A CONCEPTUAL AND EMPIRICAL APPROACH FROM KNOWLEDGE ORGANIZATION AND MANAGEMENT TO THE ANALYSIS OF THE UNIVERSITY INDUSTRY RELATIONSHIPS

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Abstract: The aim of this paper is to overcome the inability of present-day econometric models to identify the most efficient modes and mechanisms of transmitting knowledge from the academic world to industry. To do so, it incorporates knowledge-based theories (a combination of concepts from Knowledge organization, knowledge management and knowledge's Ontology disciplines), into the analysis of the relationships between the academic and business sectors. First, we address the concepts of tacit, explicit and incorporated knowledge as units of analysis in these relationships, linking them to sources of knowledge. Some activities are identified in relation to these sources which increase and feed back knowledge to said sources by five basic processes: the acquisition, combination, creation, utilization and dissemination of knowledge. These processes are measured quantitatively by applying a knowledge management model to produce performance indicators.

The results obtained stem from an empirical study conducted in 2005 in Mexico on the basis of the proposed model. Suggest that the knowledge-based approach applied to academic-industry relationships is feasible and that the methodology employed makes it possible to determine which sources of knowledge, lecturers and institutions carry out most knowledge acquisition, creation and utilization activities vis-à-vis the business sector.

KEYWORDS: management, organization, sources, knowledge, acquisition, creation, utilization, performance, relationships, university, industry.

JEL CLASSIFICATION: D83, M15

1. Antecedents.

The effects caused by the accumulation of knowledge in the academic sector have been studied from different viewpoints (Agrawal, 2001). Interaction and relationships with academic bodies in order to use said knowledge is, at present, a relevant activity for any social, economic or political agent (Etzkowitz, 1998). However, this approach has been criticised by certain schools of thought (Cooke, 2005).

At the individual level, relationships with academic bodies are born of the need to endorse one's knowledge. The most basic accreditations, such as diplomas, are a gateway to the competitive labour market whilst post-graduate diplomas are deemed to facilitate professional advancement (Acemoglu, 2002).

Against this backdrop of competence, but at the organisational level and in a market of products and services, a variety of studies [Acs et al. (2002) in the U.S.A., Blind & Grupp (1999) in Germany, and Rondé & Hussler (2005) in France, etc.] have confirmed that relationships with the academic sector are also more frequent in industries and territories producing technology-based products and services, with a high degree of such relationships being observed in regions clearly committed to a specific industrial sector (Anselin et al., 2000; García, 2001).

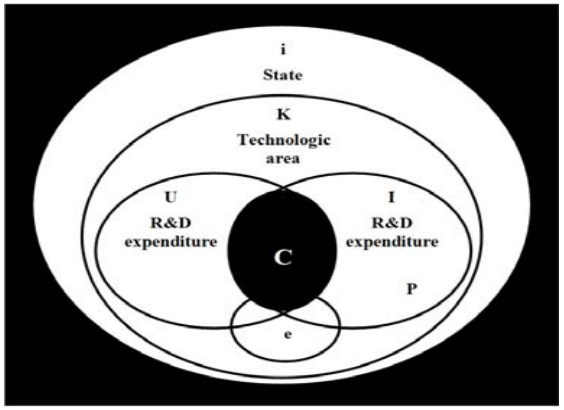
However, several studies conducted in the 1990s point out that academic-industry relationships focusing on technological innovation were more relevant to small than large companies, regardless of whether they were in regions specialising in a specific industry or not. See, for example, the cases in Italy from 1978-1986 analysed by Piergiovanni et al., (1997), in the U.S.A. from 1972-1981 analysed by Acs et al. (1994), and in Spain from 1996–2000 analysed by Del Barrio & García (2005).

Moreover, since the early 1980s, academic-industry relationships in industrialised countries have become genuine channels for the transmission of knowledge that have been used by both the academic sector on the supply side and the business sector on the demand side, adopting a wide range of complex ways for the basic transfer of knowledge and the activation of innovation (Rosenberg and Nelson, 1994; Saxenian, 1994; Cooke and Leydesdorff, 2006; Golob, 2006; Gunasekara, 2006).

The complexity of the forms of knowledge channels (or means see: Andersen, 2002) in academic-industry relationships is a challenge to econometric models when attempting to determine their effectiveness. This is because they usually lack the variables able to identify the modes and mechanisms that may exist in any given case of academic-industry relations (Acs, et al., 1991; Breschi & Lissoni, 2001).

One classic model now, which attempted to demonstrate the importance of academic R&D in the innovative results of companies based in the university's environment, is Jaffe's knowledge production function (1989)[1] in which the analysis unit is the state (i in Fig. 1)[2], and several technological areas (K in Fig. 1). In these areas, attempts were made to determine the correlation between the development of industrial patents (P in Fig. 1), and academic and industrial research (U/I in Fig. 1). The main aim of this model is to determine whether knowledge has a local component (C in Fig. 1).

Figure 1: Griliches-Jaffe Conceptual Model.



Source: based on Griliches (1979) and Jaffe (1989)

[1] This function is based on Griliches's proposal framework (1979), into which Jaffe (1989) incorporated several new variables in the analysis of the university-industry relationships case (see Acs et al., 1991, for comments about the advisability of introducing these variables).

[2] The Griliches-Jaffe formula is:
$log(P_{ikt}) = \beta_{1k}\, log(I_{ikt}) + \beta_{2k}\, log(U_{ikt}) + \beta_{3k}\, [log(U_{ikt})\, log(C_{ikt})] + e_{ikt}$, where P is the number of corporate patents, I is private-sector R&D expenditure. U is the research expenditure of universities. C is a measure of the similar geographical location of universities and research corporations within a State, and e represents random error. The observation unit is the State level, i. In Jafferian terms, k represents the "technological area" or industrial sector, and t, the time index (see Griliches, 1979; Jaffe, 1989).

This strategy made it possible to evaluate academic research in a regional or local framework in successive studies (Acs et al., 2002; Blind & Grupp, 1999; Rondé & Hussler, 2005). However, it shifts analysis away from detecting modes and mechanisms in academic-industry relationships (c in Fig. 1), taking more dynamic advantage of new, financially useful knowledge that can be created between these two sectors.

