and postgraduate programs, and over 1,000 professors and researchers.

A total of 1020 professors and researchers were contacted by e-mail and requested to fill out the questionnaire. In total, 297 (29.1%) questionnaires returned, from which 121 with incomplete data were eliminated. As a result, 176 (17.3%) valid answers from 4 scientific areas (i.e. Life and Health,

Natural and Environment, Science and Engineering, and Social and Humanities) were used in the data analysis. The sample was gender balanced (50.6% female and 49.4% male). In total, 75.5% of respondents had more than 10 years of professional experience and 66.5% had more than 10 years of affiliation in the institution studied.

This study used the software *G* Power 3.1.9.2*, a flexible statistical power analysis program commonly used for the social and behavioral research (Faul, Erdfelder, Lang, & Buchner, 2007). The parameters used to estimate the minimum sample size were: 95% of statistical power (1 – β), effect size median ($f2$) of 0.15, and 5% probability of error (α). Thus, according to the results, the minimum sample size would be 74, but to have a more consistent model it is interesting to have at least twice the value (Ringle, Da Silva, & Bido, 2014). As there were collected 176 valid responses, the multiple linear regression analysis seems to have sufficient power.

VI.4.3 Measurement

The data was analyzed with the *IBM SPSS 24* statistical package. The reliability of the items was measured by using Cronbach's alpha coefficient, which is regarded as a reasonable indicator of the internal consistency reliability of an instrument, mainly when using Likert-type scales (Gliem & Gliem, 2003). Multiple linear regression with stepwise approach was the estimation method used, which is appropriate in the case of multiple independent variables. The aim of the stepwise, as stated by Silhavy et al. (2017, p. 4), "is to maximize the estimation power using the minimum number of independent variables". The stepwise was the procedure employed to select the independent variables which would be included in the regression model according to their statistical significance (Bryman & Cramer, 2005).

VI.5 Results and discussion

Since multiple sources have been used to build construct measures, it was important to establish construct validity (Eisenhardt, 1989). Construct validity refers if there is the adequacy between the theoretical constructs, and the ones under study.

The means, standard deviations, and Cronbach's alpha reliabilities for all constructs are presented in Table VI.21, along with the percentage of answers for each item. The Cronbach's alpha for each scale item exceeds .700, which is widely accepted as a good reliability score (Bryman & Cramer, 2005). Results indicated that the three independent variables, intrinsic motivation (.815), extrinsic motivation (.770), social networks (.756), and the dependent variable attitude (.778) which reveals a good internal consistency reliability.

The correlation coefficient and multiple linear regression analysis were employed for interpreting the hypotheses shown in Figure VI.43.

Table VI.21 - Items and descriptive statistics.

Constructs / Items		Relative frequency (%)						Mean	SD	Cronbach α
		1	2	3	4	5	Idk/Ida			
Intrinsic Motivation (IM)								4.440	.550	.815
IM1	I am willing to share knowledge because I like to help my colleagues	-	1.7	8.5	32.4	56.3	1.1	4.448		
IM2	I think that sharing my knowledge would help in solving colleagues' problems	-	0.6	5.7	40.3	52.3	1.1	4.460		
IM3	I think that sharing my knowledge would create new opportunities for my institution	-	1.7	5.7	40.3	51.1	1.1	4.425		
IM4	I think that sharing my knowledge would help improve my institution's performance	0.6	1.1	8.0	35.2	54.0	1.1	4.425		
Extrinsic Motivation (EM)								3.383	.792	.770
EM1	I am willing to share my knowledge because it can enhance my reputation	4.0	10.8	21.6	27.8	35.2	0.6	3.800		
EM2	I think that sharing my knowledge makes my colleagues better aware of my skills	1.7	4.0	17.0	38.1	38.1	1.1	4.080		
EM3	I consider that my institution recognizes / values those who share knowledge	6.3	18.8	25.0	30.1	16.5	3.4	3.329		
EM4	I consider that my institution provides its members with a fair evaluation / reward system for sharing knowledge	11.9	18.8	36.4	17.6	5.7	9.7	2.849		
EM5	I think that sharing knowledge has a direct impact on the progression of my career	18.8	19.3	26.1	23.3	9.7	2.8	2.854		
Social Networks (SN)								3.627	.780	.756
SN1	I interact frequently with colleagues from the institution in sharing teaching and scientific knowledge	1.1	10.8	28.4	35.2	24.4	-	3.710		
SN2	I maintain good networking with people from other organizations in the context of knowledge sharing	1.7	11.4	23.9	36.4	25.6	1.1	3.736		
SN3	I communicate with other members of my institution through informal contacts in the context of knowledge sharing	1.1	8.0	16.5	48.3	26.1	-	3.903		
SN4	I actively participate in community of practice	7.4	21.0	28.4	26.1	12.5	4.5	3.161		
Attitude Toward Knowledge Sharing (ATKS)								4.310	.604	.778
ATKS1	Sharing knowledge with my institution colleagues is important to me	0.6	1.7	14.2	44.9	38.6	-	4.193		
ATKS2	Sharing knowledge with my colleagues at the institution is an experience that pleases me	0.6	1.7	15.3	40.9	40.3	1.1	4.201		
ATKS3	I believe that the sharing of teaching and learning material between colleagues allows us to save time	1.1	2.8	11.9	31.8	47.7	4.5	4.280		
ATKS4	I consider that the sharing of knowledge and experience promotes the creation of new knowledge	-	0.6	4.5	31.5	61.4	1.7	4.566		

n = 176; Idk = I don't know; Ida = I don't answer

The correlation measures the linear relationship between a pair of variables through degree of association (Bryman & Cramer, 2005). Table VI.22 presents the correlation coefficient matrix between the variables considered and shows that the three independent variables have a significant linear association with the dependent variable. Since coefficients among independent

variables were low (r < .8) (Bryman & Cramer, 2005), there were no inter-correlations with multi-collinearity among these variables.

Table VI.22 - Correlation coefficients matrix.

Constructs	IM	EM	SN	ATKS
IM	-			
EM	0.476*	-		
SN	0.490*	0.398*	-	
ATKS	0.621*	0.384*	0.462*	-

* Correlation is significant at the 0.01 level (2-tailed).

Multiple linear regression determines causal relationships between more than two independent variables and one dependent variable.

In this study, the presented model was designed to identify the proposed individual factors that affect attitude toward knowledge sharing. As a result of the regression analysis it was possible to analyze that intrinsic motivation and social networks have influence on the attitude, since they were the variables that fulfilled the statistical criteria of the stepwise procedure, meaning that extrinsic motivation did not meet the criterion (Table VI.23). The variables included presented the highest correlation coefficient 0.621 and 0.462 respectively (Table VI.22).

Table VI.23 - Summary of regression analysis.

Coefficients[a]				
Model	Unstandardized coefficients		*t*	*p-value*
	B	*Std. error*		
Constant	1.100	.300	3.670	< .0005
IM	.557	.077	7.222	< .0005
SN	.205	.058	3.544	.0010

a Dependent variable: ATKS, R^2 = .472, Adjusted R^2 = .464

The coefficient of determination (R^2) is the measure of the proportion of the variance of the dependent variable that is explained by independent variables. The coefficient of determination is 0.464, i.e. 46.4 % of the dependent variable attitude was explained by the independent variables intrinsic motivation and social networks. This is denoted by the adjusted R^2 value in Table VI.23. For models with more than one independent variable adjusted R^2 shall be analyzed (Bryman & Cramer, 2005).

Given that the independent variables are those that affect attitude toward knowledge sharing, the estimation model controlled as follows:

$$ATKS = 1.100 + 0.557\ IM + 0.205\ SN$$

Thus, every extra point of intrinsic motivation affects attitude toward knowledge sharing by 0.557, and every extra point of social networks increases attitude by 0.205.

The model obtained is presented in Figure VI.44.

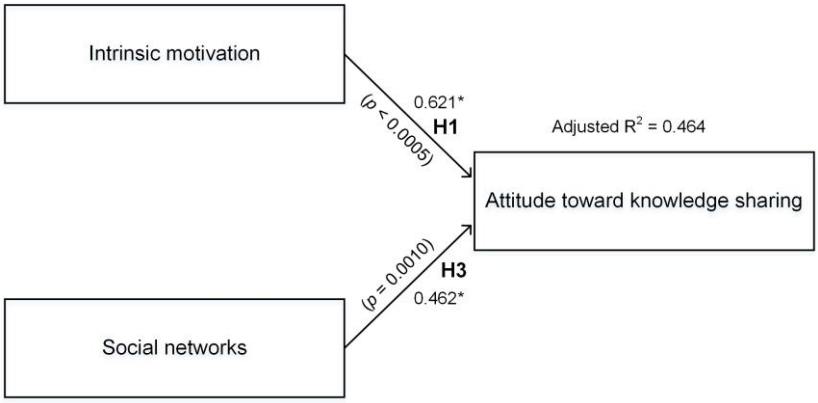

Figure VI.44 - Results of multiple regression analysis.

Since intrinsic motivation and social networks are found to influence attitude toward knowledge sharing, H1 (IM positively affects ATKS) and H3 (SN positively affect ATKS) were supported, and H2 (EM positively affects ATKS) was rejected. The values shown in parentheses are the p-values that assess the statistical significance between the constructs.

As expected, given that members of higher education institutions have inviolable values, like freedom and autonomy (Sporn, 1996) and intrinsic motivation is an activity moved by self-determination, and is free of external prods, pressures, or rewards (Ryan & Deci, 2000), this factor was the one that most positively affects attitude toward knowledge sharing. Consequently, consistent with the concept of extrinsic motivation as a controlled motivation, this factor was not considered as one that affects attitude.

Social networks were the other factor that affects attitude on this institution. Social networks refer to the extent of individuals' contact with other people. Knowledge is dynamic, and members of higher education institutions are critical actors involved in the creation and dissemination of knowledge. This form of interaction assumes an important role since it is not just an activity related to knowledge sharing but also about leverage of knowledge (Riege, 2005).

VI.6 Conclusion

Higher education institutions are currently under intense pressure, driven by the knowledge society and the internationalization of institutions. This pressure demands a positive attitude that enhances knowledge sharing in these institutions and among their actors.

The purpose of this study was to examine and analyze the individual factors that affect attitude toward knowledge sharing among professors and researchers in the specific context of a public Portuguese higher education institution. The conceptual research model was developed based on

the theory of reasoned action and included the motivational factors (intrinsic and extrinsic motivations), and social networks as antecedents of the attitude.

The empirical study, based on a multiple regression analysis results, identified that intrinsic motivation and social networks positively affect attitude toward knowledge sharing. However, extrinsic motivation did not significantly affect attitude. Taking into account the characteristics of this institution and of their members, the analysis of the results obtained shows that it is important to establish mechanisms based on intrinsic motivation and social networks, in order to promote and encourage knowledge sharing and, consequently, improve the collaborative relationships.

In a practical perspective, this work contributes to the identification of relevant facts related to the individual factors that affect attitude toward knowledge sharing in the context of a Portuguese higher education institution, through the development of an empirical study. The results obtained can support the institution's management in the strategies definition and development of future actions, in order to promote a knowledge sharing culture. In a theoretical perspective, this study contributed to the increase of the knowledge sharing literature by investigating the attitude toward share knowledge from a different viewpoint. Previous studies mostly focused on business organizations and only few studies based on empirical data have been conducted in Europe, and in particular in Portuguese higher education institutions.

The findings of this study cannot be generalized, since the data collected are restricted to only one higher education institution. In further researches, this work should be extended to include other higher education institutions. It will be also important to incorporate other factors, such as subjective norm, trust, and demographic variables, to analyze the intention and behaviour of knowledge sharing.

VI.7 References

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Chapter VII - Knowledge sharing and collaborative behavior: An empirical study on a Portuguese higher education institution

Reference

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Knowledge sharing and collaborative behavior: An empirical study on a Portuguese higher education institution

Abstract

Collaboration has been considered a way to address the challenges of the 21st century, fostering the necessary innovation, growth, and productivity for all parties involved. Several studies reveal that collaboration can be strongly influenced by knowledge sharing. The purpose of this work is to examine and analyze if knowledge sharing intention has a positive relationship with collaborative behavior among professors and researchers in the specific context of a public Portuguese higher education institution, taking into account other constructs that can have effect on the knowledge sharing intention. In order to reach this main objective, a conceptual research model was developed based on the theory of reasoned action.

The empirical study has been implemented in the form of an online self-administered questionnaire. In total, 176 valid answers from four different scientific areas were used in the data analysis which was performed using Partial Least Squares. The results indicate that intrinsic motivation and networking are the factors which positively affect the attitude toward knowledge sharing, while extrinsic motivation did not show a statistically significant effect. Nevertheless, it is concluded that trust is the variable that more strongly affects the knowledge sharing intention. Finally, the study identified that knowledge sharing intention has a positive influence in collaborative behavior, this influence being stronger in the case of internal rather than external collaborative behavior.

The main contribution of this work is the adaptation of the theory of reasoned action model in order to analyze the impact of knowledge sharing on the collaborative behavior, and its application in a higher education institution involving professors and researchers.

Keywords

Collaborative behavior; Higher education institutions; Knowledge sharing; Partial Least Squares; Theory of Reasoned Action

VII.1 Introduction

Higher education institutions (HEIs) are knowledge intensive organizations (Howell & Annansingh, 2013) where knowledge is simultaneously their input and their output (Ali, Gohneim, & Roubaie, 2014). Despite knowledge sharing being one of their core missions (Fullwood, Rowley, & Delbridge, 2013), studies show that it does not emerge strongly within HEIs (Ramayah, Yeap, & Ignatius, 2013). The values and practices associated with knowledge sharing within this context are complex: this is due to the particular characteristics of this type of institutions, such as an individualistic culture, knowledge being held as property and source of differentiation, the specific needs of researchers, and academic freedom (Rowley, 2000; Tian, Nakamori, & Wierzbicki, 2009; Tippins, 2003). However, knowledge sharing is necessary to integrate the different disciplines, ideas, and the knowledge of each different member of the institution (Nissen, Evald, & Clarke, 2014).

On the other hand, collaboration refers to the relationship and high level of knowledge sharing between team members (Nissen et al., 2014), and is the creation base for new knowledge (Nissen et al., 2014; Tan, 2016).

Since the end of the last century, factors such as globalization, increasing competition, and fast technological advances make the environments of organizations with impact on the life cycle of processes, products and services (Kauppila, Mursula, Harkonen, & Kujala, 2015; Mendes, Nunes, & Sequeira, 2012) more complex. Knowledge also becomes more complex and not all the organizations have enough resources to manage it (Desouza, 2003; Walz, Elam, & Curtis, 1993). In this scenario, so they can respond to new challenges, organizations need to identify partners, with the collaboration relationship representing a key resource in promoting innovation (Lee, 2000), technological development (Cohen, Nelson, & Walsh, 2002; Freitas, Geuna, & Rossi, 2013; Lee, 2000; Mansfield & Lee, 1996) and a positive impact on their productivity and competitiveness (Freitas et al., 2013). Like in the business sector, HEIs should encourage and promote internal and external collaboration. Collaboration relationships, besides the creation of new knowledge, may result in publications, dissemination of research results, a decrease in the redundancy of research efforts, and consequently lead to academic productivity (Melin, 2000; Nissen et al., 2014). Furthermore, strategies to promote the sharing of knowledge and collaboration are important requirements that contribute for the overall result being greater than the sum of its parts (Weber, Morelli, Atwood, & Proctor, 2006).

There is limited previous research within the context of HEIs concerning this subject (Ali et al., 2014; Fullwood et al., 2013; Sadiq Sohail & Daud, 2009). However, the main studies on knowledge sharing within the context of HEIs have been carried out in the UK and in Asian countries (Tohidinia & Mosakhani, 2010). Clearly, only few studies have been conducted in Europe, particularly in Portuguese institutions. In a recent study, Al-Kurdi et al. (Al-Kurdi, El-Haddadeh, & Eldabi, 2018, p.

239) claim that “other regions and countries must invest in quality research in this area, as it is essential for the development of a nation’s higher education system”.

Conceptually following the theory of reasoned action (TRA), this present study proposes that the collaborative behavior (within the institution and with other organizations) of HEIs members is affected by individual knowledge sharing intention. Even though the TRA has been widely used (Wang & Noe, 2010), this study introduces two important aspects into the research model. First, this study includes the motivational factors (intrinsic and extrinsic) studied by Lin (2007a), and networking applied by Jolaee et al. (2014) and Soonhee Kim and Lee (2006), as antecedents of the attitude. Second, in addition to the dimensions attitude and the subjective norm used to interpret the intention, the study also analyzes trust (Tan, 2016) as another significant dimension of intention.

This work presents the findings of an empirical study carried out with professors and researchers of a Portuguese higher education institution and has as its main objective to examine and analyze if the knowledge sharing intention has a positive relationship with collaborative behavior. It should be emphasized that knowledge sharing intention can be affected by other factors, also studied in this context. Data analysis will be performed using partial least squares (PLS).

VII.2 Theoretical background

VII.2.1 Knowledge sharing in higher education institutions

Knowledge is dynamic, and it is not a useful resource by itself (Kang et al., 2010), unless it is shared in order to be used and evolved. Knowledge sharing is a fundamental process of making individual knowledge, ideas, experiences, or technologies available through the conversion into a manner which can be understood and used by other individuals or communities (Ali et al., 2014; Wang & Noe, 2010). This process can occur via written form, through documentation and systematization of knowledge, or in a social context through networking with other stakeholders. Knowledge sharing is associated to the collaboration process, since it is possible to leverage and create new knowledge, solutions, process, or products through it (Seonghee Kim & Ju, 2008; Tan, 2016).

HEIs are recognized as knowledge-intensive organization (Fullwood et al., 2013; Howell & Annansingh, 2013), composed of a group of individual experts, which are simultaneously developers, users, and holders of knowledge (Omerzel, Biloslavo, & Trnavcevic, 2011), with a high degree of specialization in certain disciplines, which are organized into different scientific domains (Tippins, 2003). Throughout their history, HEIs have played a crucial role in creating and disseminating knowledge (Chedid & Teixeira, 2017). HEIs have experienced intensified pressure (Omerzel et al., 2011), influenced by the knowledge society and the internationalization of institutions, where knowledge, creativity, innovation and entrepreneurship emerge as essential elements for competitiveness. On the other hand, this pressure demands a new attitude toward

knowledge sharing from the HEIs in general, and their main actors (e.g. professors and researchers).

In this environment, it is expected that knowledge is shared freely among their members, since knowledge sharing is fundamental in integrating different disciplines, ideas, and knowledge possessed by the different HEIs' actors (Ramayah et al., 2013). However, HEIs' members generally place a higher priority on individual goals (Seonghee Kim & Ju, 2008), consider knowledge as their property (Tan, 2016), and put more emphasis on knowledge creation rather than on knowledge sharing (Seonghee Kim & Ju, 2008). With this individualistic model, knowledge sharing in HEIs quite often means to break down some silos of knowledge, offering very little chance for collaboration (Howell & Annansingh, 2013). Another important point of the impact of knowledge sharing among HEIs' members, is the current high degree of specialization of disciplines caused by the increasingly rate of innovation, which may lead toward the decline of involvement and the lessening of social ties with disciplinary and institutional colleagues (Dill, 1982).

In the present study, the survey is focused on knowledge which is related to the expertise and know-how of HEIs members (professors and researchers) which is comprised of educational knowledge (i.e. teaching materials, teaching methodologies, and program contents), and scientific knowledge (i.e. scientific materials, research results, and scientific publications).

VII.2.2 Collaboration in higher education institutions

Collaboration is the willingness to work together in order to search solutions and to accomplish outcomes that go beyond the limited vision of each individual concerned party (Gray, 1989; Seonghee Kim & Ju, 2008). Collaboration has been considered a way to address the challenges of the 21th century, fostering the necessary innovation, growth, and productivity for all parties involved. In Grays' (1989, p. 5) opinion, collaboration is based on the simple adages of "two heads are better than one", where different points of view about existing problem-solving can often be the source of immense creative potential. However, according to the observation of some authors, collaboration itself is not a solution (Gray, 1989), but an enabler in bringing about added value. Currently, collaboration is viewed as a critical competence for organizations (Diamond & Rush, 2012). That said, it is not always easy to involve difficult issues, such as processes not clearly defined or management difficulties (Diamond & Rush, 2012; Gray, 1989). To collaborate successfully, considerable effort is necessary (Gray, 1989). One needs to understand and develop a behavioral approach, embracing all relevant interested parties and making it possible to establish a strong linkage and a high level of knowledge sharing between teams (Nissen et al., 2014).

The scenario of the last few years required a focus shift from inter-organizational collaboration to intra-organizational collaboration (Jakubik, 2008), for the purpose of achieving other sources of resources, knowledge, and needed skills (Freitas & Verspagen, 2017).

The literature regarding the collaboration in HEIs highlights that "collaboration is characterized by strong pragmatism and a high degree of self-organization" (Melin, 2000, p. 31), and that its members collaborate when necessary, configuring itself as a weak point in this kind of organization (Buckley, 2012; Tian, Nakamori, Xiang, & Futatsugi, 2006). In general, HEIs members emphasize self-study more and they are not always aware of the valuable expertise within the HEIs that can contribute to their work, preferring instead to achieve their goals and objectives independently and individually (Howell & Annansingh, 2013; Seonghee Kim & Ju, 2008; Tian et al., 2006). Collaborative activities can result, in publications, dissemination of research results, the creation of new knowledge, and consist an important source of career advancement, reputation, and self-empowerment of the members (professors and researchers) of higher education institutions (Patel & Ragsdell, 2011).

Collaboration also leads to a decrease in the redundancy of research efforts and an increase in resource savings, reducing the costs for research (Bruneel, D'Este, Neely, & Salter, 2009). Considering the pre-conditions for successful collaboration addressed by Diamond and Rush (2012, p. 297), such as "a more holistic approach to problem-solving (less rule and status bound), and a more open approach to discussion and problem-solving", it is expected that HEIs are a special context so that collaboration can be successful.

VII.3 Research model and hypotheses

The conceptual research model is developed based on the TRA theory formulated by Fishbein e Ajzen (1975). TRA is a well-known theory used to predict and explain individual behavior (Lin, 2007a), and has been applied to examine knowledge sharing intention under different contexts (Deci et al., 2017). According to Ajzen and Fishbein (2005, p. 174) "specific behaviors are guided largely by a reasoned action approach that assumes that people's behavior follows reasonably from their beliefs, attitudes, and intentions". From this perspective, the TRA is based on the premise that an individual's behavior is determined by his/her behavioral intention to perform it. This intention is itself determined by the individual's attitudes and his/her subjective norms toward the behavior (Fishbein & Ajzen, 1975).

Conceptually following the TRA, this study applies a framework (Figure VII.45) which proposes that collaborative behavior (within the institution and with other organizations) of HEIs members is affected by the individual knowledge sharing intention. Even though the TRA has been widely used, this study introduces two important aspects into the research model. First, according to the Wang and Noe's (2010) statement, few studies have examined attitude antecedents, and Lin (2007a, p. 136) alerts to the "need to include other components to provide a broader view and a better explanation of human behaviors". Thus, this study includes the motivational factors (intrinsic and extrinsic) studied by Lin (2007a), and networking applied by Jolaee et al. (2014) and Soonhee Kim and Lee (2006), as antecedents of the attitude. Motivation means being energized or activated

toward an end, and "orientation of motivation concerns the underlying attitudes and goals that give rise to action" (R. M. Ryan & Deci, 2000, p. 54). Whereas networking has a significant effect on the attitude toward knowledge sharing, as highlighted in the Wang and Noe's (2010, p. 122) literature review where individuals "do not work, learn, or share knowledge in isolation, but are embedded in social networks". Second, in addition to the dimensions attitude and subjective norm used to interpret the intention, the study also analyzes trust (Tan, 2016) as another significant dimension of intention. It is presupposed that the knowledge sharing intention requires trust (Świgoń, 2015), since trust plays an important role in the knowledge sharing process among members of institutions (Patel & Ragsdell, 2011).