The disadvantage of econometric models like Jaffe's, which try to measure the impact of academic knowledge by the number of patents per region, is that patents cannot be deemed to be the only measure of innovation. This is because not all innovations are patented and not all patents have any economic impact (Pakes & Griliches, 1980, p. 378; Acs et al., 1991, p. 363). The main problem of these models is that it is difficult to draw the line between academic knowledge and industrial knowledge because the structures established for academic-industry relationships are both closely related and superimposed.

A start-up company or a spin-off with an academic base, for example, may be inside a business incubator, which is part of a science, or technology park, which may, in turn, be related to a consortium. In such interwoven relationships, it is not clear where the dividing line between the academic sector and the business sector lies and to whom a given patent should really be attributed.

It is difficult to structure the knowledge and understanding of the relationship phenomena that have been implemented and can now be seen in these relationships. The crucial problem of econometric indicators, however, arises when a university, an industrial sector, a government or region attempts to translate these indicators into policies.

In the case of industrialised nations, the results obtained by the Griliches-Jaffe knowledge production function, based on patents per region, may be similar to reality. In developing countries, as in the case of Mexico (Casas et al., 2000), however (where the number of patents is sometimes non-existent), the knowledge production function can hardly be applied (Acs, et al., 1991, p. 363).

In this context the following questions arise:

How can the transfer of knowledge from the academic sector to the business sector be measured without using R&D expenditure data or a significant patent ratio?

Is it necessary to consider patents or R&D expenditure to enable academic sectors to transfer knowledge to the business sector?

These questions are the basic cause of the constant renewal of thinking about academic-industry relationships, which can be classified into five core areas: the historical approach, the organizational, territorial, economic approaches and the knowledge-based approach. (See table 1).

Approach	Historical	Organizational	Territorial	Economical	Knowledge
Objectives	"Evolution of the relationships between university and industry until now"	"Modes of the relationship university-industry"	"Characterization of the support agents of the relationships university-industry"	"Performance Results of the between university and industry"	"Performance Results of the relationships between university and industry"
Type of Information	States of Art	Studies of Case	Studies of Case	Quantitative Studies	Qualitative Studies
Authors	M. A.	Brodsky, et al., 1980. Allen, et al., 1989. Saxenian, 1994. etc.	Etzkowitz, 1990; 1994. Nelson,1993., etc.	Griliches, 1979. Jaffe, 1989. Acs, et al. 1991; 1994; 2002. Anselin, et al., 1997. etc.	Kogut & Zander, 1992. Anselin, et al., 2000; Breschi, & Lissoni, 2001. Chakrabarti, & Santero, 2004. Rondé & Hussler, 2005, etc.
Indicators				R&D Expenditure. Number of patents. Measurement of economically useful Knowledge Technological change	Absorption Capacity Intellectual Capital

Table 1: **A synthesis of approaches to the analysis of academic-industry relationships.**

To date, however, the econometric approach has made the most relevant contribution on the relevance of academic-industry relationships in an industrialised society. Examples include the field of patent development (Henderson et al., 1998), regional technological development (Coe & Helpman, 1995), economic development (Temple, 1999), and the accumulation of territorial intellectual capital (Chakrabarti & Santoro, 2004; Rondé & Hussler, 2005), etc. Econometric indicators are essential in order to understand the impact of academic-industry relationships on all these aspects, although the distance between such indicators and

the day-to-day activities of knowledge managers[1] is still too great to turn them into policies or strategies.

For that reason, the latest approach to the analysis of the academic-industry relations, based on knowledge theories, constitutes a promising field of study since, this research, offers a new information dimension providing a rich amount of data for the design and establishment of public policies.

The knowledge focus has developed multiple theories based on three basic perspectives: knowledge management, knowledge organization and knowledge ontology.

Knowledge management undertakes the study of the use of knowledge in an organization, considering it a resource than must be managed in order to reach the organization objectives (see Penrose, 1959; Polanyi, 1966; Barney, 1991; Brown & Duguid, 1991; Kogut & Zander, 1992; Nonaka, 1994).

Knowledge organization analyses how an organization classifies the knowledge elements in accordance with a structure that absorbs it from the society and from the means that this society utilises to disseminate it (see Eisenstein, 1979; Ong, 1982; Bolter, 1991; Meyrowitz, 1994; Finnemann, 1999; Goody, 1987, 2000; Andersen, 2002; Hjørland, 2003)

Finally, Knowledge Ontology challenges the knowledge prospect, its reason of being, its states, categories and constituent elements, and this always analysed under a philosophical, entrepreneurial or even academic-pedagogical paradigm (see Nonaka & Takeuchi, 1995; Spender & Grant, 1996; Garud, 1997; Matusik & Hill, 1998; Porter & Sölvell, 1998; Andreu & Sieber, 1999; Sullivan, 2000; Hjørland, 2003)

Considering the theoretical progress of these perspectives, we believe they can be applied, with a relative success, to the analysis of the knowledge transfer modes and mechanisms, which are established in the academic- industry relationships.

Subsequently, and in order to clarify matters, we must point out that, in this paper, the term academic sector is used in reference to

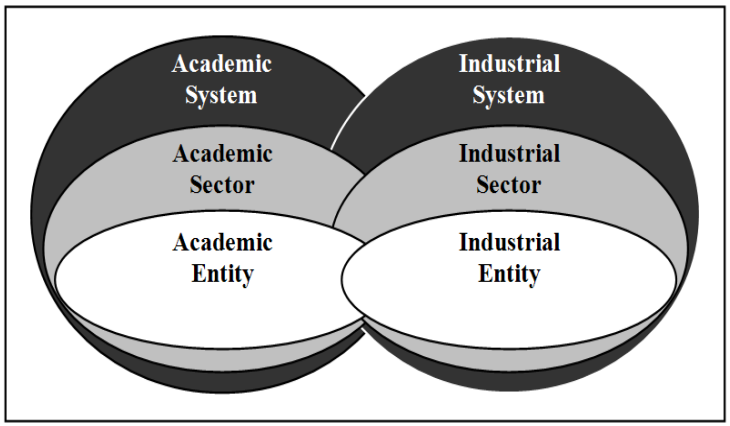
[1] Or "*Knowledge workers"* as Drucker denominated them (1959) in "*Landmarks of Tomorrow.*" Harper & Brothers. New York.

the teaching and research community in higher education and in technology R&D centres with different legal structures, regardless of the surrounding institutional or social structures. This, since the terms university, higher education institutions, research bodies, research centres, academic societies, research groups etc, whether public, private or mixed, are sometimes dissimilar terms that do not encompass each other.

Generally speaking, business sector refers to the productive agents in the fields of agriculture, industry, commerce and services, of a public, private or mixed nature, with which the academic sector has some sort of knowledge exchange. These conceptual elements create the concept of relationships between the academic sector and the business sector, in an attempt to embrace a wider and more complex area of relationships than can be conveyed by the term university-industry relationship.

As a result, the term academic-industry relationships, under study in this paper, focuses on the relationships between academic and business communities regardless of the organisational structures they are associated with. In this case, different analysis levels arise from this concept, as shown in Fig. 2:

Figure 2: Analytical level's of academic-industry relationships.



The foregoing is relevant when analysing the phenomenon of academic-industry relationships, since the inferences made about them may not apply to all levels of relationships, nor to all the sectors that may be involved in such relationships, particularly as already demonstrated by several of the authors mentioned above.

2. Paper objectives. Base model assumptions.

The goal of this paper is demonstrating the feasibility of analysing academic-industry relationships by means of a knowledge management model based on theories originated in the firm context as well as in the library and information science (LIS) research community, taking the following considerations into account.

First, it is considered that both companies (Barney, 1991) and universities are made up of human resources, which deal with common knowledge management processes.

Second, this knowledge may take different forms such as tacit, explicit and incorporated (Nonaka & Takeuchi, 1991, 1995; Nonaka, 1994; Nonaka and Toyama, 2000; Polanyi, 1966, Dasgupta & David, 1992; Callon, 1994.) The transformation of one form into another requires different sensorial and intellectual processes: acquisition or capture, combination, creation, and utilization (a and b in Fig. 3). These sources operate upon the internal and external knowledge sources, which human resources have access to. Therefore, in addition to transforming knowledge, these sources can be perceived as receiving feedback and increasing their stock.

Third, the growth and feedback of these sources, takes place in accordance with the means and resources available in the society. In this sense, Andersen (2002) synthesizes the history of knowledge transmission socio-cultural means and, consequently, she proposes a taxonomy of four basic socio-cultures: oral, writing, printing and computer/ Internet based-societies. This is based on the approach based on resources or means theory developed by Meyrowitz (1994), who outlines that the socio-cultures, utilise these same means or resources in order to accumulate, classify and disseminate knowledge, in the shape of a "cultural inheritance".

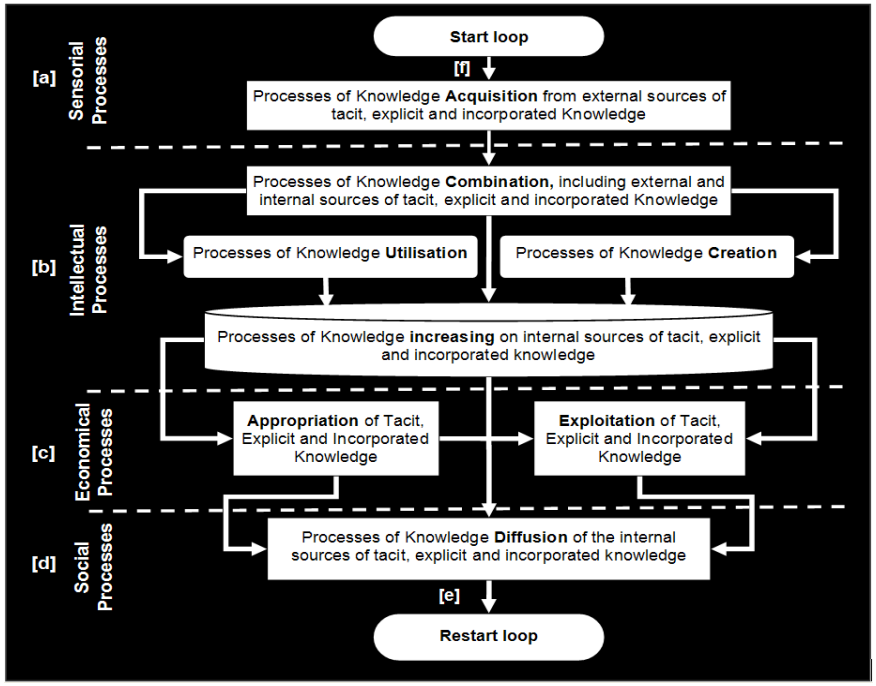
In fourth place, prior to dissemination, knowledge sources have basically three process alternatives (c, in Fig. 3). Two of them are economic processes: appropriation, and exploitation of knowledge. Both add economic value to knowledge. However, in the third, knowledge is also disseminated without seeking economic benefit, i.e. during direct dissemination.

Finally, in fifth place, the dissemination of internal knowledge sources (e in Fig. 3), provides feedback to the external knowledge sources, thereby activating a knowledge management process loop (f in Fig. 3) by triggering the external knowledge acquisition processes once again.

Figure 3 presents a general and holistic scheme that explains how knowledge is managed in the four socio-cultures described by Andersen (2002). Each socio culture differentiates by the resources it utilises to increase and disseminate knowledge. A similar model, representing a socio culture based on printed channels, has been proposed by Hjørland (2003: pp. 95-96) in its revised UNISIST-model.

Based on the information provided by the activities carried out by human resources, in all the described processes and said transformations, to activate internal knowledge sources, it is possible to determine their performance on the basis of a knowledge management approach.

Figure 3: Loop of knowledge management general process.



Source: By the authors.

3. Knowledge framework.

The study of organisations from a knowledge-based approach stems from identifying knowledge within the company as a resource, and acknowledging the relevance of people and their learning processes within an organisation. This approach dates back to the studies by Say (1803: I.IV.9-10, I.VI.1-6), Ricardo (1817: 5.21, 20.14 -16) and Penrose (1959).

In this respect, according to Barney (1991), unlike other organisation resources, knowledge is not easy to transfer since it is based on the characteristics of each organisation and on the persons composing them. In this context, knowledge becomes a rare and valuable resource difficult to imitate and substitute and, therefore, from an economic viewpoint, knowledge constitutes a competitive edge for the organisations that have it and a disadvantage for those that do not. Furthermore, on the basis of Polanyi's model (1966) with the incorporation of Nelson & Winter's evolutionist theories (1982), Brown & Duguid (1991) conducted the first formal knowledge-based analysis of organisations. This was followed shortly afterwards by Kogut & Zander (1992), who viewed the firm as an institution that processes information.