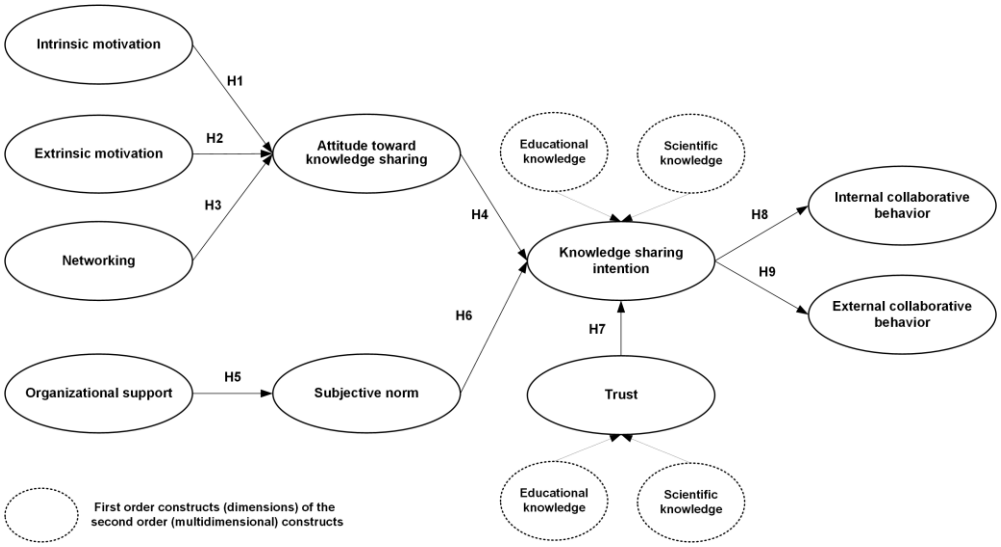

Figure VII.45 – The research model.

The authors stress that no study was found in the literature that had examined and analyzed the knowledge sharing intention effects on the collaborative behavior in Portuguese higher education institution.

Each construct involved in the basis of research hypotheses and the design of the questionnaire is discussed ahead.

Intrinsic motivation

Intrinsic motivation behavior is based in the individuals' need to be competent and autonomous (Deci & Ryan, 1985). Intrinsic motivation will occur only for activities that hold intrinsic interest for an individual; in other words, activities which are performed out of interest and to satisfy individuals' need for competence (self-efficacy) and autonomy (self-determining) (Deci et al., 2017). Studies have shown the role of intrinsic motivational factors in explaining individual behavior in several domains (Deci & Ryan, 1985), including knowledge sharing (Lin, 2007a). This study proposes that knowledge self-efficacy, and enjoyment in helping others, as intrinsic factors that motivate towards knowledge sharing in HEIs. According to social cognitive theory, knowledge self-produced factors

influences an individual's attitude and behavior (Bock & Kim, 2001), whereas enjoyment in helping others derives from the concept of altruism (Lin, 2007a). For this reason, the following hypothesis is presented:

Hypothesis 1. Intrinsic motivation positively affects the attitude toward knowledge sharing.

Extrinsic motivation

The extrinsic motivation contrasts with the intrinsic motivation, since its fundamental goal is to receive organizational rewards or reciprocal benefits (Lin, 2007a). As suggested by Deci and Ryan (1985, p. 35), extrinsic motivation "refers to behavior where the reason for doing it is something other than an interest in the activity itself". Although, extrinsic motivation is considered to be a pale and impoverished form of motivation (R. M. Ryan & Deci, 2000), many extrinsically motivated attitudes and behaviors, are important in the social world (Deci & Ryan, 1985). Organizational rewards are incentive systems which can motivate individuals to share their knowledge (Nonaka et al., 2000; Yang & Chen, 2007). However, monetary compensation is not the only incentive for extrinsically motivating an individual's behavior or attitude, it also includes enhanced reputation, learning opportunities, and career advancement (Yang & Chen, 2007). Reciprocal behavior in a higher education institution context can provide a sense of mutual collaboration, inspiring knowledge owners to improve their relationships with each other, which can ensure ongoing knowledge sharing (Lin, 2007a). Supposing that individuals believe they can receive rewards or reciprocal benefits by sharing knowledge, and therefore they will develop a more positive attitude toward knowledge sharing, the following hypothesis is proposed:

Hypothesis 2. Extrinsic motivation positively affects the attitude toward knowledge sharing.

Networking

Individuals do not work, learn, or share knowledge in isolation (Wang & Noe, 2010). According to Avram (2006), networking consists of circles in which individuals interact and connect with others. That networking is supposed to enhance knowledge sharing (Du Chatenier et al., 2009), and affect the extent of knowledge sharing (Argote & Ingram, 2000), constituting an essential context in making knowledge sharing efficient and effective (Avram, 2006). Nahapiet and Ghoshal (1998) suggest that members of HEIs have recognized the important role of networking in promoting early access to new knowledge, facilitating its sharing and development, which often accelerates the advancement of science. According to Cormican and Dooley (2007), knowledge sharing depends on personal networks and the willingness of individuals to participate in the process. Riege (2005) considers the lack of networking to be one of the barriers of knowledge sharing. Therefore, the following hypothesis is proposed:

Hypothesis 3. Networking positively affects the attitude toward knowledge sharing.

Attitude toward knowledge sharing

According to Fishbein and Ajzen (1975, p. 6), attitude is a "learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object". The TRA theory (Fishbein & Ajzen, 1975) has been used to investigate the influence of attitude toward knowledge sharing. Studies have shown that a positive attitude leads to a positive intention to share knowledge (Bock et al., 2005). Wang and Noe (2010), cite that individuals with a higher level of education and longer work experience are more likely to have positive attitudes toward knowledge sharing. Fullwood et al. (2013) identify that, in general, members of HEIs have positive attitudes and intentions toward knowledge sharing. This leads to the formulation of the following hypothesis:

Hypothesis 4. Attitude toward knowledge sharing positively affects the knowledge sharing intention.

Organizational support

Jolaee et al. (2014, p. 418) suggest that organizational support is "one of the important concepts in management literature", the lack of which being one of the main barriers in the knowledge sharing initiatives (Ford & Mason, 2013a; Franco & Haase, 2015). Some authors (e.g. Lin, 2007b; Safa & Von Solms, 2016) highlight that organizational support significantly influences knowledge sharing more than trust. The concept has recently been discussed more in HEIs, which has resulted in an increased provision organizational support for knowledge sharing (Freitas et al., 2013). In this study, organizational support is comprised of technologies, processes, and endorsement for the creation of informal networks. The following proposed hypothesis is based on the findings of the study of Igbaria et al. (1996), which confirm the importance of organizational support in influencing the subjective norm:

Hypothesis 5. Organizational support positively affects subjective norm.

Subjective norm

The TRA theory posits that a person's intention is in turn a function of his/her attitude toward performing an action and of his/her subjective norm (Ajzen & Fishbein, 1977, 2005). According to Fishbein and Ajzen's (1975, p. 302) definition, subjective norm "is the person's perception that most people who are important to him/her think he/she should or should not perform the behavior in question". Several empirical studies have found evidence that besides the attitude toward knowledge sharing, subjective norm positively impact the knowledge sharing intention (e.g. Bock et al., 2005; Charband & Navimipour, 2016; Ramayah et al., 2013; Safa & Von Solms, 2016). Therefore, it is expected that the subjective norm concerning the knowledge sharing intention affects professors' and researchers' intentions toward knowledge sharing. The following hypothesis is proposed:

Hypothesis 6. Subjective norm positively affects knowledge sharing intention.

Trust

In this study, trust refers to a person's reliance on sharing educational knowledge and scientific knowledge with others from the same institution or other institutions. Currall and Inkpen (2006, p. 236) define trust as “the decision to rely on another party (i.e. person, group, or organization) under a condition of risk”. Due to this condition, the development of trust is often slow and incremental (Currall & Inkpen, 2006), which could turn into an important barrier to overcome when it comes to knowledge sharing (Cormican & Dooley, 2007). Trust is an integral part of the knowledge sharing process (Patel & Ragsdell, 2011), and this process promotes the creation of new theories and ideas, and the establishment of new research principles. The lack of trust, in terms of knowledge sharing among members of HEIs, can make this cross-fertilization difficult. Kuo (2013) believes that trust in the workplace also encourages knowledge sharing, such as collaborative behaviors. Previous study results show that trust affects knowledge sharing in HEIs (Patel & Ragsdell, 2011; Świgoń, 2017; Tan, 2016). Therefore, the following hypothesis is proposed:

Hypothesis 7. Trust positively affects the relationship with knowledge sharing intention.

Internal and external collaboration

According to Tian et al. (2006), collaboration and teamwork are not usually a concern in the context of HEIs. Probably due to the cult of the individual expert and self-motivation (Omerzel et al., 2011), members of HEIs prioritize self-study as the principal knowledge source (Tian et al., 2009), making collaboration secondary (Tian et al., 2006). Gray (1989, p. 6) claims that “the opportunity for collaborating arises because parties recognize the potential advantages of working together”. The literature also suggests that knowledge sharing has a particular influence in building and boosting collaboration within internal and external relationships (Plessis & du Plessis, 2007; Tan, 2016; Wu, Chuang, & Hsu, 2014).

Internal collaboration occurs when members of an institution come together to solve problems or create innovations. Specifically, in the context of HEIs, knowledge sharing supports and strengthens collaboration among their members (Tan, 2016). Furthermore, collaboration promotes intense interaction among members of an institution, allowing for the resolution of issues or the discussion of common work tasks (Tan, 2016), improving the performance of these members, and contributing to the institution’s success (Seonghee Kim & Ju, 2008). Thus, it is hypothesized that:

Hypothesis 8. Knowledge sharing intention positively affects the internal collaborative behavior.

On the other hand, through external collaboration with other organizations, HEIs can find ways to have access to resources and expertise that they would not have originally (Ankrah & AL-Tabbaa, 2015), and to get support for their research activities, especially in recent years, due to cuts in government funding for research. The following hypothesis is proposed:

Hypothesis 9. Knowledge sharing intention positively affects the external collaborative behavior.

Table VII.24 shows a summary of the hypotheses proposed in the study.

Table VII.24 - Hypotheses.

Summary of the hypotheses
H1. Intrinsic motivation positively affects attitude toward knowledge sharing
H2. Extrinsic motivation positively affects attitude toward knowledge sharing
H3. Networking positively affects attitude toward knowledge sharing
H4. Attitude toward knowledge sharing positively affects knowledge sharing intention
H5. Organizational support positively affects subjective norm
H6. Subjective norm positively affects knowledge sharing intention
H7. Trust positively affects relationship with knowledge sharing intention
H8. Knowledge sharing intention positively affects internal collaborative behavior
H9. Knowledge sharing intention positively affects external collaborative behavior

VII.4 Materials and methods

VII.4.1 Method used

In general, applied partial least squares structural equation modelling (PLS-SEM) studies should provide information on the conceptual model, including a description of the inner and outer models, as well as the measurement modes, and the statistical results to support the subsequent interpretations and conclusions (Chin 2010). In addition, authors should report specific technicalities related to the software and the computational options used, as well as the parameter settings of complementary analysis procedures.

The PLS approach is appropriate for exploratory researches where theoretical knowledge is relatively scarce and a new theory needs to be developed (Chin, 2010; Hair, Sarstedt, Ringle, & Mena, 2012), and it is well suited to handling complex models incorporating both reflective constructs and formative constructs (Hair, Hult, Ringle, & Sarstedt, 2014). The assessment of a PLS path model encompasses two stages (Chin, 2010). The first stage, the measurement model, focuses on the analysis of each construct, and in a second stage the structural model is assessed in order to test the hypotheses underlying the proposed conceptual model (Eusébio, Carneiro, & Caldeira, 2016).

The model proposed in this research includes both reflective and formative constructs. All first-order constructs are reflective, while the second-order constructs (containing two layers of constructs that, in this study, correspond to trust and knowledge sharing intention) are formative. The assessment of the measurement model will thus comprise the evaluation of reflective constructs and, subsequently, the evaluation of formative constructs. A first-order measurement model is one in which covariance between constructs is explained by a single latent variable relationship, whereas a second-order measurement model contains two levels of latent variables. In

other words, the measurement model is designed to theoretically indicate the effect caused by the second-order construct on the first-order constructs, which in turn causes the measured variables (Hair, Hult, et al., 2014).

According to Hair et al. (2014, p. 43), "reflective indicators can be viewed as a representative sample of all the possible items available within the conceptual domain of the construct". Various authors (e.g. Garson, 2016; Hair, Sarstedt, Hopkins, & Kuppelwieser, 2014) suggest that the assessment of reflective constructs is carried out by analyzing the reliability of the multiple-item scales, the convergent validity and the discriminant validity. In contrast with reflective constructs, formative constructs are the indicators that cause or form the construct, and are interchangeable among themselves (Garson, 2016; Hair, Hult, et al., 2014).

This study applied PLS-SEM, using the SmartPLS 3 software (Ringle et al., 2015; Garson, 2016) to analyze the data with the application of a bootstrapping technique for significance testing (Hair, Sarstedt, Ringle, & Mena, 2012).

VII.4.2 Data collection

The study has been performed in the form of an online self-administered questionnaire from March to April 2017. A link to a survey platform was made available through e-mail. As the respondents were dispersed throughout different departments, schools and research units, the online survey was practical and convenient as a method of data collection. The questionnaires were administered anonymously to ensure confidentiality and the confidence of the respondents, preceded by a preliminary introduction that explained the objectives of the study.

The questionnaire was divided into two sections. The first section covered a set of questions eliciting the demographic characteristics of the respondents. The second section was comprised of a set of questions with items adapted from previous studies in the context of knowledge sharing (Bekkers & Freitas, 2008; Bock et al., 2005; Jolaee et al., 2014; Seonghee Kim & Ju, 2008; Soonhee Kim & Lee, 2006; Lin, 2007a). This set of questions had the objective to measure, through the opinion of each respondent, the following constructs: intrinsic motivation, extrinsic motivation, networking, attitude toward knowledge sharing, organizational support, subjective norm, trust, knowledge sharing intention, internal collaborative behavior, and external collaborative behavior (see first column of Table VII.26). The response options for these items were presented to respondents on a five-point Likert scale, generally used to measure attitudes (Likert, 1932), where '1' corresponded to the least favorable level – 'not agree at all', and '5' corresponded to the most favorable level – 'fully agree'. The option 'do not know/do not answer' was also available for all questions.

The questionnaire was submitted to a pretest before the launch. According to Adams et al. (2007, p. 136), "this is done to ensure that the questionnaire is clear to respondents and can be completed in

the way you wish". The pretest was conducted on a small scale by a panel of six professors/researchers. At the same time, they were requested to evaluate some questionnaire issues. No major problems were reported that would require a major revision of the questionnaire. The comments received in the evaluation process focused on the re-writing of some questions in order to clarify them. Subsequently, alterations were made in accordance with the comments, thus improving the questionnaire's understanding.

VII.4.3 Sample

The population for this study consists of professors and researchers from a public higher education institution in Portugal. This higher education institution (created in 1973) quickly became one of the most dynamic and innovative universities in Portugal. This institution is ranked among the 100 best institutions of higher education in the world under 50 years old, for the sixth time in a row (2017), in the Times Higher Education ranking. It is the only one out of the youngest Portuguese higher education institutions to be integrated into the world's top 100. It is one of the six largest institutions in Portugal, with the highest concentration in a single campus, and it is organized in departments through a matrix structure. This institution is organized into 16 different departments, 4 polytechnic schools, and 18 research centers, according to a wide range of fields. It has about 15,000 students on undergraduate and postgraduate programs, and over 1,000 professors and researchers.

A total of 1020 professors and researchers were contacted through e-mail and requested to fill out the questionnaire. In total, 297 (29.1%) questionnaires returned, with 121 having been eliminated due to incomplete data. As a result, 176 (17.3%) valid answers from 4 scientific areas (i.e. Life and Health, Natural and Environment, Science and Engineering, and Social and Humanities) were used in the data analysis. The sample was gender balanced (50.6% female and 49.4% male). In total, 75.5% of respondents had more than 10 years of professional experience and 66.5% had more than 10 years of affiliation with the institution. Table VII.25 presents the demographic profile characteristics of the respondents.

Although the PLS method is remarkably stable even at low sample sizes, sample size is a basic PLS method issue (Hair et al., 2012). Based on Barclay et al. (1995) several authors suggest using the '10 times rule' which specifies minimum sample size as 10 times the largest number of predictors for any dependent variable in the model. However, Hair et al. (2012, p. 420) emphasize the fact that "this rule of thumb does not take into account effect size, reliability, the number of indicators, and other factors known to affect power and can thus be misleading". This study used, as suggested by Hair et al. (2014), the software *G* Power 3.1.9.2*, a flexible statistical power analysis program commonly used for social and behavioral research (Faul, Erdfelder, Lang, & Buchner, 2007). The procedure implies the identification of the largest number of predictors that a construct receives. In the proposed model, the most complex regression involves the number of structural paths directed at the attitude toward knowledge sharing and knowledge sharing intention

constructs, which are three. The parameters used to estimate the minimum sample size were those recommended by Hair et al. (2014): 80% of statistical power (1 – β), effect size median (f^2) of 0.15,

Table VII.25 - Demographic profile of respondents.

	Frequency	
	Absolute	Relative (%)
Gender		
Female	89	50.6
Male	87	49.4
Age		
< 30 years	6	3.4
30-40 years	31	17.6
41-50 years	74	42.0
51-60 years	51	29.0
> 60 years	14	8.0
Level of education		
Aggregation	23	13.1
PhD	121	68.8
Masters	22	12.5
Degree	10	5.7
Position in department		
Full professor	11	6.3
Associate professor	28	15.9
Assistant professor	89	50.6
Lecturer	21	11.9
Researcher	19	10.8
Others	8	4.5
Dedication		
Integral	139	79.0
Partial	37	21.0
Scientific area		
Life and Health	17	9.7
Natural and Environment	18	10.2
Science and Engineering	58	33.0
Social and Humanities	83	47.2
Years of service in current institution		
< 1 year	15	8.5
1-5 years	15	8.5
6-10 years	29	16.5
11-20 years	63	35.8
> 20 years	54	30.7
Years of experience as professor		
< 1 year	8	4.5
1-5 years	13	7.4
6-10 years	22	12.5
11-20 years	52	29.5
> 20 years	81	46.0
Years of experience as researcher		
< 1 year	10	5.7
1-5 years	8	4.5
6-10 years	34	19.3
11-20 years	51	29.0
> 20 years	73	41.5
In an average year, how many conferences do you participate		
0	11	6.3
1-3	126	71.6
4-6	29	16.5
7-10	5	2.8
11-20	2	1.1
21-30	2	1.1
> 30	1	0.6
In an average year, how many scientific papers do you publish		
0	12	6.8
1-3	103	58.5
4-6	41	23.3
7-10	12	6.8
11-20	4	2.3
21-30	3	1.7
> 30	1	0.6

n = 176

and 5% probability of error (α). Thus, according to the results, the minimum sample size would be 77, but to have a more consistent model it is interesting to have at least twice the value (Ringle, Da Silva, & Bido, 2014). As there were 176 valid responses collected, the PLS analysis seems to have sufficient power.

VII.5 Results and discussion

VII.5.1 Reflective constructs

The reliability of the constructs was analyzed using composite reliability (CR), since it has been considered a more accurate measurement than Cronbach's alpha (Fornell & Larcker, 1981). This measure is appropriate for constructs with reflective indicators. In Table VII.26, the values of composite reliability of all constructs are shown to be higher than the reference value of 0.70 (Fornell & Larcker, 1981; Garson, 2016) and, furthermore the results surpassed the value of 0.80 which Garson (2016) suggests to be considered good for confirmatory research. Moreover, all of the indicators had factor loadings greater than the value of 0.60 as recommended in the literature by Henseler et al. (2009).

Table VII.26 - Measurement statistics of construct scales.

Construct / indicators	Mean	Standard Deviation	Indicator Loadings	*t*-value [a]	CR	AVE
Intrinsic motivation	4.440	0.551	-	-	0.878	0.645
I am willing to share knowledge because I like to help my colleagues	4.448	0.721	0.657	9.411		
I think that sharing my knowledge would help in solving colleagues' problems	4.460	0.629	0.864	29.313		
I think that sharing my knowledge would create new opportunities for my institution	4.425	0.678	0.871	39.164		
I think that sharing my knowledge would help improve my institution's performance	4.425	0.735	0.803	13.598		
Extrinsic motivation	3.382	0.783	-	-	0.835	0.559
I think that sharing my knowledge makes my colleagues better aware of my skills	4.080	0.928	0.698	9.348		
I consider that my institution recognizes / values those who share knowledge	3.329	1.140	0.810	17.870		
I consider that my institution provides its members with a fair evaluation / reward system for sharing knowledge	2.849	1.026	0.791	13.469		
I think that sharing knowledge has a direct impact on the progression of my career	2.854	1.245	0.684	9.259		
Networking	3.628	0.771	-	-	0.851	0.659
I interact frequently with colleagues from the institution in sharing teaching and scientific knowledge	3.710	0.992	0.875	42.198		
I maintain good networking with people from other organizations in the context of knowledge sharing	3.736	1.019	0.678	9.005		
I communicate with other members of my institution through informal contacts in the context of knowledge sharing	3.903	0.918	0.866	35.453		
Attitude toward knowledge sharing	4.310	0.595	-	-	0.890	0.731
Sharing knowledge with my institution colleagues is important to me	4.193	0.783	0.903	59.954		
Sharing knowledge with my colleagues at the institution is an experience that pleases me	4.201	0.800	0.896	50.123		
I consider that the sharing of knowledge and experience promotes the creation of new knowledge	4.566	0.607	0.759	14.114		

Table VII.26 - Measurement statistics of construct scales (continued).

Construct / indicators	Mean	Standard Deviation	Indicator Loadings	*t*-value [a]	CR	AVE
Organizational support	3.581	0.723	-	-	0.869	0.691
My institution provides appropriate technologies to support knowledge sharing (e.g. academic portal, web site, e-mail)	3.924	0.888	0.724	14.758		
My institution has appropriate mechanisms for knowledge sharing (e.g. meeting, academic meeting)	3.485	0.844	0.880	41.731		
My institution supports and encourages the creation of informal mechanisms for knowledge sharing (e.g. communities of practice, thematic meetings open to the community)	3.333	0.877	0.880	43.248		
Subjective norm	3.842	0.669	-	-	0.904	0.704
I feel that, considering the culture of my institution, I should share my knowledge	3.786	0.856	0.716	17.795		
People who influence my behavior (e.g. colleagues and friends) think that I should share my knowledge	3.800	0.791	0.883	21.942		
People who are important to me (e.g. colleagues and friends) think that I should share my knowledge	3.844	0.771	0.895	38.115		
People whose opinion I value (e.g. colleagues and friends) think that I should share my knowledge	3.939	0.798	0.844	25.299		
Trust						
Educational knowledge	4.062	0.678	-	-	0.806	0.581
I do not mind sharing my teaching materials with colleagues in my institution	4.326	0.827	0.724	15.152		
When I face difficulties in teaching, I ask my colleagues from my institution for help	4.059	0.846	0.789	19.138		
I believe that by sharing knowledge with my colleagues in my institution, they will respond in the same way	3.800	0.989	0.777	22.929		
Scientific knowledge	3.924	0.773	-	-	0.843	0.849
I do not mind announcing the results of my research to my institution colleagues before I publish them	3.953	1.084	0.743	17.118		
When I face difficulties in my investigations, I ask my colleagues from my institution for help	4.059	0.873	0.826	25.617		
I believe that by sharing knowledge resulting of my investigations with my colleagues they will respond in the same way	3.759	0.945	0.832	31.120		
Knowledge share intention						
Educational knowledge	3.990	0.720	-	-	0.919	0.695
I intend to share the tacit knowledge and know-how gained in teaching with my institution colleagues in the future	4.183	0.719	0.807	23.521		
I intend to share teaching materials developed by me with my institution colleagues in the future	4.152	0.818	0.837	39.955		
I intend to share the tacit knowledge and know-how gained in teaching with colleagues from other institutions in the future	3.893	0.898	0.903	62.853		
I intend to share teaching materials developed by me with colleagues from other institutions in the future	3.694	1.031	0.873	54.372		
I intend to participate in group discussions, workshops, and communities of practice to share knowledge in the future	4.031	0.838	0.744	18.945		
Scientific knowledge	4.160	0.716	-	-	0.918	0.849
I intend to share knowledge and know-how gained in research with my institution colleagues in the future	4.189	0.740	0.921	49.267		
I intend to share knowledge and know-how gained in research with colleagues from other institutions in the future	4.130	0.811	0.924	50.407		
Internal collaborative behavior	3.810	0.584	-	-	0.880	0.787
Regarding teaching, I prefer to work in group rather than work alone	3.830	0.962	0.908	47.077		
Regarding investigation, I prefer to work in group rather than work alone	4.227	0.829	0.866	23.960		
External collaborative behavior	3.475	0.569	-	-	0.800	0.573
I believe that collaborative relationships with others higher education institutions promote the sharing of knowledge and recognition of my work	4.036	0.887	0.805	11.058		
I believe that collaborative relationships with non-academic organizations promote the sharing of knowledge and recognition of my work	3.788	0.979	0.766	9.364		
My institution promotes and recognizes collaborative relationships with non-academic organizations	3.444	0.972	0.677	6.072		

[a] *t*-values were obtained with the bootstrapping procedure (5,000 samples) and are significant at the 0.001 level (two-tailed test).

The convergent validity is the degree to which multiple items used to measure the same concept are in agreement (Hair, Hult, et al., 2014). The convergent validity was evaluated through the average variance extracted (AVE). As presented in Table VII.26, all constructs have an AVE higher than 0.50, attesting to a good convergent validity of the scales used (Chin, 2010).

Discriminant validity assessment has become a generally accepted prerequisite for analyzing relationships between latent variables. The Fornell-Larcker criterion and the examination of cross-loading are dominant approaches for evaluating discriminant validity (Henseler, Ringle, & Sarstedt, 2015). However, Henseler, Ringle and Sarstedt (2015) show, by means of a simulation study, that these approaches have "an unacceptably low sensitivity, which means that they are largely unable to detect a lack of discriminant validity" (2015, p. 128). They demonstrate this approach's superior performance by means of a Monte Carlo simulation study, in which they compare the new approach to the Fornell-Larcker criterion and the assessment of cross-loadings. Following the recommendation of Henseler, Ringle and Sarstedt (2015), this study uses the Heterotrait-Monotrait Ratio (HTMT) criterion to assess discriminant validity (Table VII.27). According to these authors, since the HTMT value is clearly below 0.90, discriminant validity has been well established between the reflective constructs.

Table VII.27 - Discriminant validity of the constructs - HTMT results.

Constructs		1	2	3	4	5	6	7	8	9	10
1.	Intrinsic motivation	1.00									
2.	Extrinsic motivation	0.47	1.00								
3.	Networking	0.51	0.35	1.00							
4.	Attitude toward knowledge sharing	0.66	0.41	0.58	1.00						
5.	Organizational support	0.36	0.46	0.41	0.34	1.00					
6.	Subjective norm	0.54	0.49	0.54	0.55	0.56	1.00				
7.	Trust	0.38	0.29	0.43	0.48	0.22	0.35	1.00			
8.	Knowledge sharing intention	0.46	0.31	0.53	0.60	0.23	0.46	0.67	1.00		
9.	Internal collaborative behavior	0.33	0.27	0.46	0.53	0.26	0.37	0.40	0.47	1.00	
10.	External collaborative behavior	0.39	0.35	0.41	0.47	0.38	0.44	0.36	0.32	0.37	1.00

VII.5.2 Formative constructs

The second-order constructs included in the conceptual model proposed (Figure VII.45) – trust and knowledge sharing intention – were analyzed. After testing the quality of the first-order constructs, and ensuring that all requirements are met (Hair, Hult, et al., 2014), the assessment of the quality of second-order constructs is comprised of two stages. The multicollinearity among the first-order constructs is examined, as well as the weights and significance level of the first-order constructs on the second-order constructs (Garson, 2016). The multicollinearity was analyzed through the variation inflation factor (VIF), with values varying between 1.31 to a maximum of 1.95, which is far below the common cut-off threshold of 5 (Hair et al., 2012).

Values of outer weights represent the relative contribution to the construct, or its relative importance. Their values vary from 0 to an absolute maximum lower than 1 (Garson, 2016). The further the value is different from zero, the more a formative indicator truly contributes to forming the construct (Hair, Hult, et al., 2014). As shown in Table VII.28, all first-order constructs are higher than 0, which means that they positively contribute to the second-order constructs. Educational and scientific knowledges contribute almost with the same intensity as the first-order constructs on the formative construct of trust. On the other hand, in contrast with Kim and Ju's (2008) study conducted through questionnaires administered to 109 faculty members at a private university in South Korea that analyzes major factors for knowledge sharing among faculty members, educational knowledge emerges as the first-order construct with more weight on the knowledge sharing intention. As stressed by these authors, although some of these materials have high scholarly value as well as practical know-how, they are not shared among colleagues being instead organized and preserved by each individual member.

Table VII.28 - Weights of the first-order constructs on the second-order constructs.

2nd Order Constructs	1st Order Constructs	Weight	t-value
Trust	Educational knowledge	0.543	19.585***
	Scientific knowledge	0.567	23.949***
Knowledge sharing intention	Educational knowledge	0.771	43.168***
	Scientific knowledge	0.316	20.974***

***$p < 0.001$ based on 5,000 bootstraps.

VII.5.3 Structural model assessment

Following the assessment of the measurement model, the results of the structural model are depicted in Figure VII.46.

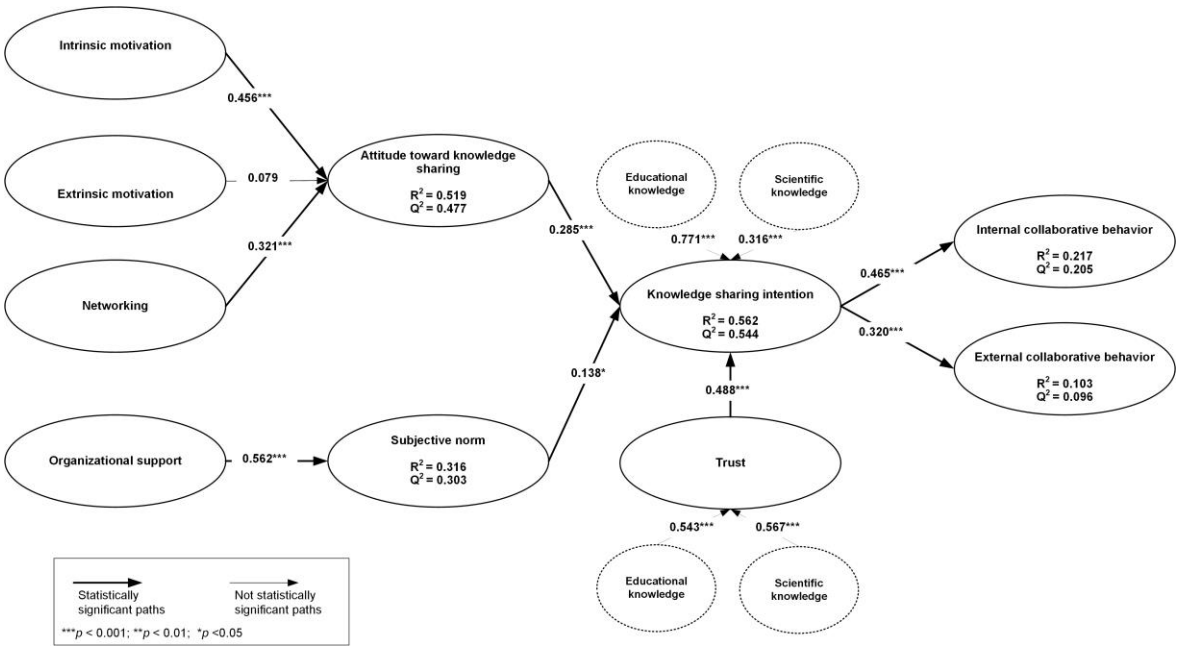

Figure VII.46 - The results of structural model.

In this study, both the model's predictive power and the relationships between the constructs were examined. To evaluate the predictive power of the research model the coefficient of determination (R^2) and Stone-Geisser's Q^2 technique were used. This is due to the R^2 of the endogenous latent variables being the essential criterion for the assessment, and Stone-Geisser's Q^2 being the predominant measure of predictive relevance (Henseler et al., 2009).

Findings presented in Figure VII.46 reveal that the model has a reasonable prediction power since the R^2 values vary between 0.103 and 0.562 and the predictive relevance Q^2 values range from 0.096 to 0.544 - showing the predictive importance of endogenous constructs (Chin, 2010). The constructs with higher variance explained by the model were the knowledge sharing intention and attitude toward knowledge sharing (R^2=0.562 and R^2=0.519, respectively) followed by the subjective norm (R^2=0.316). On the other hand, the constructs with lower variance explained were internal collaborative behavior and external collaborative behavior (21.7% and 10.3%, respectively).

Table VII.29 summarizes the results of the hypotheses testing and provides evidence that only one hypothesis is not supported.

Table VII.29 - Hypotheses testing.

Path	Result
H1. Intrinsic motivation → attitude toward knowledge sharing	Supported
H2. Extrinsic motivation → attitude toward knowledge sharing	Not supported
H3. Networking → attitude toward knowledge sharing	Supported
H4. Attitude toward knowledge sharing → knowledge sharing intention	Supported
H5. Organizational support → subjective norm	Supported
H6: Subjective norm → knowledge sharing intention	Supported
H7. Trust → knowledge sharing intention	Supported
H8. Knowledge sharing intention → internal collaborative behavior	Supported
H9. Knowledge sharing intention → external collaborative behavior	Supported

The first three hypotheses proposed that intrinsic motivation (H1), extrinsic motivation (H2), and networking (H3) positively affect attitude toward knowledge sharing. Results shown that only H1 ($\beta = 0.456$, $p < 0.001$), and H3 ($\beta = 0.321$, $p < 0.001$) had a significant and positive influence on attitude toward knowledge sharing, while hypothesis H2 ($\beta = 0.079$, $p > 0.05$) was not supported.

As expected, given that members of HEIs are used to have some freedom and autonomy (Sporn, 1996) and intrinsic motivation is an activity moved by self-determination, and is free of external incentives, pressures, or rewards (Ryan & Deci, 2000), this factor was the one that most positively affects the knowledge share attitude. Consequently, consistent with the concept of extrinsic motivation as a controlled motivation, this factor was not considered as one that affects attitude toward knowledge sharing. Networking was the other factor that affects attitude in this institution. Networking refers to the extent of individuals' contact with other people. Knowledge is dynamic and members of HEIs are critical actors involved in the creation and dissemination of knowledge. This form of interaction assumes an important role since it is not just an activity related to knowledge

sharing but also about leverage of knowledge, as suggested by Riege (2005) in his article that reviews and discuss potential knowledge sharing barriers.

As proposed in the hypothesis H4, the result showed that professors' and researches' attitudes toward knowledge sharing affect their knowledge sharing intention ($\beta = 0.285$, $p < 0.001$). This finding is consistent with that of Lin (2007a), who studied knowledge sharing intentions of 172 employees from 50 large organizations in Taiwan. Bock et al. (2005) also identified, in their study with 154 managers from 27 Korean organizations, that the intention to share knowledge is greater when the attitude towards knowledge sharing is more favorable.

Organizational support (H5) ($\beta = 0.562$, $p < 0.05$) presented a strong influence on subjective norm toward the knowledge sharing intention. This result is consistent with that found in the work of Jolaee et al. (2014), that tested this hypothesis through a survey of academic staff of 3 Social Sciences faculties at one university in Malaysia. However, for H6 ($\beta = 0.138$, $p < 0.05$), the results indicated that, in this study, knowledge sharing intention was not affected so strongly by the subjective norm. This result could be explained by the fact that professors and researchers are fully aware of knowledge sharing and its related benefit for themselves, and that they prefer to go through the decision-making process with less interventions from colleagues and peer groups when it comes to knowledge sharing intention. This finding is similar to that found in Jolaee et al. (2014). However, it is different from that of Bock et al. (2005), which suggests that subjective norms can influence intentions, specially within groups with strong collectivist orientation like Korean organizations.

In the context of this study, trust was defined as the degree of relying on sharing educational and scientific knowledge with colleagues. The result strongly supported the hypothesis H7 ($\beta = 0.488$, $p < 0.001$), meaning that trust had a positive effect on the intention of knowledge sharing. This finding is similar to those found in previous studies within HEIs. Tan (2016) conducted a survey in 5 universities in Malaysia and identifies that trust has a significant and positive influence on knowledge sharing, suggesting that HEIs should create and reinforce an environment of trust among their faculty members. The study of Patel and Ragsdell (2011), in two faculties at a British university, also concludes that trust plays an integral part in the knowledge sharing process within organizations. However, current business models with geographically dispersed companies and ongoing partnership and restructuring actions, as well as the increasing tendency to replace face-to-face communication with digital communication constitute a challenge for the development of trust in relationships. In the opinion of Cook et al. (2005), trust is no longer the central pillar of the social order and may not even be considered very important in most processes of knowledge sharing and collaboration that are managed quite effectively.

Finally, hypotheses H8 and H9 proposed that the knowledge sharing intention has a positive relationship with the collaboration behavior within the institution and with other organizations

respectively. Results confirmed that H8 ($\beta = 0.465$, $p < 0.001$) and H9 ($\beta = 0.320$, $p < 0.001$) are strongly impacted by knowledge sharing intention.

VII.6 Conclusion and future work

VII.6.1 Conclusion

This study proposed that knowledge sharing intention affects the collaborative behavior among professors and researchers positively in the specific context of a public Portuguese HEI. In order to reach this main objective, the conceptual research model was developed based on the TRA theory. This study applied PLS-SEM to analyze the data with the application of a bootstrapping technique for significance testing. First, the individual factors (i.e., intrinsic motivation, extrinsic motivation, and networking) that could positively affect the attitude toward knowledge sharing were examined and analyzed. Followed by how attitude toward knowledge sharing, subjective norm, and trust affect the knowledge sharing intention, and finally, how the latter affects internal and external collaborative behavior.

The results indicated that intrinsic motivation and networking were the factors which positively affected the attitude toward knowledge sharing, while extrinsic motivation did not influence it. It is believed that HEIs and their members should establish mechanisms based on the intrinsic motivation and the networking in order to promote and encourage knowledge sharing.

The results' analysis also allowed for the identification of trust as the variable that more strongly affects the knowledge sharing intention, which is in accordance with other studies reported in the literature.

Finally, the study identified that knowledge sharing intention has a positive influence in collaborative behavior, with this influence being stronger in the case of internal rather than external collaborative behavior.

VII.6.2 Scientific and managerial implications

The literature suggests that this theme is quite relevant and that there is an evident lack of empirical studies that properly investigate the relationship between knowledge sharing and collaborative behavior in HEIs. In a scientific perspective, this study contributed to the advancement of knowledge in the area, specifically based on empirical results. Since previous studies based on empirical data mostly focused on business organizations or non-European HEIs, with only few ones have been conducted in Europe, and in particular in Portuguese HEIs.

In a managerial perspective, this work contributes to the identification of relevant facts related to the knowledge sharing in the context of a Portuguese HEI. The results obtained can support the institution's management in the strategies definition and development of future actions, in order to

promote an organizational culture based on knowledge management that significantly leads to knowledge sharing and collaboration relationships.

Considering the results of this study, which show that members of this HEI prioritize the intrinsic motivation, the institution should establish mechanisms favorable for effective knowledge sharing such as:

- Encouraging members to share knowledge by organizing open discussions, forums, seminars or colloquiums, or applying communities of practice with the aim to create a collaborative sharing environment among members with a common scientific interest;
- Making the individuals' sharing activities and knowledge contributions more visible to the remaining of the institution can enhance intrinsic motivation and so encourages knowledge sharing and collaborative behavior.

VII.6.3. Limitations and future research

Since the data collection was restricted to one Portuguese public higher education institution, the conclusions cannot be extended to other institutions and thus making it impossible to generalize the obtained conclusions.

Considering the limitation of the study and that the literature review showed that most of studies focused on a single higher education institution or a single country, future researches should apply this study to other Portuguese HEIs in order to obtain more data and better characterize Portuguese HEIs' knowledge sharing and collaboration behavior. Then, it will be interesting to compare our results with the ones from HEIs from other countries and cultures. Analyzing and characterizing the knowledge sharing and collaboration practices among researchers and/or teachers at this institution will also be important.

VII.7 References

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Chapter VIII - Characterization of knowledge sharing and collaboration practices in a Portuguese university: An empirical study

Reference

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Characterization of knowledge sharing and collaboration practices in a Portuguese university: An empirical study

Abstract

The mission of universities is closely related with knowledge management, where there are some key elements that facilitate it, such as broad experience in the creation and development of knowledge and an organizational structure that tends to be horizontal. Nevertheless, the literature indicates that universities have been faced with some difficulty in establishing an organizational culture based on knowledge management that significantly promotes knowledge sharing and collaboration relationships. This work aims to explore the practice of knowledge sharing and collaboration in a Portuguese university context, based on an empirical study that was conducted on the basis of a questionnaire prepared taking into account the literature on the area. The sample consisted of teachers and researchers from a Portuguese university and the questionnaire was provided online. The analysis of the results obtained shows that in general, actions of knowledge sharing occur more frequently in the internal environment of the institution, using personal contact, phone calls, face-to-face meetings e-mail and e-Learning tools as the main ways of communicating. The external collaboration is mainly with other higher education institutions and research centers, and according to the results, external collaboration relationships are established through guidance and/or supervision of dissertations, internships, and projects and participation and/or organization of conferences. Therefore, it can be concluded that is important to establish mechanisms that promote and encourage the sharing of knowledge and, consequently, collaborative relationships, internally, but also externally, in particular with industrial organizations.

Keywords

Knowledge sharing, Collaboration, Collaboration relationships, Higher education.

VIII.1 Introduction

Today, universities are under intense pressure, motivated by the knowledge society and by the internationalization of institutions, where creativity, innovation and entrepreneurship emerge as essential elements of competition. Collaboration has been considered one way to address the referred challenge, helping in the promotion of innovation, growth and productivity which are necessary for all parties involved. Several studies show that collaboration can be strongly influenced by knowledge sharing (e.g. Tan, 2016).

As in business organizations, universities should foster and promote internal and external collaborations which, in addition to the creation of knowledge, can result in publications, dissemination of research results, reduction in redundancy of research efforts and consequent academic productivity (Melin, 2000; Nissen, Evald, & Clarke, 2014). Moreover, strategies to promote knowledge sharing and collaboration are important requirements that contribute to the overall result being greater than the mere sum of the parties (Weber, Morelli, Atwood, & Proctor, 2006). According to Kim and Ju (2008, p. 285) "collaboration is significantly associated with knowledge sharing among faculty in academic institutions".

However, Tian, Nakamori and Wierzbicki (2009) identify the presence, at the universities, of an individualistic culture where knowledge is related to the experience and the competence of each researcher and/or teacher. In this context, knowledge is frequently considered as property and as a differentiation factor of each individual. Consequently, the individual characteristics tend to show a major impact on knowledge sharing, which, according to some authors, is higher than that caused by the departmental and institutional characteristics (Geuna & Muscio, 2009).

The literature revision on knowledge sharing and collaboration in the context of higher education institutions revealed a limited existence of empirical studies (Ali, Gohneim, & Roubaie, 2014; Fullwood, Rowley, & Delbridge, 2013), having been the main ones conducted in the United Kingdom and Asia (Tohidinia & Mosakhani, 2010).

This work aims to explore the practice of knowledge sharing and collaboration in a Portuguese university context, based on an empirical study conducted using a survey based on a questionnaire applied to teachers and researchers from a Portuguese university, which results were statically analyzed.

VIII.1.1 About knowledge sharing in higher education institutions

Knowledge sharing is the most important process of knowledge management in knowledge-intensive organizations such as universities (Tan, 2016). The mission of universities is closely related with knowledge management, where there are some key elements that facilitate it, such as broad experience in the creation and development of knowledge and an organizational structure

that tends to be horizontal. Nevertheless, universities have been faced with some difficulty in establishing an organizational culture based on knowledge management that significantly promotes knowledge sharing and collaboration relationships (Bjørnson & Dingsøyr, 2008; Howell & Annansingh, 2013; Tian et al., 2009).

Howell and Annansingh (2013) highlight that often knowledge sharing in the university involves breaking down barriers and knowledge "silos". The study of Fullwood et al.'s (2013) indicates that knowledge sharing culture within universities is individualistic in nature and at times selfish. Ramayah et al. (2013, p. 133) add that "the tendency for academicians to actively limit their knowledge sharing is especially more prevalent when these individuals have specialized, unique and important knowledge that others do not possess". Considering that knowledge increases in value and importance when shared (Tippins, 2003), this individualistic characteristic is not suitable for the knowledge sharing process. This is one of the main challenges that higher education institutions face in the implementation of a knowledge sharing culture.

According to Omerzel et al. (2011) and Tippins (2003) usually, academic members consider knowledge as their private property that is not freely shared. They assume that knowledge creation is more interesting than knowledge sharing, given that they have the perception that their institutions do not clearly recognize knowledge sharing (Tan, 2016), and due to the fact of absence of system that protect their intellectual assets (Kim & Ju, 2008; Patel & Ragsdell, 2011). As stated by Świgoń (2017), teachers and researchers' preferable form of knowledge sharing practices is face-to-face talks. Also, Howell and Annansingh (2013), Mansor et al. (2015), and Tan (2016) refer that the majority of academic knowledge sharing is performed outside the institutions, where researchers assume that there are rewards of both internal and external recognition.

It seems to be consensual in the literature that knowledge sharing in higher education institutions enables innovation, collaboration and research development since it encourages people to express, exchange, negotiate, and understand, mainly, tacit knowledge (Howell & Annansingh, 2013; Świgoń, 2015; Weber et al., 2006). Howell and Annansingh (2013, p. 37), in their study, compile the following benefits of knowledge sharing in higher education institutions: (i) knowledge creation; (ii) knowledge refinement; (iii) network knowledge sharing creation; (iv) content validation; (v) recognition of knowledge as a social commodity; (vi) collaborative opportunities. The literature also suggests that knowledge sharing has a particular influence on building and strengthening internal and external collaboration relationships (Plessis & du Plessis, 2007; Tan, 2016; Wu, Chuang, & Hsu, 2014). Concerning this issue, Patel and Ragsdell (2011, p. 1) refer that "knowledge is shared not only with students and society, but it is also shared between university members and in collaborative arrangements with external enterprises".

VIII.1.2 About collaboration in higher education institutions

According to Gray (1989, p. 5) "collaboration is a process through which parties who see different aspects of a problem can constructively explore their differences and search for solutions beyond their own limited vision".

Collaboration and teamwork, in general, are not a concern in the university context (Świgoń, 2015; Tian, Nakamori, Xiang, & Futatsugi, 2006). In the perspective of Diamond and Rush (2012, p. 288), "the collaboration process is often messy, not clearly defined, difficult to manage and reactive to unplanned events or actions", and according to Melin (2000, p. 31), it is "characterized by strong pragmatism and a high degree of self-organization". Probably due to the culture of expert individuals and self-motivation (Omerzel et al., 2011), members of this type of organization prioritize self-study as the main source of knowledge, collaborating when necessary (Buckley, 2012; Tian et al., 2009, 2006).

Internal collaboration occurs when members of an organization come together to solve problems or create innovations. Specifically, as regards internal collaboration within higher education institutions, knowledge sharing supports and enhances collaboration among its members (Tan, 2016). In addition, it promotes intense interaction among its members, which makes possible to solve problems and/or discuss common work tasks, improving their performance and contributing to the success of the institution (Kim & Ju, 2008; Tan, 2016). However, according to Diamond and Rush (2012, pp. 289, 293), internal collaboration "is rarely prioritized, resourced and commended", and "is often perceived as risky or a challenge to the prevailing organizational cultures/orthodoxies". Lauring and Selmer (2012, p. 99) highlight that members of higher education institutions "show acceptance of external colleagues while at the same time are reluctant to collaborate with other department members".

On the other hand, through external collaboration with other organizations, academic or non-academic, higher education institutions can find ways to have access to resources, expertise, and knowledge they do not have (Ankrah & AL-Tabbaa, 2015). Due to government cuts of funding, external collaboration has become a means to obtain financial support for the research activities (Patel & Ragsdell, 2011).

According to Diamond and Rush (2012) and Howell and Annansingh (2013), universities, in order to achieve success in the process of collaboration, should adopt a holistic approach which emphasizes the value of knowledge creation and sharing at the individual level and that also recognizes group performances and collective accomplishments.