According to these early approaches, knowledge could be found in the firm as coordinated human resources. Thanks to this coordination, firms not only become knowledge warehouses but also develop the ability to learn and obtain new knowledge. Kogut & Zander (1992) labeled this skill as the firm's "combinative capability".

Kogut & Zander (1992) postulated the static perspective of the knowledge accumulated in an organisation. They considered firms having knowledge sources that were produced and reproduced within a social framework of information and know-how. Such sources would be the persons in charge of company sales in present-day markets. After analysing which knowledge may constitute technological and organisational opportunities leading to future market opportunities, the competitive edge based on knowledge can be developed.

A dynamic analysis perspective, directly related to the creation of knowledge or organisational learning can be perceived in these studies. Kogut & Zander's study (1992), for example, analyses the combination capacity of a firm to synthesise learning processes from inside or outside. At a individual level, this turns firms into

different historical entities, bearers of tacit knowledge of a social nature, that take shape and develop following the paths or steps taken beforehand during their development. This clearly marks the evolutionary nature of individual and group actions linked to a set of organisational principles that protect organisational capacities of others, just as structures protect the relationships between individuals and groups.

Several studies have adopted this viewpoint when addressing knowledge management analysis in the context of organisational management, looking upon it as one of the key processes in any organisation. It is therefore postulated, in a wider sense, that since firms most important asset is knowledge, they must learn to manage it as effectively and efficiently as possible (Grant, 1996, 1997). Similar sub processes or stages that have gradually been attributed to knowledge management are summarized in table2.

Grant (1996)	**Wiig, (1997)**	**Davenport and Prusak, (1998)**	**Wensley and Verwijk-O'Sullivan, (2000)**
Generation (external Acquisition, internal creation) Application (Identification, measurement, storage and transference)	Generation Codification Transference	Generation Codification Coordination Transference	Generation Codification Refinement Transmission

Table 2: Processes involved in Knowledge Management according to several authors

Knowledge management is deemed to be a dynamic, organizational process that depends on the efficiency and effectiveness of people in the utilization of existing knowledge, the creation of new knowledge and the acquisition or capture of additional knowledge from the outside. However, in parallel to the dynamic suggestion of knowledge management, an ontological analysis has arisen from the static perspectives of accumulated knowledge, which attempts to explain what knowledge itself is.

Business literature has classified and defined the nature of knowledge in many ways. However, it is important to emphasise that the bivalent tacit and explicit concept has prevailed in such literature due to the great influence of Polanyi's work (see Polanyi, 1958; 1966). Other taxonomy proposed on the basis of those studies is shown in table 3.:

Nonaka & Takeuchi (1995)	Dasgupta & David (1992) Callon (1994)	Spender & Grant (1996)	Garud (1997)	Matusik & Hill (1998)	Porter & Sölvell (1998)	Andreu & Sieber (1999)	Sullivan (2000)
Tacit and explicit	Incorporate	Individual and collective	Know-how, know-what, know-why	Component and architectural	High and low international mobility	External and Internal	Tacit and codified

Table 3: **Classifications of knowledge proposed by several authors**

A relevant contribution of the ontological analysis is the concept of incorporated knowledge, which can be ascribed to human beings, instruments or machines and which can take the form of technical knowledge, common-sense rules, etc. It plays an essential role in interpreting results, conducting experiments and craft activities (Dasgupta and David, 1992; Callon, 1994). Nevertheless, a review of studies on knowledge management or the ontology of knowledge makes it obvious that a theoretic conciliation between the two viewpoints is still required in order to explain its feasibility and nature in an organisation.

Moreover, in this context the new school emerging in the library and information science (LIS) research community, in relation to Knowledge Organization, contributes with concepts and theories towards a more complete vision of what constitutes the knowledge in a society, in general, but also in an organization, in particular. Above all, the idea that the means, resources, and ways by which knowledge is transmitted alter the existing forms of thinking, and therefore, of producing, communicating and organizing knowledge (Andersen, 2003), is quite valuable since it complements this knowledge vision. This, almost anthropological, vision vindicates knowledge as the main human strategy for survival, according to its developed capacity to transmit the cultural legacy (knowledge), that it has managed to accumulate from a generation, to the next. This capacity seems to be evolutionary since it is based on the improvement of means that a socio-culture has at reach to transmit knowledge between succesive generations.

Therefore, various authors coincide in that each socio-culture bases knowledge transmission on five basic means (see Meyrowitz, 1994; Andersen, 2002), identified as: oral resources (Ong, 1982), writing (Goody, 1987, 2000), printing (Eisenstein, 1979; Meyrowitz, 1994), computing (Finnemann, 1999) and Internet (Bolter, 1991)[1].

Observed from this point of view, it is amazingly clear the set of possibilities that a socio-culture has to increase its knowledge. Hence, to a larger dominion over a means of knowledge transmission, developed by a socio-culture, its efficiency in terms of acquisition/ recuperation, combination/ creation, application, diffusion/ utilization, side will be also augmented.

Consequently, the present paper considers that if the ontological theory of the different forms of analysed knowledge is complemented by the dynamic perspective of its management, then knowledge management can be observed as involving three basic activities that transform knowledge: sometimes from tacit to explicit, or from explicit to tacit, or to incorporated knowledge (see Polanyi, 1958, 1966; Nonaka & Takeuchi, 1991, 1995; Dasgupta and David, 1992; Callon, 1994). These, depending upon its utilization (Ong, 1982; Goody, 1987, 2000; Eisenstein, 1979; Meyrowitz, 1994; Finnemann, 1999; Bolter, 1991; Andersen, 2002;) will increase more or less efficiently its own knowledge sources. This constitutes a differentiated process of states that increase the various sources of knowledge.

4. Methodology

Our methodology is based on the epistemological approach to knowledge (Polanyi, 1958, 1966; Nonaka & Takeuchi, 1991, 1995; Dasgupta and David, 1992; Callon, 1994) which supports the fact that knowledge can be found in different states, and Kogut & Zander's view (1992) that postulates organisations have knowledge sources produced and reproduced within a social framework of information and know-how. Different sources are

[1] This latter resource, although it has been dealt with in academic literature in relation to KO, has not been identified as another mean. It has been contemplated, rather as a whole, within the computing resource. However, it has to be considered that Internet already has embedded all the other means/ resources to transmit knowledge and, additionally, is developing other such as hypertext, data mining, web changes alerts, etc. This must be taken into account when observing and interpreting the Internet concept in a holistic form.

associated with these states, and within these sources it is assumed, in what is an original approach, that human resources interact by means of tree basic processes – acquisition, creation and utilization – to transform the knowledge from said sources.