VIII.2 Methodology

VIII.2.1 Data collection

The study has been performed in the through an online self-administered questionnaire. The link to the survey platform was made available by e-mail. The respondents were professors and researchers from departments, schools and research units of the University of Aveiro, Portugal. The questionnaires were administered anonymously and had a preliminary introduction that explained the objectives of the study. Concerning the structure, the questionnaire is composed by three parts, being this work based on the data collected in two of them. The first one covered a set of questions eliciting demographic characteristics of the respondents and the second one was composed of a set of questions aimed at collecting information about (i) the means of communication used in the knowledge sharing within the institution, (ii) the types of knowledge shared within the institution, (iii) the types of external organizations with which relations are established, and (iv) the way of how these relationships are established. For this second group of questions a five-point Likert scale was used, where level '1' corresponded to the least favorable level – 'never' and '5' corresponded to the most favorable level – 'very often'.

To ensure that the questionnaire was clear to respondents (Adams, Khan, Raeside, & White, 2007), a pre-test was conducted on a small scale under conditions similar to those of its definitive application in a sample of six teachers/researchers. The comments received in this evaluation process focused essentially on the re-writing of some questions to facilitate their understanding.

VIII.2.2 Sample

The population for this study consists of professors and researchers from University of Aveiro (UA). This higher education institution (created in 1973) quickly became one of the most dynamic and innovative universities in Portugal. This institution is ranked for the sixth time in a row (2017) among the 100 best institutions of higher education in the world under 50 years old, in the Times Higher Education ranking. It is the only one of the youngest Portuguese higher education institutions to integrate the world's top 100. It is one of the six largest institution in Portugal, with the higher concentration into a single campus, and it is organized in departments through a matrix structure. This institution is organized into 16 different departments, 4 polytechnic schools, and 18 research centers, according to a wide range of fields. It has about 15,000 students on undergraduate and postgraduate programs, and over 1,000 professors and researchers. Sample demographic characteristics are presented in Annex 1.

A total of 1020 professors and researchers were contacted by e-mail and were requested to fill out the questionnaire. In total, 297 (29.1%) questionnaires were returned, from which 121 with incomplete data were eliminated. The low ratio of responses is one of the limitations of the online

survey and rarely exceeds 20% (Adams et al., 2007). As a result, 176 (17.3%) valid answers were obtained.

It can be observed that respondents were from 4 scientific areas (i.e. Life and Health, Natural and Environment, Science and Engineering, and Social and Humanities), the sample was gender balanced (50.6% female and 49.4% male) and, in total, 75.5% of respondents had more than 10 years of professional experience and 66.5% had more than 10 years of affiliation in the UA.

VIII.3 Results

In this section the findings of the study are presented and discussed. Descriptive statistics and box-plots were performed using the *IBM SPSS 24* statistical package.

VIII.3.1 Means of communication used in knowledge sharing within UA

Table VIII.30 presents the results concerning the different means of communication used by the respondents in their institution in order to share knowledge. The results show that the set of personal means of communication are the most widely used, namely 'e-mail' (MIC4) (mean=4.58) and 'personal contact' (MIC1) (mean=4.41) with median of 5, followed by 'face-to-face meeting' (MIC3) (mean=3.79) and 'phone call' (MIC2) (mean=3.76) with median of 4, as can observed in Figure VIII.47. It is also observed that MIC1 to MIC4 present negative skewness in the distribution of the data, being MIC1 and MIC4 more asymmetric than MIC3 and MIC4, presenting also outliers. These results may be supported by different perspectives. Snyder and Lee-Partridge's (2013) identify that the adoption of these means of communication allows direct knowledge sharing only to individuals with whom a relationship of trust is established, which suggest that trust is a facilitator element of knowledge sharing. Conversely, Kim and Ju (2008) report that the frequent use of means of communication characterized by personal is justified by the lack of information on how and where members of higher education institution should share their knowledge or who has need or interest in their knowledge, which suggest the need for a dedicated and appropriate channel for knowledge sharing.

Table VIII.30 - Descriptive statistics of the results concerning the use of the means of communication within the UA.

Means of communication	Mean	*Median*	*SD*
Personal contact (MIC1)	4.41	5	0.71
Phone call (MIC2)	3.76	4	1.09
Face-to-face meeting (MIC3)	3.79	4	0.98
e-mail (MIC4)	4.58	5	0.69
Groupware (MIC5)	2.07	2	1.24
Social network (MIC6)	2.18	2	1.24
Video conferencing (MIC7)	2.54	2	1.25
e-Learning tool (MIC8)	3.41	4	1.23

n = 172

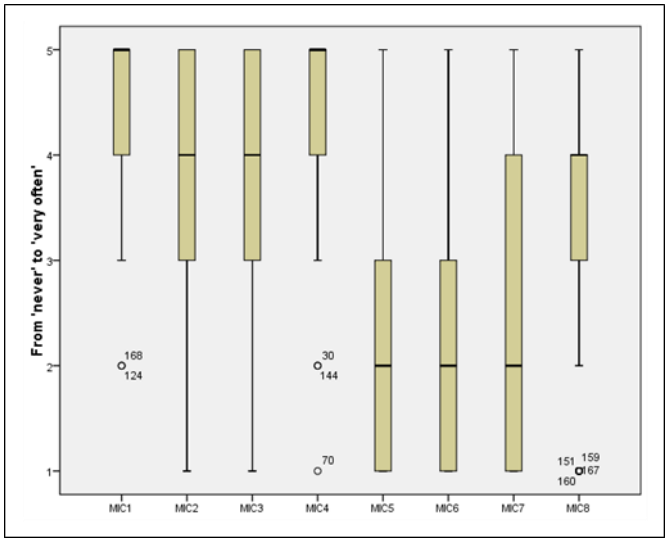

Figure VIII.47 - Boxplots of the variables related to the use of the means of communication within the UA.

On the other hand, it is interesting to note that the set of means based on technological infrastructure (groupware, social networks and videoconferences) have the lowest level of utilization with median of 2. The results also show that the set of data presents an amplitude of 4 and the 1º quartile is in the lower level of the scale – '1-never use'. The 'e-Learning tool', another technological infrastructure, can be seen as an exception since has a median value of 4. This result may be explained by the fact that professors use this mean to provide subjects' contents and information to their students, albeit due to its main function, it was expected a higher use of this option in the university. The limited use of means of communication based on technological infrastructure does not contribute to richer interactions between the members of university, reducing the ability to enhance knowledge sharing and collaboration (Chen, Wu, & Wu, 2013; Kane, Labianca, & Borgatti, 2014).

VIII.3.2 Types of knowledge shared within UA

Based on the results achieved, in particular in types of knowledge shared within UA, it is clear that, in general, the several types of knowledge are shared among the members of this institution. The results in Table VIII.31 indicate that all the types of knowledge studied, namely 'teaching material' (TKS1), 'knowledge resulting from researches' (TKS2), 'best practices' (TKS3), and 'expertise and know-how' (TKS4), have quite similar mean and standard deviation values, being TKS2 the item that present the higher mean (mean=3.95), while TKS3 is the lower one (mean=3.58). The profile of responses assigned to the type TKS2 probably reflects the requirement of publications that teachers and researchers face in Portugal, since it is the main factor of their evaluation.

It can also be observed in Figure VIII.48 that for all the items studied the medians are similar (median=4), but the answers of items TKS1, TKS2 and TKS4 have a higher variability (interquartile range=3) than TKS3, that represents 'best practices' (interquartile range=2).

Overall the results obtained suggest that teachers and researchers are in some way aware of the benefit of knowledge sharing, and in this way, they share some their knowledge within the UA. However, despite knowledge sharing being one of the core missions of the universities, the study shows that this does not emerge strongly within this institution. It was expected that knowledge would flow more freely among members of institution, since knowledge sharing is fundamental to integrate the different disciplines, ideas, and knowledge possessed by the different university's actors (Ramayah et al., 2013).

Table VIII.31 - Descriptive statistics of the results concerning types of knowledge shared within the UA.

Types of knowledge shared	Mean	Median	*SD*
Teaching material (TKS1)	3.83	4	1.08
Knowledge resulting from researches (TKS2)	3.95	4	0.92
Best practices (TKS3)	3.58	4	1.05
Expertise and know-how (TKS4)	3.83	4	0.97

n = 172

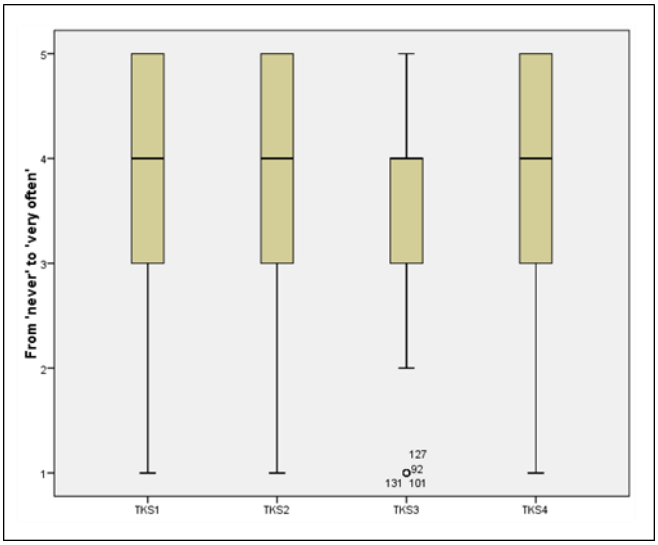

Figure VIII.48 - Boxplots of the results concerning types of knowledge shared.

VIII.3.3 Types of external organizations with which respondents establish collaboration

According to the results presented in Table VIII.32, regarding types of external organizations with which respondents establish collaboration, 'other higher education institutions' (TEO2) and 'research centers' (TEO1), stand out as the main organizations (mean of 3.82 and 3.52, respectively). As can be seen on Figure VIII.49, TEO1 and TEO2 present data with similar median (median=4) and amplitude (amplitude=4) values. On the other hand, the types characterized as non-academic organizations, namely 'industrial organizations' (TEO3) and 'consulting firms' (TEO4), present mean values of 2.49 and 1.91, respectively. TEO3 and TEO4 present data with the 1º quartile of in the lower level of the scale (never use), and the median value of TEO4 (median=1) is

less than all the other types of external collaboration, as can be observed in the Table VIII.32 and Figure VIII.49.

These results may be explained by the fact that, in general, academics give more importance to the participation in basic research than in technological development projects with companies (De Fuentes & Dutrénit, 2012). Additionally, the evaluation criteria of teachers and researchers, even in prestigious universities, do not privilege relations with non-academic communities (Jongbloed, Enders, & Salerno, 2008). However, collaborative relationships with non-academic organizations should be prioritized by teachers and researchers as they provide the opportunity to develop research in a practical setting, to create teaching and learning conditions in real environment, and to obtain funding for research (Vuori & Helander, 2016).

Table VIII.32 - Descriptive statistics of the results concerning types of organizations.

Types of organizations in the external collaboration	Mean	Median	*SD*
Research centers (TEO1)	3.52	4	1.30
Other higher education institutions (TEO2)	3.82	4	1.14
Industrial organizations (TEO3)	2.49	2	1.34
Consulting firms (TEO4)	1.91	1	1.12

n = 172

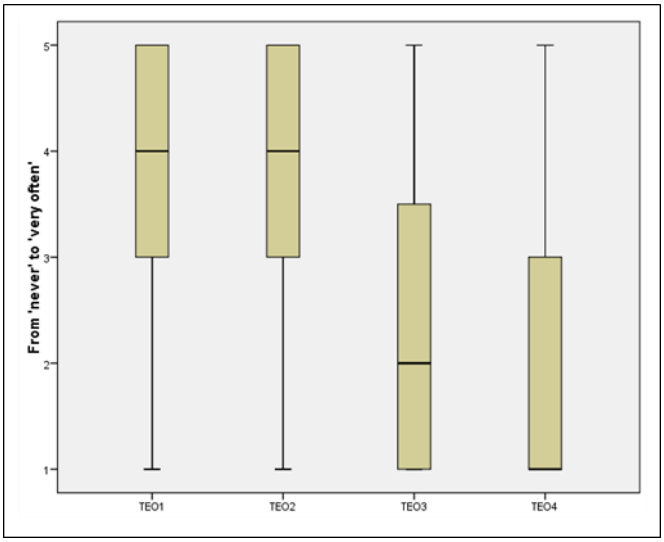

Figure VIII.49 - Boxplots of the results concerning types of organizations.

VIII.3.4 Ways of how external collaboration relationships are established

The results of the study concerning the ways of how external collaboration relationships are established, are presented in Table VIII.33 and Figure VIII.50. They reveal that most of the external collaboration relationships occur in typical academic activities like 'participation and/or organization of conferences' (WEC2) (mean=3.93) and 'guidance and/or supervision of dissertations, internships, and projects' (WEC1) (mean=3.60), as can be seen in Table VIII.33. Despite the different mean values, these typically academic activities present the same median (median=4) and amplitude

values (Figure VIII.50). However, collaborative relationships based on academic activities are generally characterized as a short-term relationship with benefits for only one of the partners (i.e. industry) and a one-way knowledge flow, that is, from university to industry (Dutrénit & Arza, 2010; Franco & Haase, 2015).

Concerning WEC3, WEC4 and WEC5, that correspond, respectively, to ‘networking’, 'projects (R&D, consultancy, contract)’ and ‘training courses’, they present the same median (median=3), and amplitude values. These results seem to be consistent with those reported by Jongbloed et al. (2008), where the traditional model based on technology transfer has been gradually replaced by a model that is more strongly based on collaboration, closer to the partners, and in which networking and consulting contracts are prominent.

In the other hand, although 33% of the respondents are from of the scientific area of 'Exact Sciences and Engineering', currently strongly associated with innovation, 'licenses, patents and trademark registration' (WEC6), 'joint ventures' and/or physical facilities' (WEC7) and 'spin-offs and/or start-ups creations' (WEC8) are referred to as forms of collaboration that are still very little used (median=1). It is important to highlight that in WEC8 there are severe outliers and presented the majority of the answers (77%) corresponded to the lowest level of the scale – ‘never’. These ways of how external collaboration relationships are established present very low mean values, from 1.34 (WEC8) to 1.51 (WEC6). The results obtained are convergent with those reported by Kutvonen et al. (2013) where it is concluded that these forms of collaboration are typically modest activities in European universities and that only a small part of the members of these organizations are involved in entrepreneurship activities.

Finally, the results concerning ‘mobility of employees between organizations’ (WEC9) present a higher mean (mean=2.16) than the previous and a median of 2, which mean that, although the values pointed out are low, the respondents have the perception that the mobility of employees has a higher tendency to occur than, for example, the licenses, patent or trademarks registrations.

Table VIII.33 - Descriptive statistics of the results concerning ways of external collaborations.

Ways of external collaboration	Mean	Median	*SD*
Guidance and/or supervision of dissertations, internships, and projects (WEC1)	3.60	4	1.25
Participation and/or organization of conferences (WEC2)	3.93	4	1.01
Networking (WEC3)	3.16	3	1.30
Projects (R&D, consultancy, contract) (WEC4)	3.27	3	1.33
Training courses (WEC5)	2.58	3	1.24
Licenses, patents and trademark registration (WEC6)	1.51	1	0.86
Joint ventures and/or physical facilities (WEC7)	1.41	1	0.79
Spin-offs and/or start-ups creations (WEC8)	1.34	1	0.73
Mobility of employees between organizations (WEC9)	2.16	2	1.27

n = 172

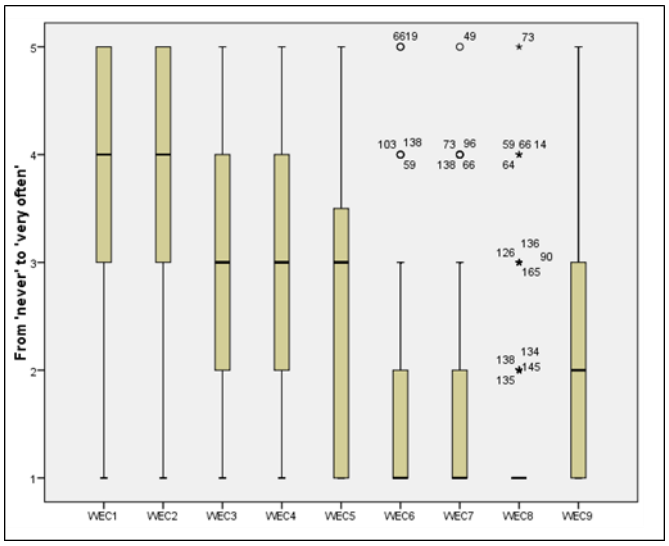

Figure VIII.50 – Boxplots of the results concerning ways of external collaborations.

VIII.4 Conclusions

Based on the results obtained in this study, it can be seen that, in general, the different types of knowledge, more specifically teaching material, knowledge resulting from researches (scientific), best practices, and expertise and know-how are shared among the members of this institution, since the major part of the answers corresponds to the upper part of the scale. The results also show that, in this sharing process, the main means of communication used are personal contacts and e-mail. On the other hand, the least used forms of communication for the same purpose are networking, video conferencing and groupware.

Regarding external collaboration relationships, 'other higher education institutions' and 'research centers' emerge as the organizations with which respondents (teachers and researchers) usually establish external collaboration relationships. Concerning relations with industry organizations and/or consulting firms, the answers showed lower levels of occurrence. It should be noted that, according to the results, external collaboration relationships are established mainly through 'participation and/or organization of conferences', and 'guidance and/or supervision of dissertations, internships and projects'. On the other hand, it was verified that 'licenses, patents and trademark registration', 'joint ventures and/or physical facilities', and 'spin-offs and/or start-ups creations' were referred to as forms of collaboration still very little used.

Currently, universities are under intense pressure, motivated by the knowledge society and the internationalization of institutions, where creativity, innovation and entrepreneurship emerge as essential elements of competition. This pressure, on the other hand, demands a positive attitude toward knowledge sharing from the universities in general, and from their actors, in particular. However, the analysis of the results obtained shows that the actions of knowledge sharing still occur concentrated in the internal environment of the institution. Therefore, it is important to

establish mechanisms that promote and encourage the sharing of knowledge and, consequently, collaborative relationships.

This study provides a contribution for knowledge development concerning knowledge sharing and collaborative behaviour in the university context, more specifically based on empirical results, since this is one of the main gaps in the area, reported in the literature. While this study contributes to this under researched area, limitations are recognized. Since the exploratory nature of the study, and the data collection restricted to one Portuguese university, the conclusions obtained cannot be generalized to other institutions.

Considering the limitation of the study and that the literature review showed that most of studies focused on a single higher education institution or a single country, future researches could extend this study to others higher education institutions, Portuguese and foreign. It would also be interesting to compare results from public and private institutions.

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Chapter IX - Collaboration relationship between software industry and university based on knowledge management: An empirical study in Portugal

Reference

Chedid, M., Carvalho, T., & Teixeira, L. (-). Collaboration relationship between university and software industry based on knowledge management: An empirical study in Portugal. *Journal of Knowledge Management*. (undergoing review).

Collaboration relationship between software industry and university based on knowledge management: An empirical study in Portugal

Abstract

Purpose – The objective of this work is to conduct a study, using qualitative analysis to identify factors that can facilitate a sustainable collaboration relationship based on knowledge management.

Design/methodology/approach – In methodological terms and given the exploratory nature of the study, a qualitative approach using interviews was adopt for the collection of data. A set of interviews was applied to a group of participants from the university and the software industry considered relevant, since they assumed positions with decision-making powers, on the other hand, able to provide the opportunity to obtain different and complementary visions and experiences. The content analysis approach was used for the analysis of the qualitative data obtained through interviews.

Findings – In nutshell, collaboration relationships established among these organizations are set-up only as a 'connection'. Motivations associated with the immediate opportunities or needs of each of those directly involved in the relationship take priority, with only one of the parties usually benefiting from the results. This 'connection' is characterized by being a simple exchange, without building a sustainable collaboration relationship; although, those involved do point out advantages in its existence. This relationship is generally conducted through informal communication channels, which makes it difficult to capture and disseminate knowledge to other members of each of the related organizations.

Originality/value – The literature suggests that this theme is quite relevant and that there is an evident lack of empirical studies that properly investigate factors that can facilitate a sustainable collaboration relationship based on knowledge management.

Keywords

Collaboration relationship; Software industry; Tacit knowledge; Software industry; University-industry

IX.1 Introduction

The software industry plays a fundamental role in today's modern society, because its products can be found in every field and in diverse sectors (Aurum et al., 2008). This fact contributes to the current extremely dynamic and somewhat complex environment that characterizes this type of industry (Huzita et al., 2012), leading companies in the field to suffer the pressure for high performance solutions, rapid development and cost-efficient processes (Vasconcelos et al., 2017).

Given this scenario, and in order for companies to respond to the new challenges, they are forced to search for new partners, with the university-industry collaboration (UIC) relationship representing a fundamental resource in promoting innovation (Lee, 2000) and technological development. In fact, the literature points out several strong advantages for this type of collaboration, including a positive impact on the competitiveness and productivity of the related organizations (Cohen et al., 2002; Freitas et al., 2013).

In this study, the term "university-industry collaboration relationship" is defined as an activity that involves the interaction between teams composed of people from academia (teachers, researchers and students) and company professionals. The objective of this collaboration is to create and share knowledge and technology, with neither party being relegated to a simple case study (Daria & Kostiantyn, 2018; Schubert & Bjør-Andersen, 2012). This collaboration is expected to benefit the related members and teams (teachers, researchers, students and professionals), the organizations that establish the relationship and, consequently, the surrounding society (Boyarchuk et al., 2018). As suggested by Wholin (2013, p. 43), when universities enter into a collaboration relationship with the industry, they should not see it as just a place to study, but rather as a partner to do the study with.

According to Philbin's approach (2008), this type of relationship relies heavily on knowledge sharing, especially tacit knowledge, thus valuing the role that knowledge has in its success and, above all, in its sustainability. Knowledge management provides mechanisms to create, capture, analyze and act on knowledge. This helps to manage the volatility of products and the dynamics that characterize most organizations in these sectors. Having a knowledge base allows university and industry members to see their needs met and thus strive to develop stronger relationships (Daria & Kostiantyn, 2018).

Although the literature suggests that this theme as quite relevant, there is an evident lack of empirical studies that properly investigate the factors that can contribute to the sustainable promotion of this type of collaboration relationship (Feng et al., 2015). Additionally, there are few studies that address knowledge management in collaboration relationships (I.-E. Hansen et al., 2017). The few that do exist, conduct their research while viewing the university as the sole

provider of knowledge and technology (Jongbloed, 2015; Kutvonen et al., 2013; Subramonian & Rasiah, 2016) or focus on individual contributions of knowledge (Gibson et al., 2016).

In order to fill this gap, the present article is based on a case study, using qualitative analysis with a group of actors belonging to the aforementioned industries - University and Software Industry, in order to identify a set of factors that can enhance and/or be the source of a sustainable collaboration relationship based on knowledge management.

In terms of structure, this article is divided into 5 sections. Section 2 presents the theoretical framework, starting with a brief characterization of the studied industries, followed by topics that address the collaboration relationship between the organizations belonging to those industries. Section 3 details the study objectives and presents the methodology used in the research. Section 4 presents the main results of the study, with section 5 being devoted to conclusions and future work.

IX.2 Theoretical background and related work

IX.2.1 About the software industry

The history of software has evolved significantly in the last 30 years and its increasing relevance and criticality is well documented in several studies in the literature (Druffel, 2017). Looking back at the history of software, it can be divided into two important phases: a first phase where software was exclusively associated with technology and, more recently, another phase where emphasis has been put on applications and social changes brought about by software-based innovation processes, with increasingly significant changes in all societal contexts (Campbell-Kelly, 2007). “Modern society is increasingly more dependent on software that offers quality and reliability” (Mead et al., 2016, p. 28), since these represent cross-cutting solutions for diverse products, services and processes that are part of everyday life in society. Currently, software represents a critical building element for the main types of systems (Druffel, 2017) and remains a fundamental resource for their connectivity and interoperability. This leads companies in this industry to rely heavily on the ability to discover opportunities and create innovative products, devices and solutions, so they can succeed in their marketplaces.

To define the software industry, this study uses the broad definition that Lippoldt and Stryszowski have adopted (2009, p. 41): “the software industry includes the traditional ‘software industry’ (i.e. companies or institutions that primarily deal with development of software) as well as parts of other industries that are involved in software development”.

The software industry is characterized as being “high technology, knowledge intensive and highly mutable - with weak entry-barriers and short innovation cycles - which demands continuous adaptation, learning and access to knowledge” (Salavisa et al., 2009, p. 1). The current

technological complexity, resulting from the wide range of economic activities, goods and services, requires extended competences and a constant update in terms of knowledge on the part of work teams; making this aspect one of the most challenging when managing this type of industry (Druffel, 2017). It should be noted that this industry is highly dependent on the availability and access to human resources. As such, one of the biggest challenges that this industry has been facing for some years now is precisely the scarcity of resources with adequate software skills (quantity) and the lack of preparation in critical and emerging areas (quality) (Lippoldt & Stryszowski, 2009). It is believed that by 2020 there will be a shortage of more than 900 thousand professionals in the European Union (EU) (OECD, 2017a).

In Portugal, according to Salavisa et al. (2009, p. 1), the software industry is divided into three segments: (i) multinational affiliates (e.g. Microsoft, and others); (ii) medium and large-sized domestic companies that mainly produce standardized/customized software for business solutions; and (iii) small and medium-sized domestic enterprises that produce specialized software, exploring market niches and taking advantage of specific technological opportunities. However, most of the existing companies in this sector are small and medium-sized enterprises (SMEs), associated with national entrepreneurs with low R&D investment value (OECD, 2017a). Many of these companies have been created in the last decades as start-ups or spin-offs from universities (Salavisa et al., 2009), and a significant portion of these still maintains this link.

IX.2.2 About the university

Initially, it is important to note that the term "university" used in this study refers to an academic community, made up of schools/departments/colleges, research units (RUs) and laboratories and interface units (e.g. technology transfer units).

Universities are complex and heterogeneous organizations (Bozeman & Boardman, 2013), fragmented into different knowledge domains, structured through communities (e.g. pedagogical, scientific, and institutional) with inviolable values of freedom and academic autonomy based on traditions and histories (Sporn, 1996; Tippins, 2003). The various communities assume their own culture with a symbolic context, making it difficult to establish a culture with a rational process of management and strategic vision (Dill, 1982). Currently, the high level of specialization also contributes to the existence of subcultures within their own universities, and their integration into a single institutional culture is a great challenge that universities have been facing for years (Sporn, 1996).

It should also be noted that universities nowadays suffer from the impact: (i) of life cycles associated with technological innovations (Gill, 2002); (ii) of the globalization of the economy and culture; (iii) of the educational needs of an increasingly knowledge-driven society; and (iv) of the training needs for high-performing professional activities (Bruckmann & Carvalho, 2014; Duderstadt, 2001). Solutions to these factors - which constitute major reasons for change in higher education

institutions around the world - may be found in a collaboration relationship with the software industry.

IX.2.3 The university-software industry collaboration relationship

In a rapidly changing scenario with increasingly disruptive innovation processes, the software industry needs more technology-based solutions to ensure its competitiveness (Wohlin et al., 2012). Companies in this industry have generally sought collaborations with universities, in order to have access to specific knowledge, which allows them to complement the skills that they already possess (Ehrismann & Patel, 2015). On the other hand, universities driven by technological progress and social pressure have also sought solutions to some of their problems by establishing collaboration relationships with the software industry (Coccoli et al., 2011). It should be noted, that businesses and universities have faced a common problem related to the lack of professionals in emerging technological fields. This is happening at a time when the paradigm is to migrate to industry 4.0 solutions. This problem is exacerbated by the mismatch/misalignment between the profiles that the market demands and the qualifications that graduates obtain from their university education (Johanyak, 2016; Mead et al., 2016). According to Mead (2016, p. 29), this mismatch is currently "too high, with significant adverse consequences for employers and jobseekers".

Given this scenario, Boyarchuck (2018, p. 667) states that, "successes in this field are impossible without the fruitful collaboration between universities and the software industry." In today's social and economic context, a successfully collaboration relationship is a relevant indicator of the level of innovation of an economy and crucial for all parties involved. For this reason, this indicator has been the subject of analysis and studies in the EU, the USA and other developed countries (Boyarchuk et al., 2018; Melese et al., 2009). It also served as an incentive measure, integrating the policies of governments of industrialized countries (Schuetze, 2000). However, several authors believe that the traditional models of collaboration relationships are not adequate to the dynamics of these types of industries (e.g. Boyarchuk et al., 2018; Mead, 2015). This reinforces the importance of studies based on empirical data, on factors that may be the origin and that sustain a collaboration relationship between these two types of industries. The importance of factors related to new collaboration strategies, with new approaches based on the convergence of technologies, teaching and research, as well as on the increasing importance of knowledge, are also highlighted (Boyarchuk et al., 2018; Garousi et al., 2016).

Although it seems obvious and that the parties involved recognize the need for collaboration, the difference between their individual expectations may make the opportunity for collaboration impossible, and/or even eliminate it completely (Wohlin, 2013). Rodríguez et al. (2014) also point out that one of the challenges of this type of collaboration relationship is that many software industry professionals view academic research as theoretical and of little value in practical applications (product development). On the other hand, researchers often complain that they do not have access to industry data and practical problems needed to develop their applied research

(Rodríguez et al., 2014). A collaboration relationship between these industries can help address these challenges by bridging their interests and converging the expected objectives and benefits. In Ehrismann and Patel's point of view (2015, p. 2), "a clear understanding on common but also diverging interests is the most truthful and realistic negotiation basis"; which may lead to a successful collaboration relationship. The same authors also point out that understanding and respecting one's organizational culture and combining existing intellectual and technological resources to respond to emerging issues can accelerate and improve the quality of their collaboration relationship (Ehrismann & Patel, 2015).

IX.2.4 Knowledge management in the university-software industry collaboration relationship

Given the intensive knowledge nature of these two types of organizations, the collaboration strategy requires the integration of specialized knowledge, often multidisciplinary, and highly specialized, dispersed throughout each member of the work teams (Boyarchuk et al., 2018; Hermans & Castiaux, 2007). I.-E. Hansen et al. (2017) add that it is not enough to simply save the results of collaborative projects, but rather that it is necessary to transform the results into knowledge and make it accessible, in order to be reusable in new and future projects. According to (Hermans & Castiaux, 2007), the knowledge obtained from a collaboration relationship can represent an excellent starting point for new collaborative projects. Gill (2002, p. 263) states that "it is the sharing of a common knowledge base that continuously builds upon local knowledge bases which is at the heart of a collaboration process." These facts, evidenced by the literature, indicate that possible solutions aimed at the sustainability of university-software industry collaboration (USIC) relationships should be explored and evaluated from a knowledge management standpoint (Daria & Kostiantyn, 2018; Philbin, 2008).

However, knowledge management in collaboration relationships lacks empirical studies, since the few existing studies on this topic focus on outcomes or structures of success of the relationship (I.-E. Hansen et al., 2017), on reports of lessons learned (Bjørnson & Dingsøyr, 2008) or, as some authors have pointed out, identify universities as the only providers of knowledge and technology. There is a lack of evidence about the university's role as the recipient of knowledge created by the industry (Bozeman & Boardman, 2013; Jongbloed, 2015; Kutvonen et al., 2013). In addition, the scientific community has paid little attention to the role of knowledge in collaboration relationships and the consequent impact on the promotion of innovation and on society (I.-E. Hansen et al., 2017).

Thus, knowledge management assumes an important role for organizations in delivering the best performing solutions (Tippins, 2003). Particularly in the case of tacit knowledge, its value can ensure a more efficient and effective solution creation process (Bierly et al., 2009), and the ability to manage such knowledge will define the difference between a good and a better performance (Kidwell et al., 2000).

IX.3 Research objectives and methodology

IX.3.1 Research objectives

As mentioned previously, this study aims to identify a set of factors which enhance and facilitate the collaboration relationship between the university and the software industry in a sustainable way, based on knowledge management. In line with the overall goal and taking into account a set of evidences reported in the literature, three specific objectives were defined, composing the three dimensions explored in this study:

a. What are the main motivations that lead to the decision of establishing a collaboration relationship;
b. What are the management mechanisms used in the governance of collaboration relationships;
c. What are the principles and culture of knowledge management and of knowledge sharing in these organizations?

IX.3.2 The data collection instrument

In methodological terms and given the exploratory nature of the study, a qualitative approach using interviews was adopted for the collection of data. The interviews were semi-structured, since it is the most appropriate method for exploring each participants' experience and reconstructing past events (Quivy & Van Campenhoudt, 1998).

In order to conduct the interview, a previously elaborated script was used, and structured according to the specific objectives mentioned above. All the interviews were conducted by the researcher and audio-recorded with the consent of the interviewees. Note that only one interview was not recorded, because it did not have the author's consent. Due to the individual conditions of availability, two interviews were conducted through the *Skype* communication software and the rest of the interviews were carried out at the interviewees' premises.

At a later stage, the interviews were transcribed verbatim and subjected to content analysis at a subsequent stage with the help of the *webQDA* software. It should be noted that the software served only to facilitate the analysis and representation of the results, not in portraying the active role of the researcher in the interpretation of the results (Duriau, Reger, & Pfarrer, 2007).

IX.3.3 The sample

The semi-structured interview was applied to a group of participants considered relevant, since they assumed positions with decision-making powers and, on the other hand, able to provide the opportunity to obtain different and complementary visions and experiences related to collaboration activities.

The chosen university is organized into 16 departments, 4 polytechnic schools and 18 RUs, and is located in the Portuguese central region. Thus, the university sample was composed of professors and researchers responsible for RUs. The criterion for choosing these RUs was related to their involvement in software development activities.

The criterion for the companies belonging to the software industry sample was that they needed to belong to the same region as the university. Company leaders that had, among their activities, some involvement in software development projects, were interviewed.

A sampling procedure appropriate to the objectives of the instrument in question was defined for each of the populations (software industry and university), as detailed in the following subsections.

IX.3.3.1 The software industry sample

For the industry, the non-probabilistic technique called snowball (network or chain) was used. It uses the interviewees' contact network to indicate other contacts that have interesting characteristics to the study (Adams et al., 2007). Figure IX.51 outlines the sampling technique, showing the researcher's first contacts – direct contacts and contacts established during a conference organized by the associative entity of the software industry located in the region –, as well as contacts that emerged from them (network effect).

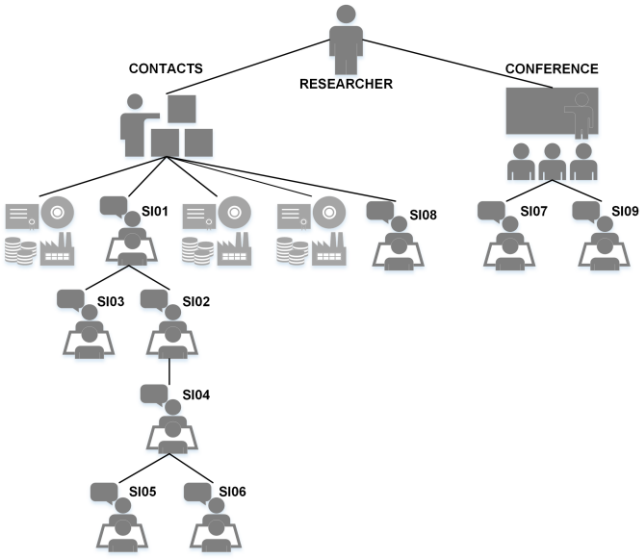

Figure IX.51 – Representation of the snowball sampling technique used in the present study.

The theoretical saturation criterion was used to determine the appropriate end point of the empirical data collection (Guest, Bunce, & Johnson, 2006). Saturation is a conceptual tool used in qualitative investigations, employed to establish the final size of a sample. This criterion is used when no new information is obtained from new interviews. In other words, the data obtained through new interviewees adds little to the information already obtained; it doesn't contribute in a relevant way to

the improvement of the theoretical reasoning (Glaser & Strauss, 2006) nor does it show any marginal improvement (Eisenhardt, 1989).

As can be seen in Figure IX.51, nine interviews were conducted over a period of three months. The point of saturation appeared in the eighth interview, where it was possible to perceive that the interviewees' discourses on the relevant topics did not add new contributions. A final interview (ninth) was carried out, confirming the saturation.

In order to anonymize the results, the interviews were coded, with 'SI01' referring to the first interviewee representing the software industry. Table IX.34 presents the characterization of the respondents belonging to the software industry.

Table IX.34 - Characterization of the respondents belonging to companies related to the software industry.

Interview	Interviewed profile	Type of company*	Company age (years)	Main economic activity	Interview duration (min.)
SI01	Partner	Small	19	Software development	80
SI02	Partner	Small	3	Software development	80
SI03	Partner	Small	7	Software development	105
SI04	Partner	Medium	22	Electronics and telecommunications	75
SI05	Chief Technical Officer	Small	17	Electronics	70
SI06	Partner	Small	11	Energy	30
SI07	Head of Knowledge Management and Exploratory Innovation	Large	23	Telecommunications	60
SI08	Director of Development	Small	25	Electronic security systems	40
SI09	Director of Institutional Relations	Large	12	Software development	40

* According to the European Commission' definition (2015).

IX.3.3.2 The University sample

For the University, a non-probabilistic sample, referred to as purposive, was used, where the participants that composed the sample were intentionally selected according to certain representative criteria for the research objective (Adams et al., 2007). Thus, four RUs that could bring greater contributions to the developing theory were chosen; RUs with an effective participation in the development and/or use of software in their activities.

Five interviews were conducted over two months for the four RUs, which belonged to two different scientific areas. Participants were selected according to their role in the unit (responsible for the unit or per research group). The fact that these interviewees have an active participation in the decision-making processes in these RU makes it possible to classify them as privileged informants for this study.

In order to maintain the anonymity of the interviewees, the interviews are coded similarly to the previous sample, with 'RU01a' referring to the interview with the head of the first RU and interview

'RU01b' referring to the interview with the group leader of the same unit. Table IX.35 presents the characterization of the respondents who belong to the university sample.

Table IX.35 - Characterization of the respondents belonging to the university sample.

Interview	Interviewed profile	Scientific Area	Interview duration (min.)
RU01a	Professor and Coordinator of RU	Science and Engineering	40
RU01b	Professor and Vice-Coordinator of RU	Science and Engineering	40
RU02	Professor and Coordinator of RU	Social and Humanities	40
RU03	Professor and Coordinator of RU	Science and Engineering	70
RU04	Professor and Coordinator of RU	Science and Engineering	70

IX.4 Analysis and discussion of results

The content analysis approach was used for the analysis of the qualitative data obtained through the interviews. The content analysis aimed to broaden the knowledge of the studied context (Bardin, 2002) and to possibly elaborate an explanatory conceptual model. There is no 'ideal' model for the application of content analysis; however, Bardin (2002) stresses that the analysis model must be constructed using the theoretical framework and the objectives of the study as a reference. This implies the active involvement and participation of the researcher.

In this study, the analysis took place over two main phases. In a first phase, the recorded interviews were carefully transcribed. Their repeated reading allowed us to rethink relevant themes and events that indicated responses to the study objectives. Afterward, the unit of registry was defined based on the thematic criterion, which according to Bardin (2002) is used "to study the motives for opinions, attitudes, values, beliefs, leanings, etc.". The selection of the categories emerged from the study objectives and the evidences present in the literature. Thus, two central themes arose: (I) the collaboration relationship between the university and the software industry; and (ii) knowledge management. The *webQDA* software was used in a second phase, in order to help with the systematization process, and the interviewees' responses were categorized and codified. The coding system is considered the 'brain' of a *webQDA* software project and uses the coding tool called 'tree codes' (Souza et al., 2016). With the support of this software, the structure was constructed using 'tree codes', into categories and their respective subcategories, for each of the central themes (Figure IX.52).

After completing the content analysis phases based on the software, all the evidence found was systematized in terms of results. This was done in order to answer the starting questions that were the basis of the objectives of this study. The results are then presented, based on those evidences.

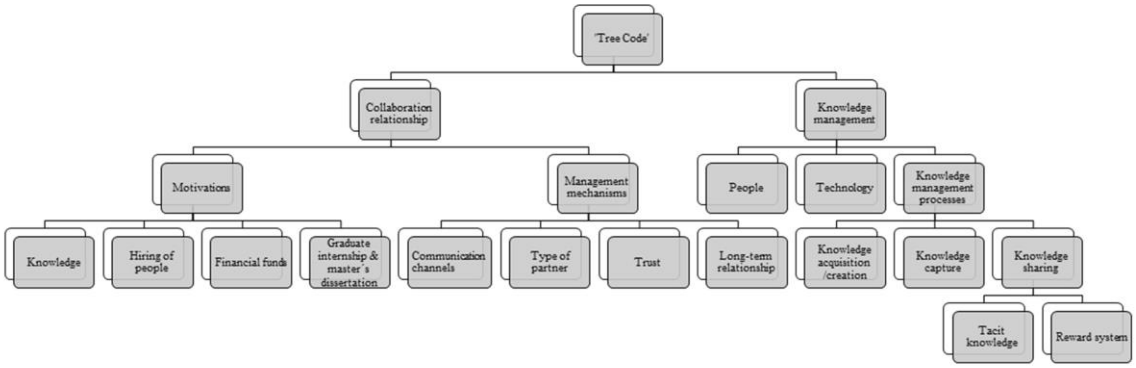

Figure IX.52 – Representation of the 'tree code' structure used in the *webQDA* software in the present study.

IX.4.1 University-software industry collaboration relationship

In this central theme, the following categories were analyzed: (i) **motivations** that underlie the establishment of a USIC relationship; and (ii) **relationship management mechanisms**, which allow for the governance of the relationship.

IX.4.1.1 The main motivations that lead to the decision of establishing a collaboration relationship

In this category, we sought to understand what motivations are identified by the interviewees as essential in making the decision to establish a collaboration relationship.

Motivations can be defined as internal and external factors that may lead to the decision of establishing a collaboration relationship. The literature indicates that the motivations are different between the universities and the industry (Ankrah & AL-Tabbaa, 2015) and play an important role in achieving results (Lee, 2000).

Regarding the motivation category, the main subcategories that emerged from the interviews were: (i) knowledge creation; (ii) hiring of people; (iii) fund raising for project financing; (iv) graduate internships leading to end-of-course projects and/or master's dissertations (Figure IX.53).

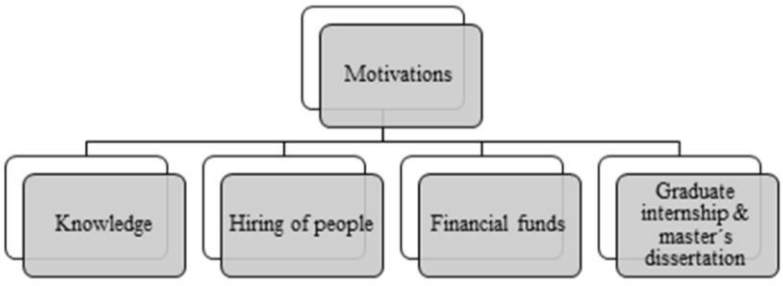

Figure IX.53 – Categories and subcategories that emerged from motivations that lead to the decision of establishing a collaboration relationship.

The '**knowledge creation**' category represents an important aspect of the motivation that leads to the establishment of a collaboration relationship. The difference observed between the university institution and the participating companies is highlighted. The answers obtained from the university show a certain individualistic motivation (i.e. centered on the options of the main protagonists of the process); while in the industry, the creation of knowledge arises naturally due to the need to search for new solutions for its customers (i.e. according to market preferences).

These results are associated with the existence of a more individualistic work culture in higher education institutions, as some studies in this area have revealed. In Portugal, the work of Guellec et al. (2018, p. 25) emphasizes the fact that in universities "teaching, research and innovation activities in individual departments and institutions are, to a large extent, planned and implemented in isolation, without reference to the goals of the institution as a whole". One of the interviewees clearly expresses the existence of this culture when stating that:

> *"(...) we have our own projects (...) the university career is very individualistic, both in terms of people and in terms of projects."* (RU01b)

On the other hand, companies emphasize that the creation of knowledge represents a mission naturally incorporated into the existing work processes, systems and infrastructures. This result corroborates evidences already reported in the literature (Howell & Annansingh, 2013; Tian et al., 2009).

> *"The continuous approach to the needs, difficulties and suggestions of the customers and the constant search for differentiating technologies, allowed for the acquisition of knowledge in various areas of activity."* (SI06)

As the main motivation for establishing a collaboration relationship, the software industry identifies the people dimension; in other words, the possibility of **hiring experts** in the field. The fact that the main motivation of the industry is centered on this factor may perhaps be justified by the increasing difficulty that technology companies have faced when hiring qualified personnel with skills in the technological fields that matches their needs (Guellec et al., 2018). In fact, in this field, the training supply has not been able to keep up with the markets' needs.

> "*We have a shortage of people in this market, especially in software (…) the company has to go to universities to get the best talent (…) so if there's anyone at a university who worked a little bit with software, then we'll go for them."* (SI02)

The university's motivation for seeking a collaboration relationship seems to be rooted in the need imposed by certain programs which lead to the raising of financial funds. This motivation seems to become increasingly more important due to the reduction of resources by the government; a result of the economic situation of recent years (Jongbloed, 2015; Carvalho & Videira, 2019), which has caused major changes in the funding structure of Portuguese universities (Feijó & Tamen, 2017).

> *"We have had good results (...) with projects in conjunction with companies, regarding the 2020 funding programs. The [Portugal] 2020 project strengthens this university-company integration a bit."* (RU04)

Although the main motivation for the industry is based on access to specialists in the field, companies resent the gap between the market needs and the knowledge of recent graduates. For companies, a modernization or update of the curriculum in a way that the needs of the market are met, is a pressing necessity.

> *"(…) all students have jobs, that isn't the issue, but a lot of them are doing things that they have to relearn, because they did not learn it at university."* (SI04)

Some companies with a more proactive stance, have developed actions together with universities in an attempt to fill some of these gaps. In this sense, UIC is an important relationship (Kövesi & Csizmadia, 2016), promoting gains and benefits for both parties. The university has access to practical problems that allow them to conduct and validate their theoretical research – which influences teaching, namely promoting the development of new skills for teachers (Thune & Støren, 2015). The industry can see their problems solved while having access to the knowledge created by the universities and the skills therein.

In fact, the objectives that underlie the establishment of a collaboration relationship in this study have been proven to be distinct; having the purpose of responding to different needs. The university is predominantly interested in research that can later be turned into papers. The industry prioritizes the search for solutions that lead to the rapid development of new products.

> *"(…) partnerships with external entities to universities for the purposes of research (…) what we seek in these partnerships with external entities is essentially concrete problems to which there is justification, a basis for working and developing research and creating new knowledge." (*RU02*)*

> *"(…) we went in search of them [RUs] when we thought we should release something into the market within those fields [health and knowledge management]." (*SI02*)*

While consistent with the premise that being in the same region provides opportunities for collaboration based on teaching and training (Jongbloed et al., 2008), the industry and the university show that they have the same motivation for **internship programs leading to master's projects and/or dissertations**. It should be noted that for the industry, this motivation was not proven to be a priority in the case of doctoral projects.

> *"(...) we have very strong partnerships with companies for the second cycle at the master's level, we are betting (...) on the involvement of companies in the submission of project themes and master's dissertations." (*RU02*)*

> *"(...) when we have a project that may be interesting for some curricular internship or some [master's] dissertation project, we send it to the university and then we select the candidates to work with us. But always for a degree and master's, never a doctorate."* (SI09)

The recent OECD study 'Review of the Tertiary Education, Research and Innovation System in Portugal' (Guellec et al., 2018) indicates a lack of incentives for establishing collaboration relationships with non-academic organizations by the universities. However, the present research indicates that it was possible to observe a certain necessity to work on the third mission; in other words, to be closer to the needs of society and the real problems of the organizations.

This study also reveals differences in timings associated with gains, which in most cases contribute to the establishment of a collaboration relationship, or lack thereof. While companies work with short gain timings, because they are embedded into a very volatile market, universities are working on more time-consuming processes, which are characteristic of the research itself.

> *"(...) what makes us hesitate from contacting universities is that we do not have immediate answers and the research and development process is often something that takes time, which the IT market doesn't have much margin for." (SI09)*

The testimony of one of the interviewees from the industry, with experience in a business incubator and very knowledgeable in the process of technology transfer by universities, suggests that the process' operational model can generally be one of the causes for the rare collaboration between the two organizations.