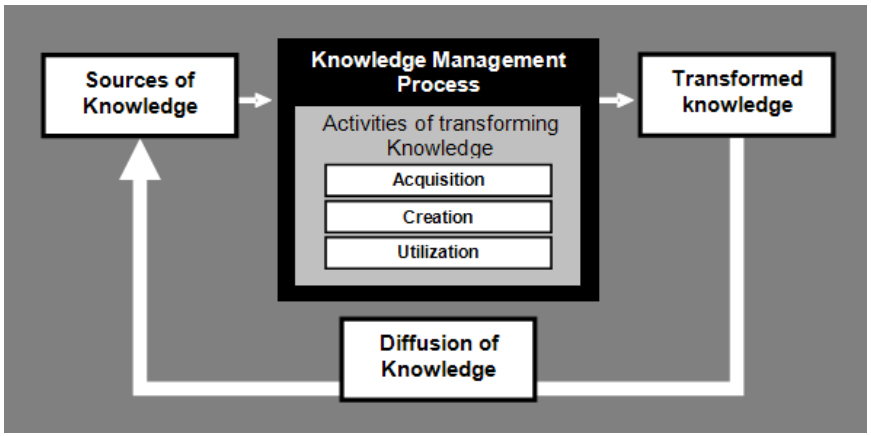
Knowledge is acquired or captured when someone creates new knowledge in their internal sources by extracting knowledge from external sources or combining the knowledge from internal sources, thereby increasing the internal sources of tacit knowledge.

Knowledge is created when someone codifies it, thereby increasing not only internal and external sources of explicit knowledge but also external sources of the tacit type.

Finally, knowledge is utilised when someone used knowledge from both external and internal sources to solve day-to-day problems, thereby increasing both internal and external sources of incorporated knowledge.

The present paper aims to determine which knowledge sources are most effective depending on the level at which the acquisition, creation and utilization processes are balanced, and will do so by analysing academic organisations and applying the knowledge management model shown in figure 4.

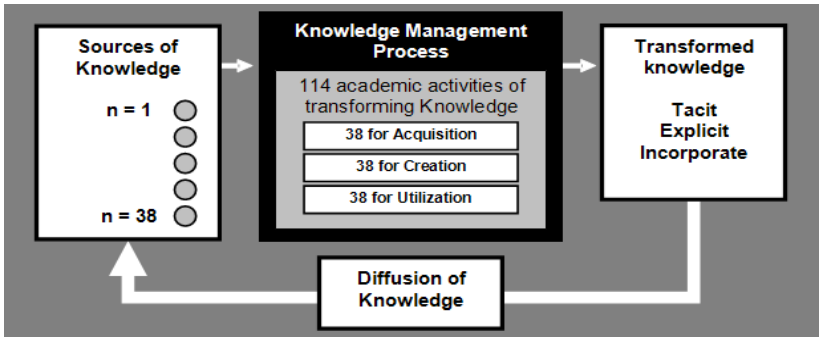
Figure 4: Simplified measure model performance of KM.



Source: the authors.

Extrapolating this model to the academic context revealed 38 sources of knowledge and 114 academic activities that transform the knowledge from these sources by means of 38 different knowledge acquisition, creation and utilization activities.

Figure 5: Application of the simplified model to the academic context.



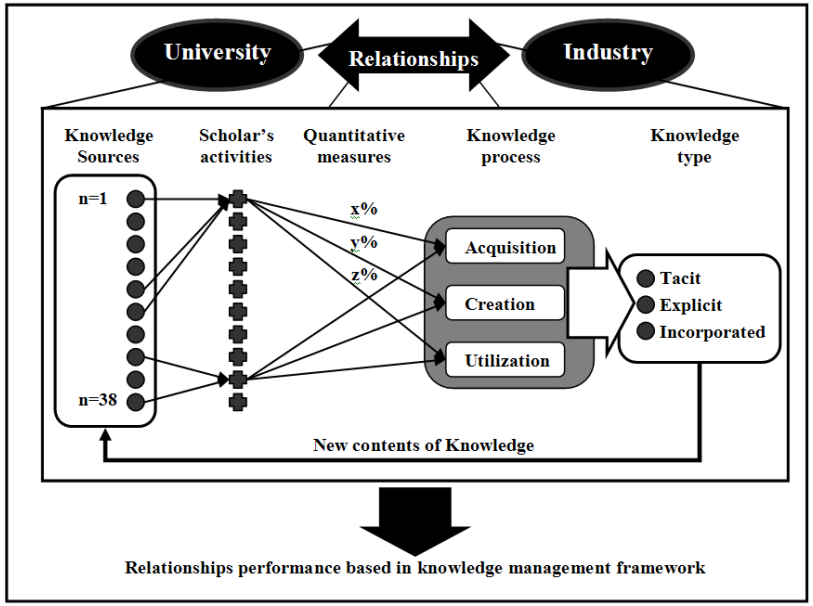
Source: the authors.

Hence, if knowledge can be classified as tacit, explicit or incorporated, it is necessary to identify and measure the transformation processes making this possible, since the status changes will probably be human (for the context of the model, see figure 6).

The empirical analysis was based on the qualitative study of several cases and also on the quantitative analysis of a sample of 35 university scholars. Despite the size of the sample, the results obtained from the compiled data upheld the theoretical model.

Lecturers and researchers were interviewed to analyse the frequency and time devoted to the different activities carried out in the context of their relationships with industry from a knowledge viewpoint. These activities included the acquisition, creation and utilization of knowledge. They were compared with 38 sources of knowledge (newspapers, journals, meetings, workshops, congresses, projects with firms, etc. See table 4). The performance level of each activity was evaluated in terms of each of these three transformation processes. An analysis was then carried out to evaluate their potential in terms of their composition within the knowledge management process.

Figure 6. University–industry relationships within a knowledge management framework



Source: the authors.

.5. Results

The survey results are set forth in table 4 which shows the frequency of activities observed for the acquisition, creation and utilization of knowledge from the 38 academic sources identified. (See table 4). This table also shows the reliability indices of the scales created to measure the processes of knowledge acquisition: 0.831; creation: 0.859; and utilization: 0.930.

Fig. 7 reveals that the academic activities recorded in the sample lean, above all, towards the acquisition rather than the creation or utilization of knowledge. It also shows the particular performance of each source of knowledge as regards the acquisition, creation or utilization of knowledge from it.

In order to analyse whether the 38 academic sources of knowledge could be classified in terms of performance, the dendogram technique was used (see Fig. 8) with three well-differentiated groups emerging on the 10th iteration.

Id.	Sources of Knowledge	Type of stock (According to bibliography)	Frequency acquisition	Frequency creation	Frequency utilization
1	States of Art	Explicit	859	115	230
2	Congresses	Tacit-Explicit	149	137	199
3	Courses organized by your Institution	Tacit-Explicit	141	96	158
4	Seminars and Conferences	Tacit-Explicit	160	41	137
5	Workshops	Tacit-Explicit	75	41	181
6	Internet	Explicit	4358	12	678
7	Courses on line	Explicit	622	12	113
8	Agencies or Institutions providers of data and statistical information	Explicit	689	3	34
9	Data Bases	Incorporated	1523	21	191
10	Specialized/Expert Software	Incorporated	694	6	237
11	Management Computer Systems	Incorporated	163	18	10
12	Colleagues	Tacit	869	441	74
13	Experts belonging to other institutions	Tacit	572	486	36
14	Students	Tacit	1049	1202	51
15	Entrepreneurs	Tacit	237	202	21
16	Performance Studies about the professional sector of interest	Explicit	395	53	3
17	Politicians	Tacit	121	100	0
18	Directives of universities/institutions	Tacit	170	237	22
19	Recorded papers in any type of format	Tacit-Explicit	395	135	17
20	Study of Cases	Explicit	351	123	142
21	Internet Forums	Tacit-Explicit	212	91	18
22	Recommended books related with the professional sector of interest	Explicit	313	132	317
23	Books without recommendation, related with the professional sector of interest.	Explicit	677	29	306
24	Newspapers, weekly magazines	Explicit	3377	22	26
25	Scientific Journals, Congress Proceedings	Explicit	1777	135	489
26	Technical and specialized Journals	Explicit	1589	79	350
27	Registers of phenomenon observations	Explicit	619	5	135
28	Consulting meetings with colleagues	Tacit	293	95	206
29	Consulting meetings with entrepreneurs	Tacit	71	58	18
30	Computer Simulations	Incorporated	467	16	3
31	Television specialized on themes related with the professional sector of interest	Tacit-Explicit	300	6	10
32	Market studies related with the professional sector of interest	Explicit	306	25	3
33	Original documents in foreign languages	Tacit-Explicit	2149	224	454
34	Original documents in pre-Columbian languages	Tacit-Explicit	306	0	0
35	Documents translated from a foreign language	Explicit	1062	59	127
36	Documents translated from a regional pre-Columbian languages	Explicit	3	0	10
37	Documents of Latin-American authors in foreign languages	Tacit-Explicit	147	0	12
38	Original documents in Spanish or foreign languages translated to regional pre-Columbian languages	Tacit-Explicit	51	0	10
	Cronbach's Alpha		**,831**	**,859**	**,930**

Table 2: Frequency of knowledge transformation activities based on surveys results.

Figure 7: Academic activities recorded in the sample

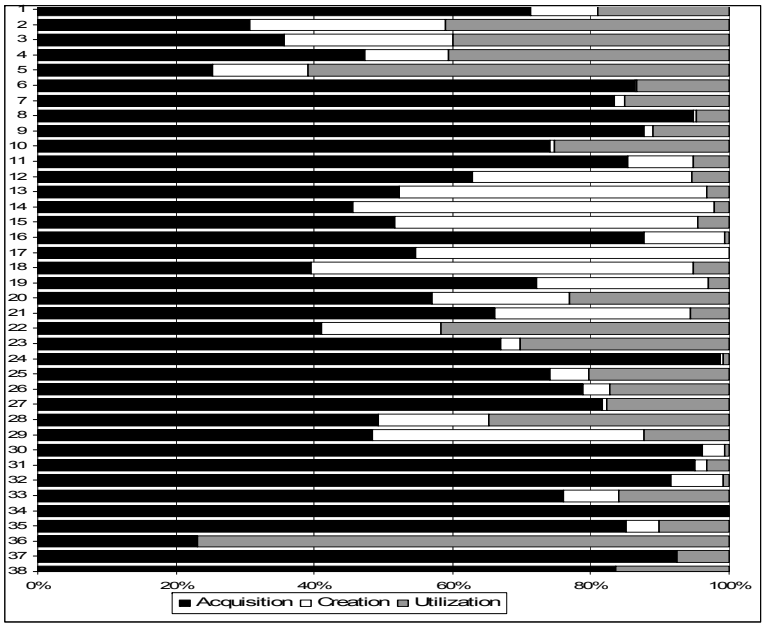


Figure 8. Academic sources of knowledge

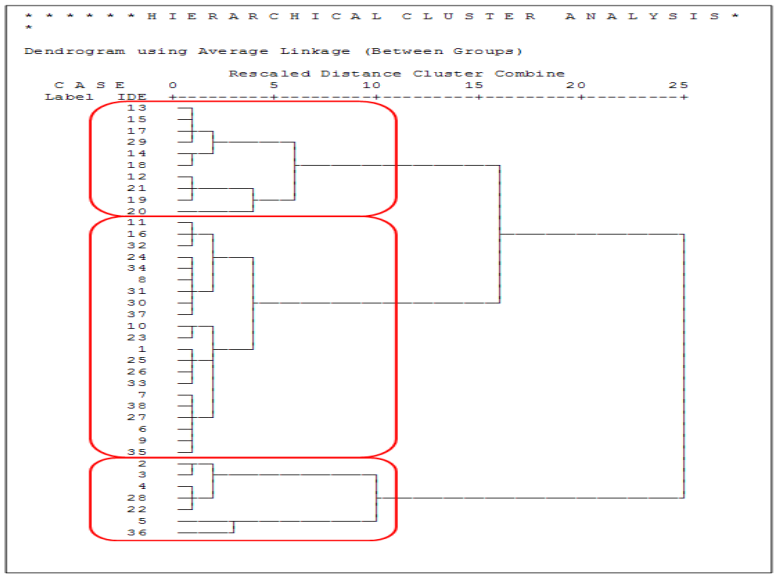


Figure 1: **based on surveys results.** **Figure 2: based on surveys results.**

On the basis of the clustering data in figure 8, an appraisal was conducted of how each group acquires, creates and utilizes knowledge. The results appear in figures 9, 10 and 11.