> *"(...) 'last but not least' the link to universities for very specific and very niche things (...) I think the university can be more useful for specific knowledge" (SI08)*

The interviewee highlights that the success of collaboration relationships by a RU is based on the preparation of an attractive strategy for the industry. Its structure should not only be dedicated to capturing new partners, but mainly focused on maintaining current partners.

> *"(...) any company that is really interested in doing a project in our field will be able to deal with us (...) I have it all already structured for the company (...) the company cannot be led into thinking that we are very different (...) Above all else, we have to realize that the company's speed is not the same as ours."* (RU03)

Another issue pointed out by the companies refers to situations where the development of new products or solutions for clients requires the total or partial confidentiality of the results. One of the main motivations of collaboration for the university is associated with the possibility of publishing the results of the produced knowledge, thus promoting the public disclosure of the obtained data. Therefore, projects where the confidentiality has to be maintained until the product's launch, are often of no interest to the academic community. Jongbloed (2015) points out that this is often a point of tension between academia and industry, where academics resist accepting these conditions.

> *"We mainly focus on papers, because that's what builds our curriculum."* (RU03)

"The objective of universities or university research nowadays is mainly on the production of papers, we have to be realistic (...) the university focuses heavily on publishing a paper and not so much on creating a final product." (SI05)

Table IX.36 summarizes the main results obtained through the interviews related to the motivation category and presented above.

Table IX.36 - Summary of results concerning the motivation category.

	University	Software industry
Main motivation for knowledge acquisition/creation	– Develop of individual projects	– Meet the market and customer needs
Main motivations in the collaboration relationship	– Raising financial resources for research	– Have access to qualified human resources
Difficulties affecting motivation for the collaboration relationship	– Research resulting in the publication of articles	– Get short-term solutions and develop new products
	– The industry does not wish to invest in university research	– Lack of motivation of academics for industrial projects
	– Unlike the timings, the industry looks for solutions ready or short term	– The difference of timings, the lack of immediate answers on the part of the university, the market is volatile and demand short deadlines
	– The requirement by the industry for total or partial confidentiality of results, which delays or prevents publications	– The university's focus on projects that enable the production and publication of papers

IX.4.1.2 Management mechanisms used in the governance of collaboration relationships

The UIC is characterized as a relationship between partners with different organizational and cultural models. This requires special attention to the definition of systematic management procedures, in order to produce results for both parties (Kauppila, Majava, & Kropsu-Vehkaperä, 2016). According to Clauss and Kesting (2017, p. 186), these mechanisms "serve to define mutual objectives, facilitate coordination, and reduce uncertainties and opportunism".

From the management mechanisms category, the subcategories were: (i) communication channels; (ii) type of partner; (iii) trust and; (iv) long-term relationship (Figure IX.54).

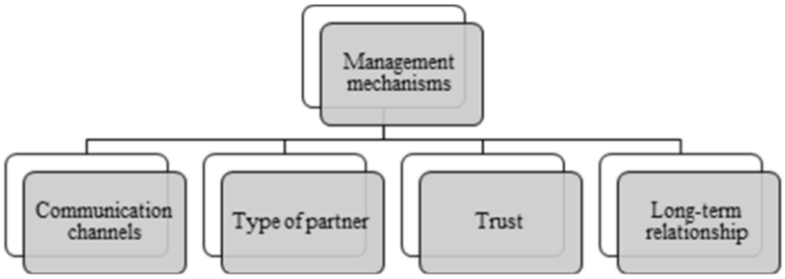

Figure IX.54 - Categories and subcategories that emerged from management mechanisms used in the governance of collaboration relationships.

A collaboration relationship's result is associated with the form of interaction chosen by the parties involved in it (Edmondson et al., 2012). As such, the **communication channels** play an important role in the approach to motivation, which is reflected in the results. Chen et al. (2013) add that choosing effective communication channels also has an impact on the quality of the shared knowledge. However, despite the importance attributed to the communication channel in the literature, in the context of this study, software industry and university are practically unanimous in identifying what they consider to be the best channels. Generally speaking, regardless of motivation, contact occurs through informal channels, using personal contacts derived from past events, more specifically, from former teachers and/or former students.

> *"(…) when I want a project, I call a specific company (…) we know certain companies and we go to them."* (RU03)

> *"[when identifying the best communication channel with the university] I always go to someone I know [at the university]"* (SI08)

When considering the industry interviewees' perspective, it is possible to point out that one of the reasons associated with the high demand for informal channels is due to formal/institutional channels being more time-consuming and highly bureaucratic. Additionally, formal channels often lead to meeting previously unknown partners, and the 'trust' factor emerges as an element to be considered in the collaboration relationship. This means that trust plays a positive role when defining such a relationship (De Fuentes & Dutrénit, 2012; Ehrismann & Patel, 2015).

> *"[when contacting a university] we do it through a friend, because it is an easier and more controlled process. Normally we avoid institutional channels, so as to not run the risk of working with people we do not know"* (SI04)

Several authors emphasize the importance of developing a relationship of **trust** and the fact that it plays a key role in the success of the process (Kuo, 2013; Sherwood et al., 2011). Furthermore, it is common sense to these authors that trust becomes an important issue when the shared knowledge in this type of relationship presents itself in a more tacit, rather than explicit, form. Despite the opinion expressed by several authors regarding the importance of trust, current business models with geographically dispersed companies – which focus on digital communication rather than communicating face-to-face – have been a challenge for the development of trusting relationships.

According to nearly unanimous responses by RUs, the use of informal channels, based on networking, is the most effective means for collaboration relationships. The university's opinion matches that of Edmondson et al. (2012, p. 9), when they suggest that "people determine the success or failure of industry-university partnerships".

> *"Usually they are informal channels based on networks that we accumulate over the years (…) relationships are not institutional (…) Therefore, they are ultimately relationships between people"* (RU01b)

It should be noted that industry interviewees demonstrate a lack of knowledge toward the collaboration relationship interfaces existing in the university. It is assumed that if they exist, they serve to identify groups of competencies within the institutions. On the other hand, RUs report that the use of these interfaces is aimed at responding to specific needs related to certain types of relationships – such as the creation of protocols or the registration of intellectual property. While recognizing the value of these interfaces, they point out the need for a better integrated institutional strategy for more efficient operations.

> *"If not for personal relations, the normal process is not fluid, it is very complex (…) I don't think that the university's official channels are working well"* (SI08)

> *"(...) websites and platforms are fundamental. The idea is good (…) but it is fundamental that it has a more institutional vision (…) an institutional policy to promote this collaboration"* (RU04)

Although the UIC relationship is recognized as positive by both parties, when it comes to identifying their best **partner**, they still seem to be far apart. Both have a preference for partners in the same field, as can be seen in the following transcribed testimonies:

> *"(...) we make [collaboration] agreements with other companies (…) companies are getting together, instead of doing so with the university (…) the university is important when it comes to getting money, getting projects, getting students"* (SI04)

> *"(...) there has been more collaboration with academic institutions and less with companies (...) mainly with other RUs"* (RU01b)

This result is consistent with the recent OECD study 'Review of the Tertiary Education, Research and Innovation System in Portugal' (Guellec et al., 2018) which identifies an insufficient link between the industry and university. According to the results published in the study, the reduced number of co-publications and patents originating from the collaboration between industry and university, highlights the limited extent of collaboration relationships in Portugal.

When the interviewees were questioned about their previous or current collaboration relationships, particularly regarding their management and creation of value, both sides agreed that there is still some work to be done in this area. They also mentioned the lack of evaluation of the result of a collaboration relationship as an aspect that could compromise future relationships. According to (Wilson, 2012), the existence of an evaluation process promotes the opportunity to learn more and identify strengths and weaknesses of each experience. Thus, new measures that allow for the strengthening of the link between industry and university can be proposed.

> *"(...) there is no evaluation after the fact for projects [developed in collaboration] (...) this [the lack of evaluation] can jeopardize future relations (...) It is up to each individual to manage the relationship"* (SI01)

> *"Aside from, for example, the traditional FCT [Foundation for Science and Technology] and [Portugal] 2020 projects, which are required to have follow-up reports (...) the rest have no*

evaluation system. It is up to each of individual to monitor and evaluate the project." (RU01a)

With the study, it was still possible to observe that the industry and the university share the same opinion regarding the importance of a **long-term collaboration relationship** - which is also shared by several authors (Chen et al., 2013; Edmondson et al., 2012; Wohlin, 2013). According to Chen et al. (2013, p. 582), sustainable long-term relationships promote a deep dialog of collaboration, which "constructs a space for joint academic-practitioner knowledge creation, thus solving the knowledge production and transformation problem in management research". Wohlin (2013, p. 44) surmises that, according to his experience, "the most rewarding collaboration for both industry and academia come with a long-term and continuous collaboration".

University and industry are also unanimous in recognizing that long-term relationships require some investment, mainly time and effort, from each party. This opinion is shared by Franco and Hasse (2015, p. 49) when they describe that a UIC relationship "is generally based on the assumption that the benefits are greater than the (social) costs or risks associated with interaction.".

Table IX.37 shows the main results for the collaboration relationship management mechanisms category.

Table IX.37 - Summary of the management mechanisms category results.

	University	Software industry
The most used communication channel	– Informal/networking	– Informal/networking
Motivation for choosing this channel	– More efficient	– Less bureaucratic/more reliable
Collaboration relationship interfaces at university	– Identified the need for an institutional vision	– Does not know or consider that do not work
Habitual partner in relationships	– Other academic institutions	– Other companies
Process for evaluating the results of a relationship	– Applied only to traditional projects (e.g. FCT)	– There is no record of evaluation processes
Degree of importance attributed to long-term relationship	– Important	– Important
Investment effort in long-term relationships	– They require some effort and investment	– They require some effort and investment

IX.4.1.3 Suggestions for promoting and encouraging collaboration relationships

During the interviews, it was also possible to collect some suggestions presented by the industry and the university, in order to promote and encourage collaboration relationships in a more sustainable way.

The main suggestions from the industry are:

a. The promotion of joint discussions on curriculum plans;
b. The promotion of joint discussions on student competencies;

c. Prioritizing the relationship with SMEs;
d. Establishing an event program that allows companies to understand the added value of a collaboration relationship with the university;
e. Creating a space for the discussion of topics that promote greater openness on behalf of the university and reducing the distance between organizations.

Although these suggestions are extremely valid, it is possible to identify a set of obstacles to their implementation in Portugal. Firstly, the proposed discussion to change the curriculum plans is somewhat limited to the evaluations from the Agency for Assessment and Accreditation of Higher Education (A3ES). This seems to be a universal problem for higher education institutions in Portugal, since A3ES has a tendency to favor curricular standardization in universities (Feijó & Tamen, 2017).

Regarding the proposal to give priority to SMEs, it is important to point out that companies of this size often present difficulties in clearly formulating their knowledge needs. They may also lack sufficient resources (financial and human) capable of absorbing academic knowledge, particularly technological issues (L. Fonseca & Cinar, 2017; Jongbloed et al., 2008).

Furthermore, in the past, there were actions to publicize the university, but lacked continuity, as reported by one of the interviewees.

> *"[the university]has made a series of events in the past (...) they involved every departments that developed technology at various levels, not only software, presented these same products or research results, invited companies from the general market to see what they had done up to that date and in what way it could evolve (...) It is an initiative that I think should be repeated. The only problem is that it wasn't."* (SI02)

The main suggestions from the university are related to the need to:

a. Develop an institutional strategy to promote and encourage internal and external collaboration;
b. Promote different theme-based events to demonstrate its competences in various scientific fields to the industry, thus bringing the organizations closer together.

Currently, it is necessary for the university to define an institutional strategy associated with a program that stimulates and encourages its members to collaborate. This is necessary because universities will be required to demonstrate their contribution to the knowledge society and that its education and research system plays an important role in the economy's innovative capacity (L. Fonseca & Cinar, 2017; Jongbloed et al., 2008).

IX.4.2 Culture and principles of knowledge sharing and of knowledge management

Universities and companies in the software industry are recognized as organizations based on intensive knowledge. Considering that teams are multidisciplinary in collaboration relationships, tacit knowledge becomes more important in the relations between these types of organizations (S. Ryan & O'Connor, 2013). Edmondson et al. (2012) add that the true value of collaboration relationships is often associated with the tacit knowledge that is shared. Taking this into account, several authors point to the importance of having adequate knowledge sharing and capture processes. This will allow them to be reused while saving time, effort and cost, with consequent efficiency gains in future projects (Huzita et al., 2012; Wang & Noe, 2010).

The topic of knowledge management aimed to examine and identify the culture and principles of knowledge management and of knowledge sharing present in the university and enterprises belonging to the software industry. The following categories were analyzed: (i) people, (ii) technologies and; (iii) knowledge management processes, and for the last, the following subcategories were examined: (i) knowledge acquisition; (ii) knowledge capture and; (iii) knowledge sharing (Figure IX.55).

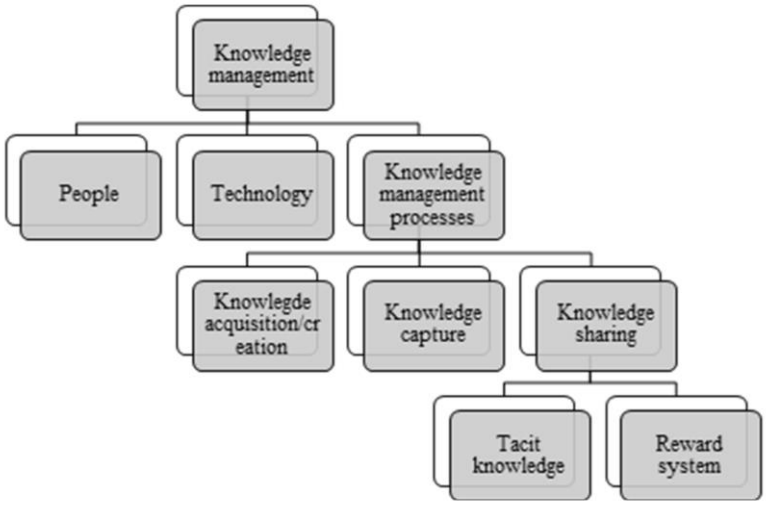

Figure IX.55 - Categories and subcategories that emerged from the culture and principles of knowledge management and of knowledge sharing.

Initially, taking into account that **people** play an important role in knowledge management initiatives, it was possible to observe that university and industry are aware of the relevance of their teams.

On the other hand, **technology** is the instrument by which knowledge is easily made available to the teams, since it offers a technological base that allows capturing, storing and sharing the explicit knowledge. The sharing of tacit knowledge is also facilitated as it provides the necessary means of communication. Industry results point to the existence of some tools that support knowledge management, such as wikis, databases and web applications with support for videos and audio. However, it was noted that these tools are more geared towards project management (e.g. JIRA

software, the FMEA method) or required certifications related to company activities (e.g. ISO 27001, ISO 13485, NP 4457), and not so much for knowledge management across the organization. University results of the study point to the existence of formal mechanisms that are a little more fragile.

> *"there are more procedures than tools [regarding knowledge management systems] (…) typical methodologies of project management"* (SI08)

> *"This is an unresolved flaw that we have (…) the knowledge management system we still lack"* (RU04)

Regarding **knowledge management processes**, namely the **creation and acquisition of knowledge**, as discussed previously in section 'IX.4.1.1, the main motivations that lead to the decision of establishing a collaboration relationship' the answers obtained from the university show a certain individualistic motivation, while the industry's motivation comes from the market.

When it comes to **knowledge sharing** among collaborators, the results indicate that it is a common practice among the studied organizations. There does not seem to be a knowledge sharing problem between the RUs. The process becomes harder and less frequent when involving other areas within the university and outside the RU.

> *"(...) internally, I do not think there are obstacles when knowledge is shared among the people of the organization (...) we could have more methods to guarantee more knowledge sharing (...) I think it becomes much easier to continue with what exists, because those teams have enough turnover."* (SI02)

> *"Sometimes, internally [in the university], the researchers have difficulty, (...) adopting an interdisciplinary attitude, an interdisciplinary thinking (...) we had the possibility and obligation to go much further in these interdisciplinary crossings"* (RU02)

Some authors argue that the implementation of a **rewards system** for individuals and/or teams can motivate and promote knowledge sharing (Inkinen, 2016). When respondents are questioned about the importance of these systems as a motivating factor for knowledge sharing, they are practically unanimous in saying that they do not consider that the reward exerts this type of influence on their teams. In other words, knowledge sharing is self-determined and free from incentives and external rewards.

> *"I think [the reward system] is not a preponderant factor and we don't do it in the company. We do not give any kind of reward, and I'm talking about any kind of booster, monetary or otherwise, no. It does not happen."* (SI09)

> *"No, it isn't stimulating (…) they do it not because they are expecting some reward from a financial or personal level, but because they understand that academic and scientific rewards are interesting enough to get them involved."* (RU02)

It should be noted that both the software industry and universities are knowledge-intensive organizations, where the work is mainly of an intellectual nature and its members hold a large component of **tacit knowledge** (Tzortzaki & Mihiotis, 2014). However, it is possible to verify that the management of this type of knowledge by the organizations belonging to the study requires some attention, so as to be able to take better advantage of its use in future situations.

> *"In the software field, it [tacit knowledge management] is not an easy problem, it is undoubtedly a big problem (…) [aggravated by] the difficulty of recruitment and turnover in the field (…) because the main knowledge, in the software field, is still in people's heads."* (SI08)

> *"There are no records [of tacit knowledge] (…) we are a group of people (…) each professional has a specialty (…) if one goes away (…) [we lose this knowledge] (…) we are not prepared for this."* (RU03)

In conclusion, it should be noted that the parties involved in the study did not have mechanisms to support the management of tacit knowledge, in a situation of loss of their collaborators. As it is not fully recorded, a good part of all tacit knowledge would be lost with the exit of its holders, creating a potential gap in organizational knowledge (Vasconcelos et al., 2017). Liebowitz (2009) had already stated that when an employee leaves the organization, it is not simply the knowledge that they possess that is lost, but also their whole network.

> *"[If my employees decided to leave] (…) this scenario would be very bad for my company and I don't even want to think about it."* (SI09)

> *"[If my collaborators decided to leave] I would also disappear (…) restoring this knowledge becomes quite difficult. We have previously lost some researchers to other universities and this has already caused some hassle."* (RU01a)

Table IX.38 presents the main results for the knowledge management topic.

Table IX.38 - Main results related with culture and the principles of knowledge sharing and knowledge management.

	University	Software industry
People	– Teams are made up of people with a high degree of maturity	– Considering the most important resources
Technologies / systematized processes of knowledge management	– Existence of fragile or non-existent mechanisms	– Existence of typical project management methodologies
Main motivation for knowledge acquisition/creation	– Develop of individual projects	– Meet the market and customer needs
Knowledge sharing among team members	– Without any difficulty, there is some difficulty in interdisciplinary situations	– Without any difficulty
Reward system for sharing knowledge	– Does not practice	– Does not practice
Capture of explicit knowledge	– Does not show any difficulties	– Does not show any difficulties
Capture of tacit knowledge	– Lack of procedures	– Lack of procedures

IX.5 Conclusion, limitations and future work

The purpose of this study was to obtain and analyze the perceptions and experiences of representatives of the software industry and the university, in order to identify a set of factors that could enhance and/or be the source of a sustainable collaboration relationship, based on knowledge management. Starting from this purpose, the following were established as study focuses (specific objectives): (i) the main motivations that lead to the decision of establishing a collaboration relationship; (ii) the management mechanisms used in the governance of collaboration relationships and; (iii) the culture and principles of knowledge management and of knowledge sharing existing in these organizations.

Regarding the first topic, the results indicate that, in general, the main motivation for establishing a collaboration relationship for the industry is associated with the search for new talent. However, the university seems to be focused on obtaining financial funds for its researches. The results also include industry objectives focused on short-term solutions, while the university concentrates on the search for research problems that result in the publication of scientific papers. It should be noted that the difference in timings associated with returns seems to be the main difficulty - negatively impacting the motivation for a relationship.

As for the results related to the mechanisms used in the management of collaboration relationships, these indicate that regardless of the motivation, these relationships are generally conducted through informal communication channels, based on networking. For the industry, the motivation for using this type of channel is associated with the reduced bureaucracy and the trust factor. On the other hand, for university's interviewees, informal communication channels are more effective. It is possible to observe that the interfaces of collaboration relationships existing in the university are practically unknown by the industry. Meanwhile, the members of the university point to a need for a better institutional strategy that promotes these relations. Regarding the identification of their best partners, the results suggest that the university and the software industry are still far apart and that, in general, they relate better to their peers. The university representatives prefer to choose other academic institutions, while industry representatives prefer other companies. It should also be noted that industry and academia have the same positive perception regarding the importance of long-term collaboration relationships, as well as the need for some investment in the relationship, in order to obtain positive results.

This study made it possible to observe the importance and, at the same time, the lack of an evaluation mechanism. Such a mechanism would allow for the proposal of improvements that could make collaboration relationships more sustainable. In this sense, some proposals have been advanced by both sides, to promote and encourage collaboration relationships in a more sustainable way. These highlight the need to create a space that promotes thematic discussions between the university and the industry.

The ‘knowledge management’ dimension results suggest that people are considered as the most important resources in both organizations. Regarding the use of technology and/or systematized processes in knowledge management, the industry reports the existence of typical methodologies for project management; while on the part of the university the existence of these mechanisms may be more fragile or even non-existent. Industry and university share the view that knowledge sharing is not a problem in their respective organizations. As for the capture of explicit knowledge, this process also occurs without difficulties in these organizations. On the other hand, although the university and the software industry are recognized as knowledge-intensive organizations with activities rich in tacit knowledge, it should be noted that the parties involved in the study have demonstrated that they do not have mechanisms to support tacit knowledge management, in a situation of loss of their collaborators.

In nutshell, collaboration relationships established among these organizations are set-up only as a ‘connection’. Motivations associated with the immediate opportunities or needs of each of those directly involved in the relationship take priority, with only one of the parties usually benefiting from the results. This ‘connection’ is characterized by being a simple exchange, without building a sustainable collaboration relationship; although, those involved do point out advantages in its existence. This relationship is generally conducted through informal communication channels, which makes it difficult to capture and disseminate knowledge to other members of each of the related organizations.

Of course, this work is not free of limitations. In addition to the inherent limitations of the qualitative research method and the subjective perceptions of the interviewees, the approach explores only a few, though important, issues of the collaboration relationship between university and software industry. Future work should involve other universities and companies in the software industry, in order to increase the body of knowledge in this area. Identifying other issues that may influence the development of this type of relationship will also be important.

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Chapter X – Discussion, conclusions, and further studies

X.1 Discussion

X.2 Final considerations

X.3 Limitations of the study and further studies

X.1 Discussion

The present thesis had the main purpose of looking for foundations that help to answer the research question "How to leverage the collaboration relationship between university and software industry in a sustainable way, based on knowledge management?". The research process began with the literature review which allowed (i) the development of a theoretical framework in order to improve the understanding of the problem domain, as well as (ii) the knowledge of the best techniques to better grasp the studied phenomenon, thus composing the rigor cycle expected in the methodology used to conduct this research (Figure I.23). The literature review also allowed us to better understand the elements associated with the main research question, enabling them to be deployed in more specific objectives and in the most appropriate research approaches in order to reach these objectives.

Taking into account the main focus of this study and considering that the research process was conducted through a set of scientific works, the first theoretical study explored the main concepts associated with UIC, as well as the main drivers related to this collaboration relationship and responsible for its success - motivation, channel of interaction and outcome and benefits of collaboration. According to Kauppila et al. (2015), the understanding of those concepts allows to mitigate barriers, overcome the differences, create an environment of trust and commitment, and, consequently, achieve mutual benefits and therefore promote the establishment of a long-term relationship. With this study, it was also possible to perceive the key role of the channels for the relationship. In fact, the proper identification and definition of channels of interaction allow that the motivations are properly addressed, with an impact on the outcomes achieved. Even if the motivation is very well outlined, the incorrect identification of the channels will lead to failure in achieving the goals and the failure of the relationship, undermining future actions of the partnership. Considering the differences in culture and in organizational models between the partners involved in the UIC, the study also suggested the establishment of a governance model in order to promote a successful relationship. Finally, still as a result, this study presents a UIC framework based on these three main drivers (Figure II.28).

The following theoretical study allowed to identify the main cultural challenges in the development and implementation of KM processes in the academic context. Knowledge in an academic context is created by different forms and is related to the experience and competence of their actors, namely professors and researchers, without any coordination or management supported by a specific strategy. In this context, Geuna and Muscio (2009, p. 99) add that “the characteristics of individual researchers have a stronger impact than the characteristics of their departments or universities”. In fact, the diversity environment that characterizes the academic institutions propitiates the development of sub-cultures (Howell & Annansingh, 2013), transforming their communities in complex social organizations composed by diverse cultures, and predominating the academic freedom and autonomy (Sporn, 1996), where close control can induce negative reactions

(Starbuck, 1992). The organizational atomization observed in the universities imposes importance in paying attention to a culture that encourages KM and also assigns equal importance to the collaboration and the teamwork (Bjørnson & Dingsøyr, 2008; Howell & Annansingh, 2013). Given the distinctive nature of the culture of academic institutions and their sub-cultures, and in accordance with Benneworth et al. (2016), there is no single model that fits all situations. However, despite the type of approach, depending on the strategy to be defined by the institution, explicit knowledge already has over the years a strong trend of shares and coding actions. A greater effort should be conducted in the sharing of tacit knowledge and in the identification of specific knowledge experts.

After understanding the challenges of KM in the academic context, the following theoretical study aimed to identify the main challenge of knowledge management in the SDO. The current SDO environment is characterized by increased diversity and complexity in software development projects. Due to this environment, software development process involves multidisciplinary teams (Huzita et al., 2012) since a member of a team no longer has all the necessary knowledge (Desouza, 2003a). The several working meetings that occur throughout a project are favorable to generate and share a lot of specialized tacit knowledge. Based on a critical analysis of some evidence present in the literature, it was possible to perceive that KM in context of SDO is extremely complex, somewhat distanced from mainstream of KM (Edwards, 2003) which requires some special attention (Bjørnson & Dingsøyr, 2008). Although most authors (e.g. Ghobadi, 2015; S. Ryan & O'Connor, 2013) have focused on the challenge in knowledge sharing, it was possible to suggest that the main challenge of the SDO is the development of approaches and tools that make the tacit knowledge more explicit as possible (Johnson & Donnelly, 2013). As suggested by Venkitachalam and Busch (2012), the desirable is discuss a way of the use of tacit knowledge consistently and efficiently, so that fosters better results in SDO.

Finally, in order to understand the role of social media in KM, a theoretical scientific work was developed, highlighting the roles of those tools in the development of KM in the organizations. It was very interesting to observe that in the extensive literature the term 'easy' is the most commonly used by different authors in relation to social media (e.g. Avram, 2006; Leonardi, Huysman, & Steinfield, 2013; M. Levy, 2009; von Krogh, 2012), and that social media oriented to KM will require much less of the 'management' component. However, in the author's opinion, the adoption of these tools often requires management actions more intense than in the traditional KM, since the workers are accustomed to using social media in a very spontaneous way and in accordance with their interests. According to Gaál et al. (2015, p. 196), "it is recommended for management to support introducing social media tools, establish the terms and conditions of usage, communicate the benefits and provide the necessary trainings". The review also suggests that while traditional KM systems are static and often act only as repositories of knowledge, social media has the potential to support the different KM processes, impacting organizational culture, encouraging participation, collaboration and knowledge sharing. However, despite its recognized impact on KM processes,

there is still some uncertainty among academics and practitioners associated with the difficulty in understanding and measuring its real impact. This is probably due to the fact that it has not yet been fully exploited, because of its continuous change and variety of platforms.

Based on the understanding resulting from the literature review, it was also possible to identify that universities often play a central role in the UIC relationships, since they "act as creators, intermediators, nodes, facilitators and resources" (Vuori & Helander, 2016, p. 952). However, there is a limited number of studies in the university's context regarding the relationship between knowledge sharing and collaborative behavior among academics (professors and researchers) - especially within Portuguese institutions. Thus, in order to proceed with this research, there was a need to explore and deepen the understanding of this phenomenon in the context of a university that is the object of this study. This approach tried to identify some elements that could help to interpret the answers given to the research questions, through empirical data collected based on questionnaires and interviews.

In a first approach and considering that the knowledge sharing attitude is motivated and executed mainly at the individual level, the individual factors that could affect the attitude toward knowledge sharing among professors and researchers were examined and analyzed. The conceptual research model was developed based on the TRA formulated by Fishbein e Ajzen (1975), and included the motivational factors (intrinsic and extrinsic motivations), and social networks applied by Jolaee et al. (2014) and Soonhee Kim and Lee (2006), as antecedents of the attitude (Figures VI.43 and VI.44). The data was collected using an online self-administered questionnaire and was analyzed based on multiple regression. The results identified that intrinsic motivation and networking positively affect the attitude towards knowledge sharing. However, extrinsic motivation did not significantly affect attitude. These findings were expected, given that members of higher education institutions have inviolable values, like freedom and autonomy (Sporn, 1996) and intrinsic motivation is an activity moved by self-determination and is free of external prods, pressures, or rewards (R. M. Ryan & Deci, 2000). Consequently, consistent with the concept of extrinsic motivation as a controlled motivation, this factor was not considered as one that affects attitude. Social networks were the other factor that affects attitude on this institution. Social networks refer to the extent of individuals' contact with other people. Knowledge is dynamic, and members of higher education institutions are critical actors involved in the creation and dissemination of knowledge. This form of interaction assumes an important role since it is not just an activity related to knowledge sharing but also about the leverage of knowledge (Riege, 2005). Taking into account the characteristics of this institution and their members, the analysis of the findings obtained shows that it is important to establish mechanisms based on intrinsic motivation and social networks, in order to promote and encourage knowledge sharing and, consequently, improve the collaboration relationships.

As the literature suggests that knowledge sharing has an influence in building and boosting collaboration within internal and external relationships (e.g. Tan, 2016; Wu et al., 2014), the previous research model was extended in order to also investigate the relationship between

knowledge sharing and collaborative behavior. In this part of the research, the data analysis was performed using Partial Least Squares. In this work, the TRA model has been adapted to analyze the impact of knowledge sharing on the collaborative behavior, and its application in a higher education institution involving professors and researchers (Figure VII.45).

Based on this analysis, it was possible to confirm the results found and discussed in the previous study, i.e., intrinsic motivation and networking positively affect attitude towards knowledge sharing, while hypothesis of extrinsic motivation was not supported. Additionally, these results showed that professors' and researchers' attitudes affect their knowledge sharing intention. This finding is consistent with the result of Lin (2007), who studied knowledge sharing intentions of 172 employees from 50 large organizations in Taiwan. Bock et al. (2005) also identified in their study that the intention to share knowledge is greater when the attitude towards knowledge sharing is more favorable. 'Organizational support' presented a strong influence on the 'subjective norm' towards the knowledge sharing intention. This result is in line with findings of Jolaee et al. (2014), that tested this hypothesis through a survey of the academic staff of three Social Sciences faculties at one university in Malaysia. However, the results indicated that, in this study, knowledge sharing intention was not affected so strongly by the subjective norm. This result could be explained by the fact that professors and researchers are fully aware of knowledge sharing and its related benefit for themselves, and that they prefer to go through the decision-making process with fewer interventions from colleagues and peer groups when it comes to knowledge sharing intention. This finding is similar to that found in Jolaee et al. (2014). However, it is different from that of Bock et al. (2005), which suggests that subjective norms can influence intentions, especially within groups with strong collectivist orientation like Korean organizations.

In the context of this study, trust was defined as the degree of relying on sharing educational and scientific knowledge with colleagues. The result strongly supported the hypothesis, meaning that trust had a positive effect on the intention of knowledge sharing. This finding is similar to those found in previous studies reported on the literate within HEIs. Tan (2016) conducted a survey in five universities in Malaysia and identified that trust has a significant and positive influence on knowledge sharing, suggesting that HEIs should create and reinforce an environment of trust among their faculty members. The study of Patel and Ragsdell (2011), in two faculties at a British university, also concludes that trust plays an integral part in the knowledge sharing process within organizations. However, current business models with geographically dispersed companies and ongoing partnerships and restructuring actions, as well as the increasing tendency to replace the face-to-face communication by the digital communication constitute a challenge for the development of trust in the relationships. In the opinion of Cook et al. (2005), trust is no longer the central pillar of the social order and may not even be considered very important in most processes of knowledge sharing and collaboration that are managed quite effectively.

Finally, this study identified that knowledge sharing intention has a positive influence on collaborative behavior, being this influence stronger in the case of internal rather than external collaborative behavior (Figure VII.46).

Regarding the knowledge sharing and collaboration practices in this HEI, the empirical results also revealed that, in the knowledge sharing process, the main forms of communication are personal contacts and e-mail. On the other hand, the least used forms of communication for the same purpose are networking, video conferencing and groupware. These results may be supported by different perspectives. Snyder and Lee-Partridge's (2013) identify that the adoption of these means of communication allows direct knowledge sharing only to individuals with whom a relationship of trust is established, which suggest that trust is a facilitator element of knowledge sharing. Conversely, Kim and Ju (2008) report that the frequent use of forms of communication characterized by personal is justified by the lack of information on how and where members of HEI should share their knowledge or who has the need or interest in their knowledge, which suggests the need for a dedicated and appropriate channel for knowledge sharing. The limited use of means of communication based on technological infrastructure does not contribute to richer interactions between the members of the university, reducing the ability to enhance knowledge sharing and collaboration (Chen, Wu, & Wu, 2013; Kane, Labianca, & Borgatti, 2014).

With this study, it was also possible to conclude that professors and researchers are in some way aware of the benefit of knowledge sharing, and in this way, they share part of their knowledge within the institution. However, despite knowledge sharing being one of the core missions of the universities, the study shows that this does not emerge strongly within this institution. It was expected that knowledge would flow more freely among members of the institution since knowledge sharing is fundamental to integrate the different disciplines, ideas, and knowledge possessed by the different university's actors (Ramayah, Yeap, & Ignatius, 2013). Regarding types of external organizations with which respondents establish collaboration, 'other higher education institutions' and 'research centers', stand out as the main organizations. On the other hand, the types characterized as non-academic organizations, namely 'industrial organizations' and 'consulting firms', are less than all the other types of external collaboration. These findings may be explained by the fact that, in general, academics give more importance to participation in fundamental research than in technological development projects with companies (De Fuentes & Dutrénit, 2012). Additionally, the evaluation criteria of professors and researchers, even in prestigious universities, do not privilege relations with non-academic communities (Jongbloed, Enders, & Salerno, 2008). However, collaboration relationships with non-academic organizations should be prioritized by academics as they provide the opportunity to develop research in a practical setting, to create teaching and learning conditions in a real environment, and to obtain funding for research (Vuori & Helander, 2016). Finally, the results of this study concerning the ways of how external collaboration relationships are established reveal that most of the external collaboration relationships occur in typical academic activities like 'participation and/or organization of conferences' and 'guidance and/or supervision of dissertations, internships, and projects'. However, collaboration relationships

based on academic activities are generally characterized as a short-term relationship with benefits for only one of the partners (i.e. industry) and one-way knowledge flow, that is, from university to industry (Dutrénit & Arza, 2010; Franco & Haase, 2015).

In order to analyze the perceptions and experiences of a group of participants considered relevant in the collaboration relationship, an empirical study based on a qualitative approach using semi-structured interview was performed. The objectives of this investigation were to understand (1) the main motivations that lead to the decision of establishing a collaboration relationship; (2) the management mechanisms used in the governance of collaboration relationships and; (3) the culture and principles of knowledge management and of knowledge sharing existing in these organizations.

The results indicate that knowledge creation represents an important aspect of the motivation that leads to the establishment of a collaboration relationship. The difference observed between the university institution and the participating companies are highlighted. The answers obtained from the university show a certain individualistic motivation (i.e. centered on the options of the main protagonists of the process); while in the industry, the creation of knowledge arises naturally due to the need to search for new solutions for its customers (i.e. according to market preferences). These results are probably associated with the existence of more individualistic work culture in HEIs. On the other hand, companies emphasize that the creation of knowledge represents a mission naturally incorporated into the existing work processes, systems and infrastructures. This result corroborates evidence already reported in the literature (Howell & Annansingh, 2013; Tian, Nakamori, & Wierzbicki, 2009).

As the main motivation for establishing a collaboration relationship, the software industry identifies the people dimension; in other words, the possibility of hiring experts in the field. The fact that the main motivation of the industry is centred on this factor may perhaps be justified by the increasing difficulty that technology companies have faced when hiring qualified personnel with skills in the technological fields that matches their needs (Guellec, Larrue, Roy, & Weko, 2018). However, the university seems to be rooted in the need imposed by certain programs which lead to the raising of financial funds. This motivation seems to become increasingly more important due to the reduction of resources by the government; a result of the economic situation of recent years (Carvalho & Videira, 2019; Jongbloed, 2015), which has caused major changes in the funding structure of Portuguese universities (Feijó & Tamen, 2017). The results also include industry objectives focused on short-term solutions, while the university concentrates on the search for research problems that result in the publication of scientific papers. Therefore, projects where the confidentiality must be maintained until the product's launch, are often of no interest to the academic community. Jongbloed (2015) points out that this is often a point of tension between academia and industry, where academics resist accepting these conditions. It should be noted that the difference in timings associated with returns seems to be one of the main difficulties – negatively impacting the motivation for a relationship.

The UIC is characterized as a relationship between partners with different organizational and cultural models. This requires special attention to the definition of systematic management procedures, in order to produce results for both parties (Kauppila, Majava, & Kropsu-Vehkaperä, 2016). According to Clauss and Kesting (2017, p. 186), these mechanisms "serve to define mutual objectives, facilitate coordination, and reduce uncertainties and opportunism".

Despite the importance attributed to the communication channel in the literature, as has already been discussed, software industry and university are practically unanimous in identifying what they consider to be the best channels. Generally speaking, regardless of motivation, the relationships are conducted through informal channels, based on networking derived from past events, more specifically, from former teachers and/or former students. For the industry, the motivation for using this type of channel is due to formal/institutional channels being more time-consuming and highly bureaucratic. Additionally, formal channels often lead to meeting previously unknown partners, and the trust factor emerges as an element to be considered in the collaboration relationship. This means that trust plays a positive role when defining such a relationship (Ehrismann & Patel, 2015). On the other hand, for the university´s interviewees, informal channels are more effective. The university's opinion matches that of Edmondson et al. (2012, p. 9) when they suggest that "people determine the success or failure of industry-university partnerships". It is also possible to observe that the interfaces of collaboration relationships existing in the university are practically unknown by the industry. Meanwhile, the members of the university point to a need for a better institutional strategy that promotes these relations.

Regarding the identification of their best partners, the results suggest that the university and the software industry are still far apart and that, in general, they relate better to their peers. The university representatives prefer to choose other academic institutions, while industry representatives prefer other companies. It should also be noted that industry and academia have the same positive perception regarding the importance of long-term collaboration relationships, as well as the need for some investment in the relationship, in order to obtain positive results. Sustainable long-term relationships promote a deep dialog of collaboration, which "constructs a space for joint academic-practitioner knowledge creation, thus solving the knowledge production and transformation problem in management research" (Chen et al., 2013, p. 582) and "create a symbiotic relationship that support the competitive advantage of the organizations involved (Calvo, Fernández-López, & Rodeiro-Pazos, 2019, p. 1).

This study also showed the importance of the existence of evaluation mechanisms in a collaboration relationship and, at the same time, revealed the lack of such mechanisms. The existence of an evaluation process promotes the opportunity to learn more and identify strengths and weaknesses of each experience (Wilson, 2012) that could make collaboration relationships more sustainable. In this sense, some proposals have been advanced by both sides, to promote and encourage collaboration relationships in a more sustainable way.

In the knowledge management dimension, the results suggest that people are considered as the most important resources in both organizations. Regarding the use of technology and/or systematized processes in knowledge management, the industry reports the existence of typical methodologies for project management; while on the part of the university the existence of these mechanisms may be more fragile or even non-existent. Industry and university share the view that knowledge sharing is not a problem in their respective organizations. As for the capture of explicit knowledge, this process also occurs without difficulties in these organizations. On the other hand, although the university and the software industry are recognized as knowledge-intensive organizations with activities rich in tacit knowledge (Tzortzaki & Mihiotis, 2014), it should be noted that the parties involved in the study have demonstrated that they do not have mechanisms to support tacit knowledge management, in a situation of loss of their collaborators. As it is not fully recorded, a good part of all tacit knowledge would be lost with the exit of its holders, creating a potential gap in organizational knowledge (Vasconcelos et al., 2017). Liebowitz (2009) had already stated that when an employee leaves the organization, it is not simply the knowledge that they possess that is lost, but also their whole network.

X.2 Final Considerations

The changes in the software industry have been ever more rapid and more substantial. Toward that scenario, it is possible to suppose that the collaboration relationship between university and software industry will become increasingly important for both organizations.

As discussed in the present thesis, university-software industry collaboration relationship offers numerous benefits for both parties. As a result of this mutually beneficial relationship, software industry firms can achieve solutions for most of their problems, since university offers firms a wide knowledge base of different scientific domains (pedagogical and scientific), specialists (teachers and researchers), training, etc. On the other hand, the university can get involved with specialized professionals and the real world of this industry, which can help its research and educational processes. These potential benefits reinforce the importance and the need to encourage and structure such collaboration.

The research findings of the present research have confirmed that knowledge sharing positively affect collaboration behavior. It was also evident from the analysis that professors and researchers have an important role in the collaboration relationships with industry, and that they prioritize the intrinsic motivation. With the findings of the present research, it is also possible to observe that some kinds of the collaboration relationships established between the university and software industry are set-up only as a ‘connection’. Motivations associated with the immediate opportunities or needs of each of those directly involved in the relationship take priority, with only one of the parties usually benefiting from the results. This ‘connection’ is characterized by being a simple exchange, without building a sustainable collaboration relationship; although, those involved do

point out advantages in its existence. This relationship is generally conducted through informal communication channels, which makes it difficult to capture and disseminate knowledge to other members of each of the related organizations. In addition to that, the university and software industry miss some opportunities to leverage existing relationships. A more structured and less individual approach can expand opportunities for intra and inter-organizational collaboration relationships.

In order to leverage the collaboration relationships between this university and the software industry in a sustainable way, based on the key findings and the body of knowledge resulting from this thesis, it is possible to suggest the following recommendations for its sustainability:

The university needs a **clearly formulated strategy to engage with industry**, something suggested by interviewees from the university: develop an institutional strategy to promote and encourage internal and external collaboration. This institutional strategy should play a leading role in defining the focus areas for collaboration, designing formats, selecting partners, evaluating collaborations, and continually managing the interactions between the university and the industry. This strategy should also establish an institutional channel providing relevant communication between university and industry and creating a collaboration environment in a holistic way. However, this institutional strategy should also consider the importance of the informal channel. Once most collaboration relationships are initiated and established through already established contacts. These contacts are often personal formed in university or through educational and/or professional networks or previous collaboration. This institutional channel can help overcome some issues addressed in the research:

- better alignment of expectations and understanding of partners;
- developing mutual trust and common motivation to collaborate;
- reducing the distance between organizations and bringing them closer together;
- allowing both organizations to understand the added value of a collaboration relationship;
- reducing the time-consuming and bureaucracy of channel formal/institutional.

The results of this study also highlighted the importance of providing **incentive and supporting structures that encourage collaborations with industry**. It became apparent from the qualitative study that existing platforms have been under-utilized or are unknown for both academics and industries. Paradoxically, the incentive for university-software industry collaboration relationship should not come from direct support measures. Although clearly needed and that may help to enhance collaboration, as previously proven in this research, the real incentive comes from the intrinsic motivation of each academic. Social media have the potential for supporting different knowledge management processes and encouraging on participation, knowledge sharing and collaboration. Social media may also help in creating a platform where academics and practitioners can network work together.

The results point to the importance of providing a **dedicated and appropriate strategy for knowledge sharing**. Since the increase of knowledge is one of the principal focus of knowledge intensive organizations, such as the university and software industry, knowledge sharing can be viewed as a primary process. Additionally, this research showed the relationship between knowledge sharing and collaboration relationship. Despite the results shown that the respondents from the university agree that the institution provides appropriated technologies and mechanisms to support knowledge sharing, a set of personal means of communication is the most widely used. On the other hand, the set of means based on technological infrastructure has a lower level of utilization. Knowledge sharing does not emerge strongly within this institution, except for knowledge resulting from researches, probably reflecting the requirement of publications, since it is the main factor of academic evaluation. However, the possibilities to influence academics are limited and difficult, decisions heavily depend on individual attitudes and intrinsic motivation of academics. This situation does not contribute to richer interactions, reducing the ability to enhance knowledge sharing and collaboration.

The results also identified, on both the university and on the software industry, a lack of **systematic approach for capturing the full potential of collaboration relationship**. A more systematic and less individualistic approach allows organizations to capture and to enhance opportunities that can derive from collaboration relationships. In this regard, the university should create and build up a collaboration relationship knowledge base. The existence of a knowledge base, among other aspects, will enable:

- the relationship moves towards a stable, long-term, mutually beneficial partnership, thanks to the lessons learned in previous collaboration and their utilization in the subsequent ones;
- the record of successful collaboration relationships with industry can provide resources to motivate internal university academics to work together on a project that might not otherwise be possible;
- the implementation of a whole-of-university engagement strategy;
- the capture and dissemination of shared knowledge during the several interactions of groups of work to other members of each of the related organizations;
- the establishment of a competence portfolio based on situations of business practices.

Figure X.56 summarizes the main results and considerations that emerged from this exploratory study that characterizes this research project. In this framework it is possible to observe not only the results that have highlighted throughout this research process, but also the main factors that seem to contribute to leverage the collaboration relationship between university and software industry in a sustainable way, based on knowledge management.

This work contributes to the identification of relevant facts related to the university-software industry collaboration relationship. The results obtained can support the institution's management in the strategies definition and development of future actions, in order to promote an organizational culture based on knowledge management that significantly leads to sustainable knowledge sharing and collaboration relationships.

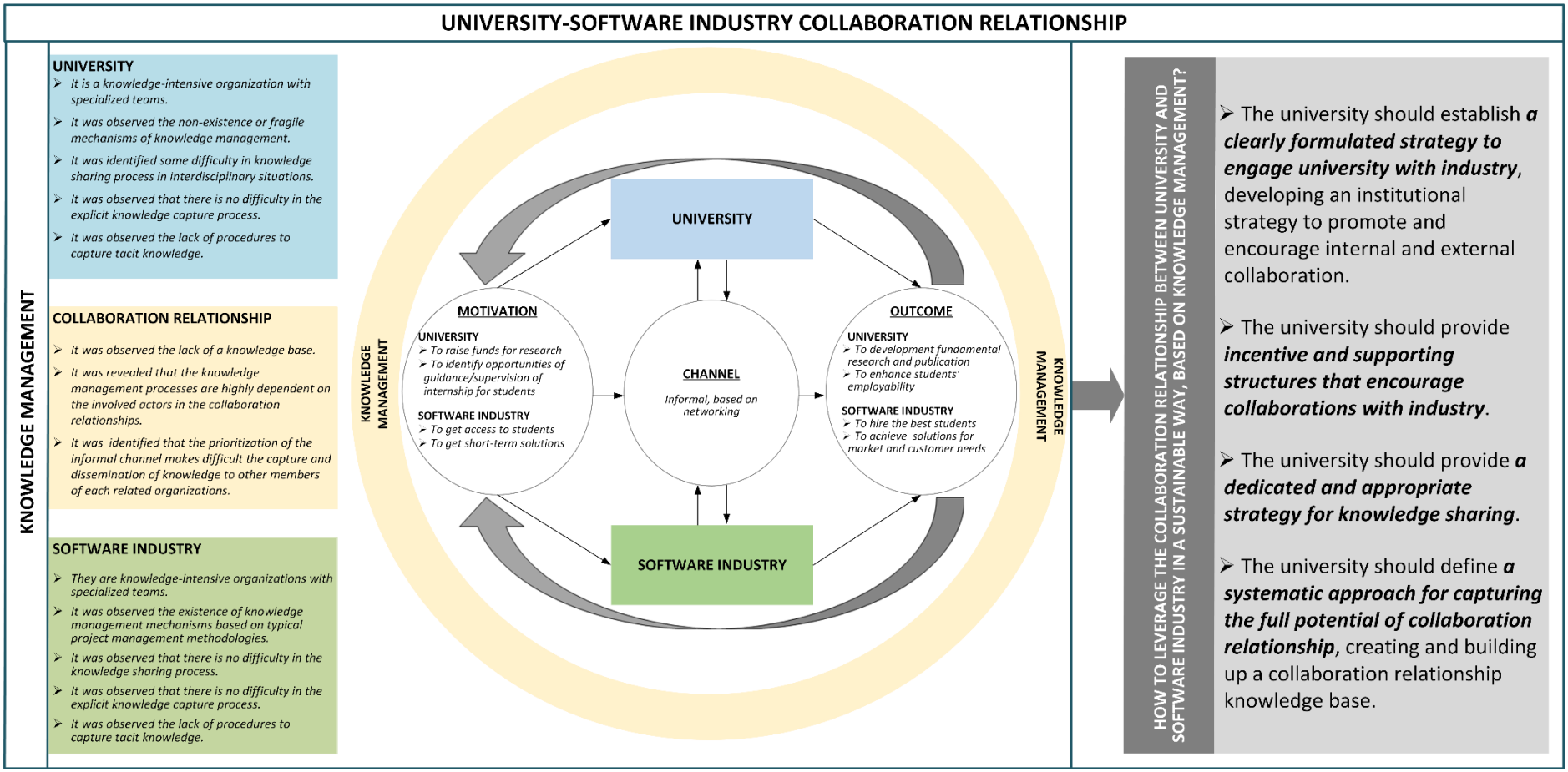

Figure X.56 - Framework of the university-software industry collaboration: state of the art and considerations about how to leverage this type of relationship.