Figure 9. Source clustering no. 1

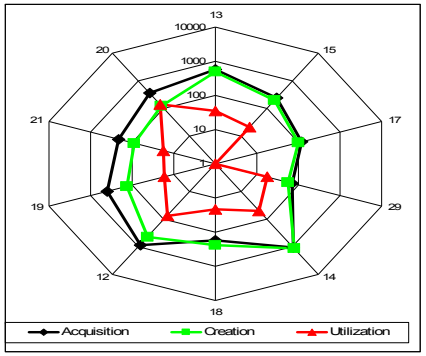


Figure 10. Source Clustering no. 2

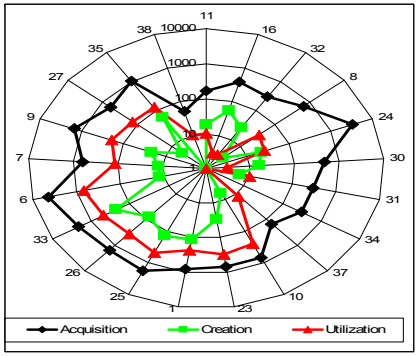
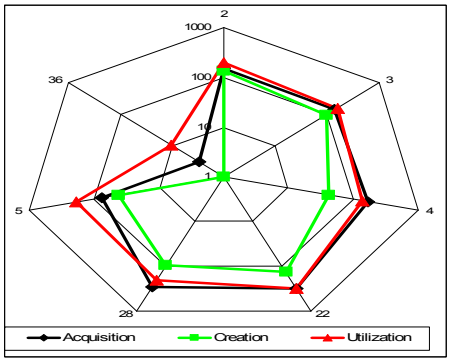


Figure 3. Source Clustering no. 3



In figure 9, the knowledge acquisition and generation activities in source clustering No. 1 are very similar in number to the log scale used to portray them (base 1,000), and they constitute the largest percentage of activities carried out in the cluster, followed by utilization activities (on a base of 100), i.e. a creation-acquisition-utilization trinomial (1,000-1,000-100).

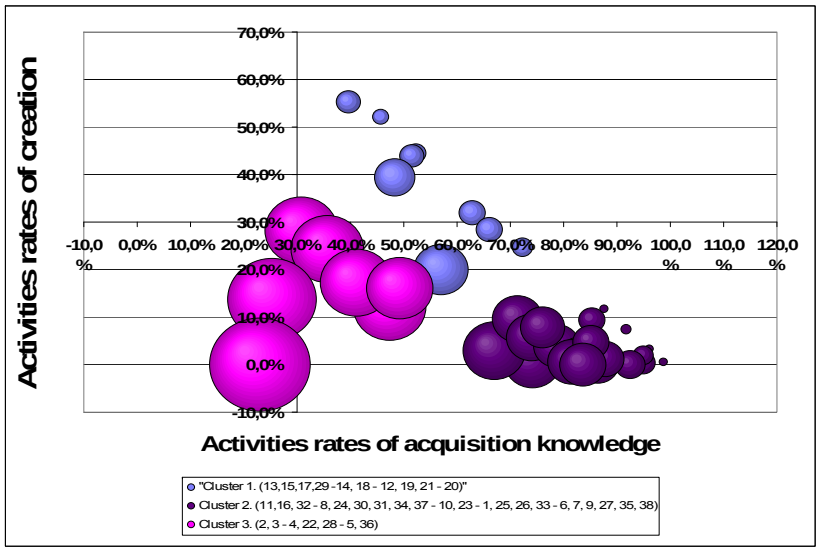
Figure 10 shows that the number of knowledge acquisition activities in source clustering No. 2, differs considerably from the other two types of activities, as regards the log scale used to portray them (base 1,000 and 100), hence they have the largest percentage of activities in the group, followed by utilization activities (base 1,000 and 100), and then creation activities (base 100 and 10). In other words, an acquisition-utilization-creation trinomial (1,000-1,000-100).

Finally, figure 11 shows how utilization activities, in comparison with the log scale used to portray them (base 10,000 and 1,000), are very similar in number to the acquisition activities carried out, and to a lesser extent (base 100) to creation activities. In other words, a utilization-acquisition-creation trinomial (1,000-1,000-100).

In order to appreciate the differences between these three groups better, dendogram data were employed in a descriptive analysis using three-dimensional orthogonal graphics. The results are shown in figures 12, 13, 14 and 15.

Figure 12. Horizontal weighting of knowledge utilization with Cluster Analysis

Figure 4 Source: clustering Nº 3 based on surveys results.



Source: based on surveys results.

Figure 12 shows each of the three groups of knowledge sources in a different colour. They are distributed across the plane along three axes. The knowledge sources with a greater component of

knowledge acquisition are distributed along the X axis, the sources with a higher percentage of knowledge creation activities along the Y axis, and the information sources with a larger proportion of knowledge utilization activities, along the Z axis.

This figure shows at first glance that knowledge sources have three attraction vertices which correspond to the three knowledge management processes measured: acquisition, creation and utilization. The data gathered from this sample clearly show that academic activities focus more on acquiring knowledge; hence such sources constitute more than 60% of all management activities, with a low level of utilization activities of not more than 30%. As regards knowledge creation, however, the sample has levels varying from 20% of the activities to a maximum of 60%.

In order to make the knowledge sources of each cluster clearer, figure 12 was blown up to produce figures 13, 14 and 15 which show the position of each source on the Cartesian plane.

Figure 13, Sources of knowledge with high knowledge utilization performance.