X.3 Limitations of the study and further studies

Although this study has important contributions, it is not exempt from limitations. Given the exploratory nature of the study and the fact that data collection is restricted to one Portuguese university, the conclusions obtained cannot be generalized to other higher education institutions. Future researches could extend this study to other higher education institutions, Portuguese and foreign. Further, it would be also interesting to compare results from public and private institutions.

Concerning the collaboration between university and software industry, in addition to the inherent limitations of the qualitative research method and the subjective perceptions of the interviewees, the approach explores only a few, though important, issues of this collaboration relationship. Future work should involve other universities and companies in the software industry, in order to increase the body of knowledge in this area. Identifying other issues that may influence the development of this type of relationship will also be important.

Given the exploratory character of this thesis, several observations have come light which can be identified as further areas to research. Some directions of further studies could be associated with the need to understand better the university-industry collaboration relationships.

- Given that knowledge sharing has a positive influence in collaboration behavior, it would be interesting to study which mechanisms based on the intrinsic motivation and the networking should be established in the university in order to promote and encourage knowledge sharing.

- Although the university-industry collaboration being a relationship between organizations with fundamental differences in their characteristics, generally, the studies emphasize the impact of the university on the industry. Future studies are needed to examine the contributions and impacts of this relationship on each partner.

- Universities are complex organizations with diversity and conflicts. The major part of the studies in university-industry collaboration relationships has treated university as a single unit. The development of a systematic model of procedures of governance and management from a holistic perspective is essential for capturing the full potential of such relationships.

- In the course of this research, it was possible to identify one research unit which created organizational a parallel structure in order to facilitate communication and collaboration with industry. This research unit has achieved very successful and effective collaboration relationships. It would be interesting to understand better this solution.

- It seems to be a consensus among authors that capture and sharing of knowledge may become easier with social media use. In this sense, it would also be important to understand what type of technologies could help in creating a platform for interactions between university and industry.

The limitations of the work presented here may shorten future research lines that, in a reasoned way, may deepen the analysis of the issues raised in this exploratory study and thus help to identify causes of problems, guiding factors and solutions to establish a sustainable collaborative relationship.

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Appendix I - Questionnaire

Appendix I.1 – Questionnaire 'Knowledge sharing in the context of the academic-scientific community'

Este estudo enquadra-se no âmbito de uma tese do Programa Doutoral em Engenharia e Gestão Industrial da Universidade de Aveiro (UA) que aborda o tema da Colaboração entre Indústria de Software e Universidade. O objetivo particular deste questionário é o de recolher informação por forma a compreender a cultura da partilha do conhecimento no contexto da comunidade académico-científica na UA.
Para o efeito são considerados o conhecimento pedagógico e o conhecimento científico, nas suas variantes de formal e informal, bem como na forma tácita e explícita.
O questionário é anónimo e pretende-se conhecer a opinião dos inquiridos, não sendo, portanto, as respostas consideradas certas ou erradas. Estima-se que a resposta não demore mais do que 15 minutos.
Agradece-se, desde já, a sua colaboração na realização deste estudo.

PART I

I. PERFIL DEMOGRÁFICO

1. Género
   - ☐ Masculino
   - ☐ Feminino
2. Idade
   - ☐ < 30 anos
   - ☐ 30-40
   - ☐ 41-50
   - ☐ 51-60
   - ☐ > 60 anos
3. Grau Académico (mais recente)
   - ☐ Agregação
   - ☐ Doutoramento
   - ☐ Mestrado
   - ☐ Licenciatura
   - ☐ Outro: especificar _____
4. Categoria Profissional
   - ☐ Professor(a) Catedrático(a)
   - ☐ Professor(a) Catedrático(a) Convidado(a)
   - ☐ Professor(a) Associado(a) c/ Agregação
   - ☐ Professor(a) Associado(a)
   - ☐ Professor(a) Associado(a) Convidado(a)
   - ☐ Professor(a) Auxiliar c/ Agregação
   - ☐ Professor(a) Auxiliar
   - ☐ Professor(a) Auxiliar Convidado(a)
   - ☐ Assistente
   - ☐ Assistente Convidado(a)
   - ☐ Investigador(a)
   - ☐ Outro: especificar _____
5. Regime de dedicação
   - ☐ Tempo integral
   - ☐ Tempo parcial
6. Departamento
   - ☐ * Combobox com Departamentos e Escolas da UA
7. Área de atuação na instituição
   - ☐ Ciências da Vida e da Saúde
   - ☐ Ciências Naturais e do Ambiente
   - ☐ Ciências Exatas e da Engenharia
   - ☐ Ciências Sociais e Humanidades
8. Número de anos de trabalho na atual instituição
   - ☐ < 1
   - ☐ 1-5
   - ☐ 6-10
   - ☐ 11-20
   - ☐ > 20
9. Número de anos de experiência na docência
   - ☐ < 1
   - ☐ 1-5
   - ☐ 6-10
   - ☐ 11-20
   - ☐ > 20
10. Número de anos de experiência em investigação
    - ☐ < 1
    - ☐ 1-5
    - ☐ 6-10
    - ☐ 11-20
    - ☐ > 20
11. Indique o número médio de conferências científicas em que participa anualmente
    - ☐ 0
    - ☐ 1-3
    - ☐ 4-6
    - ☐ 7-10
    - ☐ 11-20
    - ☐ 21-30
    - ☐ > 30
12. Indique o número médio de artigos científicos que publica anualmente
    - ☐ 0
    - ☐ 1-3
    - ☐ 4-6
    - ☐ 7-10
    - ☐ 11-20
    - ☐ 21-30
    - ☐ > 30

PART II

Por favor, indique o seu grau de concordância relativamente às questões seguintes, utilizando a escala de 1 a 5, em que 1 corresponde a "não concordo nada" e 5 a "concordo totalmente". Os valores 2, 3 e 4 correspondem a posições intermédias e NS/NR corresponde a "não sei/não respondo".	1	2	3	4	5	NS/NR
1. Estou disposto(a) a partilhar conhecimento porque gosto de ajudar os meus colegas						
2. Considero que a partilha do meu conhecimento pode ajudar na resolução de problemas de colegas						
3. Considero que a partilha do meu conhecimento pode criar novas oportunidades para a minha instituição						
4. Considero que a partilha do meu conhecimento pode ajudar a melhorar o desempenho da minha instituição						
5. Estou disposto(a) a partilhar conhecimento porque pode potenciar o aumento da minha reputação						
6. Considero que a partilha do meu conhecimento faz com que os meus colegas conheçam melhor as minhas competências						
7. Considero que a minha instituição reconhece/valoriza quem partilha conhecimento						
8. Considero que a minha instituição disponibiliza aos seus membros um sistema justo de avaliação/recompensa no que se refere à partilha do conhecimento						
9. Considero que a partilha do conhecimento tem reflexo direto na progressão na carreira						
10. Interajo frequentemente com colegas da instituição na partilha de conhecimento académico						
11. Mantenho um bom *networking* com pessoas de outras organizações no contexto da partilha de conhecimento						
12. Comunico com outros membros da minha instituição através de contactos informais (e.g. conversas informais) no contexto da partilha de conhecimento						
13. Participo ativamente em comunidades de prática (grupos de pessoas que partilham conhecimento num contexto social de interação)						
14. Partilhar conhecimento com os meus colegas de instituição é importante para mim						
15. A partilha de conhecimento com os meus colegas de instituição é uma experiência que me agrada						
16. Considero que a partilha de material pedagógico entre colegas permite economizar tempo						
17. Considero que a partilha de conhecimento e de experiência potencia a criação de novo conhecimento						
18. A minha instituição disponibiliza tecnologias apropriadas para apoiar a partilha do conhecimento (p. ex.: portal académico, site, e-mail)						
19. A minha instituição tem mecanismos apropriados para a partilha do conhecimento (p. ex.: reuniões, encontros académicos)						
20. A minha instituição apoia e incentiva a criação de mecanismos informais para a partilha do conhecimento (p. ex.: comunidades de prática, encontros temáticos abertos à comunidade)						
21. Sinto que, considerando a cultura da minha instituição, eu devo partilhar o meu conhecimento						
22. As pessoas que influenciam o meu comportamento (p. ex.: colegas, amigos) entendem que eu devo partilhar o meu conhecimento						
23. As pessoas que são importantes para mim (p. ex.: colegas, amigos) entendem que eu devo partilhar o meu conhecimento						
24. As pessoas cuja opinião eu valorizo (p. ex.: colegas, amigos) entendem que eu devo partilhar o meu conhecimento						
25. No que se refere ao ensino, prefiro trabalhar em grupo do que trabalhar sozinho						
26. No que se refere à investigação, prefiro trabalhar em grupo do que trabalhar sozinho						
27. Sinto que existe falta de informação sobre as atividades de investigação desenvolvidas pelos colegas da minha instituição						
28. Sinto que existe vontade de colaboração entre membros da minha instituição (p. ex.: de diferentes departamentos ou unidades de investigação)						
29. Sinto-me envolvido em atividades de colaboração com outras instituições de ensino superior (p. ex.: orientações, arguições, projetos)						
30. Considero que as relações de colaboração com outras instituições de ensino superior promovem a partilha de conhecimento e o reconhecimento do meu trabalho						
31. A minha instituição promove e reconhece as relações de colaboração com outras instituições de ensino superior						

32. Considero que obtenho maior reconhecimento ao partilhar conhecimento com outras instituições de ensino superior do que dentro da minha instituição							
33. Sinto-me envolvido em atividades de colaboração com organizações não académicas (p. ex.: consultoria, prestação de serviços, projetos)							
34. Considero que as relações de colaboração com organizações não académicas promovem a partilha de conhecimento e o reconhecimento do meu trabalho							
35. A minha instituição promove e reconhece as relações de colaboração com organizações não académicas							
36. Considero que obtenho maior reconhecimento ao partilhar conhecimento com organizações não académicas do que dentro da minha instituição							
Para as questões que se seguem tenha em conta a vertente pedagógica (p. ex.: conteúdos, materiais, conhecimento pedagógico)							
37. Não me importo de partilhar os meus materiais pedagógicos com os colegas da instituição							
38. Quando me deparo com dificuldades no ensino, solicito ajuda aos meus colegas de instituição							
39. Acredito que partilhando conhecimento com os meus colegas, eles irão responder de igual maneira							
40. No futuro tenciono partilhar o conhecimento tácito e a experiência adquirida na lecionação com os meus colegas de instituição							
41. No futuro tenciono partilhar os materiais pedagógicos elaborados por mim com os meus colegas de instituição							
42. No futuro tenciono partilhar o conhecimento tácito e a experiência adquirida na lecionação com colegas de outras instituições							
43. No futuro tenciono partilhar os materiais pedagógicos elaborados por mim com colegas de outras instituições							
44. No futuro tenciono participar em ações do tipo discussões de grupo, *workshops* e comunidades de prática para partilhar conhecimento							
Para as questões que se seguem tenha em conta a vertente científica (p. ex.: *papers*, comunicações, conhecimento científico)							
45. Não me importo de dar a conhecer os resultados da minha investigação aos meus colegas de instituição, antes de os publicar							
46. Quando me deparo com dificuldades na investigação, solicito ajuda aos meus colegas de instituição							
47. Acredito que partilhando conhecimento resultante da minha investigação com os meus colegas, eles irão responder de igual maneira							
48. No futuro tenciono partilhar o conhecimento e a experiência adquirida na investigação com os meus colegas de instituição							
49. No futuro tenciono partilhar o conhecimento e a experiência adquirida na investigação com colegas de outras instituições							

PART III

Por favor, indique a frequência com que considera ocorrerem as situações referidas nas questões seguintes, utilizando a escala de 1 a 5, em que 1 corresponde a "nunca" e 5 a "muito frequentemente". Os valores 2, 3 e 4 correspondem a posições intermédias.					
Na minha instituição, utilizo as seguintes formas de comunicação:	1	2	3	4	5
1. Contactos pessoais					
2. Telefonemas					
3. Reuniões presenciais					
4. Envio de *e-mails*					
5. Groupware (*software* colaborativo de apoio ao trabalho em grupo)					
6. Redes sociais					
7. Videoconferências					
8. Ferramentas de *e-Learning*					
Partilho os seguintes tipos de conhecimento com os membros da minha instituição	1	2	3	4	5
1. Material pedagógico (p. ex.: manuais e conteúdos)					
2. Material resultante de investigações (p. ex.: metodologias, modelos, artigos e comunicações)					
3. Melhores práticas					
4. Experiência e *know-how*					
Estabeleço relações de colaboração externa com os seguintes tipos de organizações	1	2	3	4	5
1. Centros de investigação públicos ou privados					
2. Outras universidades					
3. Organizações industriais (produção de bens e fornecimento de serviços)					
4. Empresas de consultoria					
Estabeleço relações de colaboração externa através das seguintes formas:	1	2	3	4	5
1. Orientação e/ou supervisão de teses, dissertações, estágios ou projetos					
2. Conferências (organização e/ou participação)					
3. Networking					
4. Projetos (I&D, consultoria, prestação de serviços)					
5. Cursos de Formação					
6. Licenças, patentes e registo de marcas					
7. *Joint ventures* e/ou partilha de instalações físicas					
8. Criação de *spin-offs* e/ou *start-ups*					
9. Mobilidade de colaboradores entre organizações					

Appendix I.2 – Survey evaluation sheet

Ficha de avaliação do inquérito

Esta ficha tem por objetivo fornecer elementos para a reformulação (se necessário) do questionário.

---

1. Quanto tempo demorou a preencher o questionário _____ minutos.
2. Quais as perguntas cujo preenchimento lhe suscitou maiores dificuldades?
   _____
3. Achou alguma questão pouco esclarecedora? ☐ sim ☐ não

Se respondeu sim à pergunta anterior, indique qual ou quais, e porquê?

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

Pergunta_____ Porquê? _____

4. As instruções eram claras? ☐ sim ☐ não
5. Na sua opinião foi omitido algum tópico importante? ☐ sim ☐ não

   Quais? _____
6. Considerou o formato do questionário adequado? ☐ sim ☐ não
7. Alguma sugestão ou comentário?

_____
_____
_____
_____
_____
_____

Muito obrigado pela sua colaboração

Marcello Chedid – e-mail mchedid@ua.pt

Appendix II - Semi-structured interview

Appendix II.1 – Interview guides

II.1.1 Software industry

Guião de entrevista com unidades de investigação da universidade	
MOTIVAÇÃO	
1.	Quais os principais fatores que contribuíram para que a sua empresa possua o atual nível de conhecimento e know-how?
2.	Como a sua empresa normalmente procura obter ideias para melhoria e desenvolvimento de novos projetos / produtos? A sua empresa tem por norma estabelecer relações de colaboração? Com que tipo de Organização?
3.	Particularmente no caso das Universidades, acha que estas podem contribuir, através de uma relação de colaboração, para o crescimento da sua empresa? Na sua opinião, quais são as razões que levam as partes a estabelecer uma relação de colaboração?
4.	Alguma vez a sua empresa esteve envolvida numa relação de colaboração com alguma Universidade? Se sim, fale um pouco dessa experiência. Quem buscou essa relação, a empresa ou a universidade? Se não, alguma vez já tentou estabelecer esse tipo de relação, ou foi abordado por alguma Universidade? Por que motivo não houve continuidade?
5.	Na sua opinião, quais são os principais benefícios e contrapartidas dessa relação?
6.	No futuro a sua empresa pretende manter ou estabelecer esse tipo de relação? Pretende continuar a ter esse tipo de relação? Porquê?
GESTÃO DESSA RELAÇÃO	
1.	Qual(is) os principais canais de comunicação utilizados pela sua empresa nesse tipo de relação (conferências, *networking*, projetos, formação, licenças e patentes, *spin-offs* e/ou *star-ups*, mobilidade de pessoal?
2.	Em função das motivações da sua empresa, como é identificado o melhor canal de comunicação na Universidade, a quem/que normalmente recorre para o primeiro contacto? (antigos professores, o senhor é ex-aluno da universidade, os seus colaboradores são ex-alunos da universidade?)
3.	Na sua opinião, como acha que uma relação de colaboração entre a sua empresa e a Universidade deveria ser gerida por forma a maximizar a criação de valor?
4.	Acha que as relações de colaboração de longo prazo exigem um maior esforço de investimento e de gestão? Porquê?
GESTÃO DO CONHECIMENTO / PARTILHA DO CONHECIMENTO	
1.	Como descreveria a cultura da partilha do conhecimento na sua empresa? Existe alguma dificuldade nessa partilha? Sente alguma dificuldade na partilha do conhecimento entre os seus colaboradores?
2.	Na sua opinião, os esquemas de recompensa estimulam a partilha de conhecimento?
3.	Os eventos que ocorrem entre os diversos grupos de trabalho promovem a partilha de experiências e *know-how* (conhecimento tácito). A sua empresa utiliza algum tipo de mecanismo ou ferramenta tecnológica para registo desses eventos?
4.	Na sua opinião, as ferramentas de média social (web, wikis, blogs, social network, etc.) podem facilitar os processos da gestão do conhecimento? A sua empresa costuma utilizar alguma dessas ferramentas com esse objetivo?
5.	Na sua opinião, qual é o papel que os registos formais de conhecimento e do conhecimento partilhado informalmente exercem no desenvolvimento de novas soluções?
6.	Vamos imaginar que por alguma razão, todos os colaboradores da sua empresa desaparecessem. Como seria a transmissão do conhecimento que a empresa possui para os novos colaboradores?

II.1.2 University

Guião de entrevista com unidades de investigação da universidade
MOTIVAÇÃO
1. Como a sua unidade normalmente procura obter ideias para o desenvolvimento de novos projetos? A sua unidade tem por norma estabelecer relações de colaboração? Com que tipo de organização?
2. Particularmente no caso das empresas desenvolvedoras de software, acha que estas podem contribuir, através de uma relação de colaboração, com a sua unidade e os seus investigadores?
3. Alguma vez a sua unidade esteve envolvida numa relação de colaboração com empresa de desenvolvimento de software? Se sim, fale um pouco dessa experiência. Quem buscou essa relação, a unidade ou a empresa? Se não, alguma vez já tentou estabelecer esse tipo de relação, ou foi abordado por alguma empresa? Por que motivo não houve continuidade?
4. Na sua opinião, quais são os principais benefícios e contrapartidas desse tipo de relação?
5. No futuro a sua unidade pretende manter ou estabelecer esse tipo de relação? Pretende continuar a ter esse tipo de relação? Porquê?
GESTÃO DESSA RELAÇÃO
1. Qual(is) os principais canais de comunicação (conferências, *networking*, projetos, formação, licenças e patentes, *spin-offs* e/ou *star-ups*, mobilidade de pessoal) utilizados pela sua unidade nesse tipo de relação para identificar o melhor parceiro?
2. Como as empresas interessadas em uma relação de colaboração chegam até a sua unidade?
3. Na sua opinião, como acha que uma relação de colaboração entre a sua instituição e a empresa de software deveria ser gerida por forma a maximizar a criação de valor?
4. Na sua opinião, acha que as relações de colaboração de longo prazo exigem maior esforço de investimento e de gestão? Porquê?
GESTÃO DO CONHECIMENTO / PARTILHA DO CONHECIMENTO
1. Como descreveria a cultura da partilha do conhecimento na sua unidade? Existe alguma dificuldade nessa partilha? E como descreveria essa cultura na sua instituição?
2. Na sua opinião, os esquemas de recompensa estimulam a partilha do conhecimento?
3. Os eventos que ocorrem entre os diversos grupos de trabalho promovem a partilha de experiências e *know-how* (conhecimento tácito). A sua unidade utiliza mecanismos/ferramentas tecnológicas para registo desses eventos?
4. Na sua opinião, as ferramentas de média social (web, wikis, blogs, social network, etc.) podem facilitar os processos da gestão do conhecimento? A sua unidade costuma utilizar alguma dessas ferramentas com esse objetivo?
5. Na sua opinião, qual é o papel que o conhecimento partilhado na relação de colaboração, de maneira formal e informal, desempenha no desenvolvimento de novas soluções?
6. Vamos imaginar que por alguma razão, todos os colaboradores da sua unidade desaparecessem. Como seria a transmissão do conhecimento que a unidade possui para os novos colaboradores?

Appendix II.2 – Interview protocol

Protocolo de Entrevista

Esta investigação, enquadrada no âmbito do Doutoramento em Engenharia e Gestão Industrial, a decorrer na Universidade de Aveiro, tem por objetivo investigar e identificar os fatores que possam potenciar a relação de colaboração entre a empresa desenvolvedora de software e a universidade, de forma a ser possível a proposição de um modelo de relação de colaboração sustentável, através de mecanismos de gestão de conhecimento.

Considerando o carácter qualitativo desta fase da investigação, optamos pela realização de entrevista semiestruturada, como técnica de recolha de dados, para a qual agradecemos a sua colaboração e disponibilidade. As questões são colocadas de uma maneira simples, direta e aberta, garantindo um diálogo construtivo que permita a recolha de perceções, opiniões e experiências dos (as) entrevistados(as).

Como é habitual, neste tipo de investigação, será garantido o anonimato da organização assim como dos(as) entrevistados(as), assegurando-se que os dados obtidos serão tratados com confidencialidade e serão exclusivamente usados para efeitos desta investigação, podendo ser publicados na íntegra ou em pequenos excertos. O registo da entrevista será efetuado pelo investigador, com recurso a áudio-gravação, após a permissão dos(as) entrevistados(as). Depois da realização da entrevista a mesma será transcrita e sujeita a validação e aprovação por parte dos(as) entrevistados(as).

Aveiro,

O investigador

O entrevistado

_____

_____

Marcello Chedid
E-mail: mchedid@ua.pt
Contato: 96XXXXXXX

Appendix II.3 – Interview characterization

Caracterização da entrevista

Esta entrevista insere-se no estudo, no âmbito do Doutoramento em Engenharia e Gestão Industrial da Universidade de Aveiro, que aborda o tema "Colaboração entre Indústria de Software e Universidade", e tem por objetivo investigar e identificar os fatores que possam potenciar a relação de colaboração entre a empresa desenvolvedora de software e a universidade, de forma a ser possível a proposição de um modelo de relação de colaboração sustentável, através de mecanismos de gestão de conhecimento.

Obrigado pela colaboração!

<table>
<tr><td>Código da entrevista:</td><td>Data da entrevista:</td></tr>
<tr><td>Horário de início:</td><td>Horário de término:</td></tr>
<tr><td colspan="2">Função do(a) entrevistado(a):</td></tr>
<tr><td>Formação académica:</td><td>Tempo de serviço nesta empresa:</td></tr>
<tr><td>Data de criação da empresa:</td><td>CAE da atividade principal:</td></tr>
<tr><td>Número de empregados:</td><td>Percentagem da atividade de desenvolvimento de software nas atividades da empresa:</td></tr>
<tr><td colspan="2">Outras atividades:
☐ Consultoria ☐ Hardware
☐ Investigação e desenvolvimento ☐ Serviços de instalação e suporte</td></tr>
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