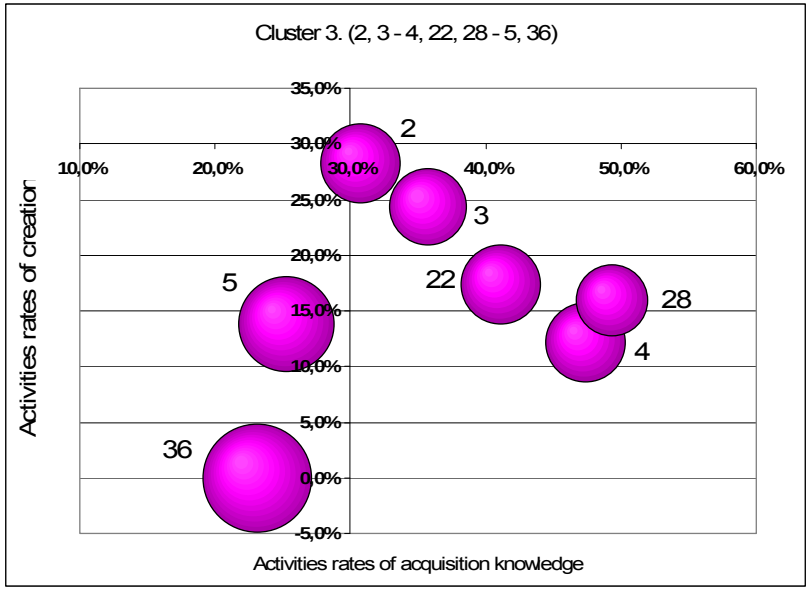


Figure 14. Sources of knowledge with high new knowledge acquisition performance.

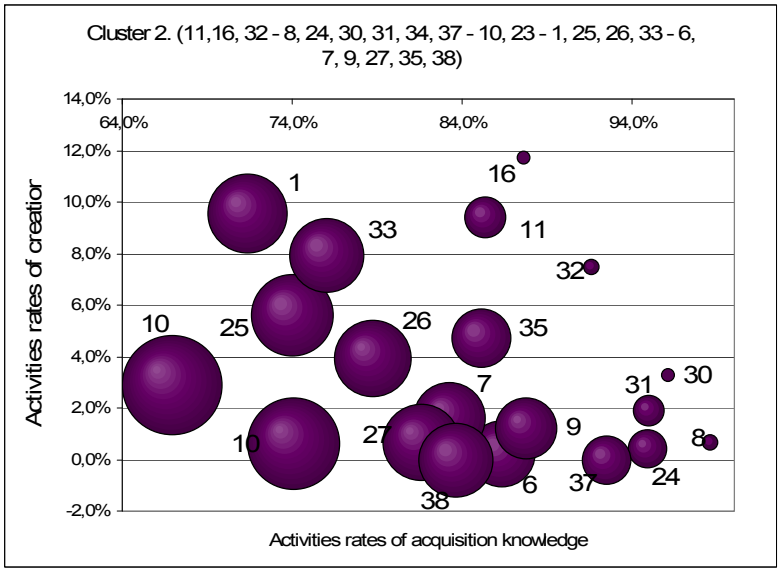
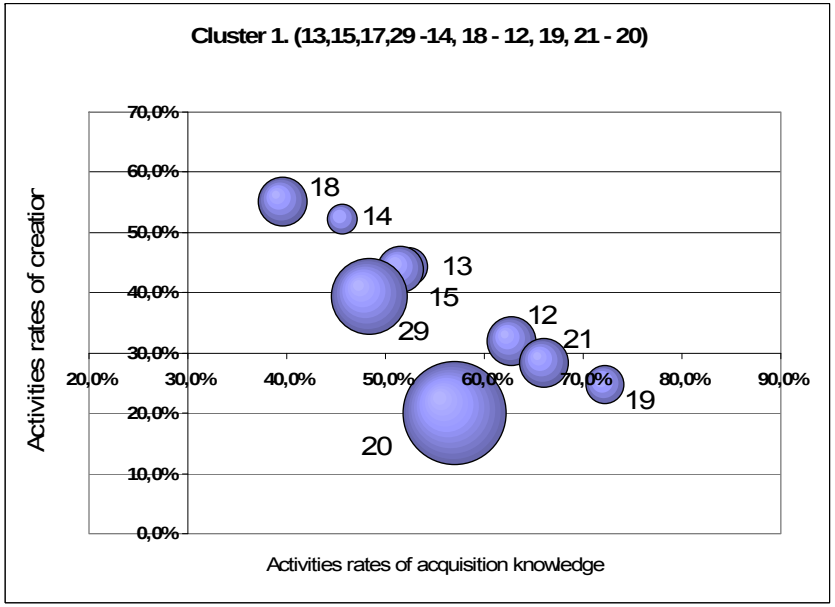


Figure 15. Sources of knowledge with high knowledge creation performance.



6. Conclusions.

The analysis of the ways and mechanisms of knowledge transmission within the academic-industry relations has concluded in the understanding that knowledge management is implicitly involved in almost any activity carried out by the academic sector. Nevertheless, by applying the latest knowledge-based theories (from Knowledge Organization, Knowledge management and Knowledge Ontology), it can be concluded that not all the activities have the same impact in the knowledge application and that not all the knowledge sources show an equal performance.

The results show that a source of knowledge with 33% of its activities aimed at knowledge utilisation, creation and acquisition, can be considered having a balanced performance since it would be equally effective at transforming knowledge of its type in either direction. Furthermore, a cluster formed by these sources may be considered precisely the cluster with the best performance in knowledge utilization, the ideal objective of academic-industry relationships.

It must be emphasised that the incorporated knowledge concept is particularly useful when representing how knowledge is used to solve specific problems. This enables it to be clearly distinguished from the creation of knowledge, aimed more at the storage and future retrieval of knowledge. This contrasts with tacit and explicit knowledge and the three processes that transform knowledge from one state to another and complement an undefined transformation cycle.

In this respect, it can be observed that the activities carried out by each university scholar contribute to the transformation of knowledge to a different extent and, likewise, have a different impact upon the knowledge management process. This varies according to whether these academic activities as a whole are related mainly to the acquisition, creation or utilization of knowledge. Similarly, the activities of these three processes will make a source of knowledge more efficient if they dedicate the same amount of time or number of activities to each process. In addition, sources of knowledge can be classified on the basis of their performance into three major groups, i.e. those focusing on a) the acquisition, b) the creation or, c) the utilization of knowledge.

By identifying and understanding how the sources of knowledge and the different types of activities transforming knowledge inside academic organisations work, specific policies can be proposed to optimise knowledge management resources and improve their efficiency focusing those activities having a greatest impact on the knowledge utilization.

Knowledge may be deemed to be a resource if we can identify the different states that make it up, and the different processes involved in transforming and changing it from one state to another, thereby influencing the performance of organisations using knowledge.

The final analysis of the ultimate impact upon the performance of university-industry relationships will be carried out in a further research phase since it has not been feasible to be achieved with the resources available for the project to date. The research reported here constitutes the development of the phases a and b of the model depicted in figure 3. A further research will carry out phases c and d of the model.

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