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AN INTERPRETATIVE SYSTEMS APPROACH TO DEVELOP A FUNCTIONAL FRAMEWORK FOR KNOWLEDGE MANAGEMENT

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ABSTRACT

The concept of Knowledge Management (KM), as an emerging research field, has become a critical issue in helping enterprises to gain the position of a competitive advantage, due to its role for providing the support to the business operational processes, as well as to manage activities performed on both tactical and strategic levels. However, the concept itself brings confusion from its definition and functions through to applications; therefore, the necessity to present an overview of it.

The objective of this paper is to put forward an effort based on the Systems Approach and the operative technique of Domain Analysis, to develop a functional framework for KM that incorporates in a holistic manner previous developments. A methodology proposal as an intervention strategy is presented, which is crucial to identify opportunities and define KM improvement initiatives within a business.

A case study is described in which the framework helps to identify KM functions, through the intervention strategy, and to provide further recommendations for the organization. The results of the analysis offer foundations of KM in practice, and a base to assess performance in enterprises.

Keywords: Knowledge Management, Functional Framework, Systems Approach, Domain Analysis, Intervention Strategy.

INTRODUCTION

The concept of KM is an essential component in all type of organizations because of its role for providing the support to the business operational processes, as well as to manage activities performed on tactical and strategic levels [Sutton, 2001; Lindgren et al., 2003]. However, the paradigm of KM has become a buzzword, caused by its extensive use in contemporary business literature. The term is employed to refer to different activities from understanding and administrating physical goods [Davenport & Prusak, 1998], to managing corporate intangible assets such as human capital [Booker et al., 2008].

Furthermore, the industrial-based economy has suffered a shift to a new information era, the "Knowledge Economy" [Druker, 1988; Nolan, 1991; Nonaka, 1991 Quinn, 2002]. In this modern economical context, knowledge and its organization have become core concepts for the study of the management processes in enterprises, to ensure their acceptance and use, and to improve their administration [Davenport, 2008].

According to some authors, the strategic organizational unit in several firms has been the prime user of KM [Randall et al., 2001; Ferguson, 2005; Wong, 2005]. It is also pointed out that not only executives but also managers directly related with technical issues must be aware of the responsibilities to handle, and to take advantage of the KM processes of creating, sustaining, applying, sharing and renewing knowledge to enhance organizational performance and generate value.

Thus, new management trends state that KM resources should be managed by a team led by a Chief Knowledge Officer(CKO) [Dalkir, 2005]. Such an officer should work in partnership with a Knowledge Coordinator, a Knowledge Creator and a Knowledge Facilitator who, in cooperation with business's users and executives, can determine the use of intellectual capital based on the company's strategy [Nielsen, 2005].

While this assumption is grounded, among other suppositions, in a natural tendency to conceptualize knowledge and the management of knowledge within the existing theoretical paradigms, up to date, a review of the KM literature reveals many different representations of reality such as functional frameworks, also called functional models [Casti, 1997].

As a result, there are an increasing number of functional KM frameworks, restricted to and limited by the specific context in which they have been elaborated and employed. The disclosure of KM frameworks is an example of the very different understandings of KM as an emerging research field, and establishes the need to unite and integrate the dispersed and sometimes independent KM domains into one specific field.

The diversification of functional frameworks for KM may imply a complexity by the vast network of relationships in concepts. Moreover, it could probably be caused by the lack of compatibility among authors who, from the beginning, deploy particular terminologies and functions of knowledge, and belong to different disciplinary schools, as happens in other arenas of thought [Churmann, 1973].

At this stage, in the development of the KM movement, it is appropriate to ask whether there are other academic disciplines from which to learn. If a suitable discipline can be found, it will assist KM to progress more rapidly and more certainly, avoiding intellectual pitfalls and enabling it to translate more readily its insights into practice.

Consequently, this paper suggests that Systems Approach can provide explicit knowledge appropriate for accelerating the research progress in KM, for the possibility of this field to design objects as systems [Rapoport, 1968; Ackoff & Emery, 1981] and determine its functional subsystems.

Furthermore, there are hints that the Systems Approach might be the paradigm to develop a functional framework for KM because of similar uses in the past [Gelman & García, 1989; Rigaud-Tellez et al. 2008].

In addition, both KM and Systems Approach as applied management interdisciplinary research fields are centrally concerned on both individual and organizational learning and control structures [Courtney, 2000]. Other studies familiar to these topics are the following: use of Viable System Model to KM [Sambamurthy, 2005], organizational learning and critical systems [Panagiotidis, 2001], analysis of the relationship between Sociotechnical Systems Approach and KM [Saito, 2007], employment of Soft Systems Methodology into

the improvement of organizational knowledge creation theory [Yoshida et al., 2004], ant the definition of significant aspects of KM from a Critical Systems Thinking [Jackson, 2005], just to name a few.

All of them suggest that developing a framework through the employment of Systems Approach, as an epistemological tool, can reduce the ambiguity and strengthen the rigor of the KM field, and help to gain a better understanding of the complexities involved in the development and implementation of KM projects by practitioners.

In this context, it is important to keep in mind that one of the main KM benefits is that it allows to achieve general improvements within organizations through the integration of disperse knowledge and the establishment of standard bases for the comparison of research findings. Additionally, there have been gains of common knowledge to promote, plan, design, develop, implement, evaluate, update and, given the case, upgrade KM, to assure that organizations will attain the expected benefits by their use.

Note that this paper does not argue that people must share the same understanding of the concept of knowledge, but aims to help those who are confused about the research field of KM, by providing them an overview of what has often been mentioned in the literature regarding this research field, and how its purpose can be deployed into general functions and activities.

The document is organized as follows. In the next section, the processes of the Systems Approach are briefly described, and the Domain Analysis is employed in order to identify functional frameworks and the most representative authors by their disciplinary field, striving not to repeat two members from the same research field.

Following on from this, a functional framework for KM is identified by integrating previous frameworks. Based on the resulting one, the practical development of KM in a multinational Latin American organization is examined in order to have a general view about the KM performed functions in practice, through the interpretation of the proposed framework.

Interdisciplinary approaches

Systems Approach, as a teleological and pragmatic epistemological mean, focus on both the content and on the structural form [Bertalanffy, 1976; Ackoff & Emery, 1981]. It is a scientific paradigm suitable to study phenomena that are characterized by an extraordinary complexity, a high level of interaction of their parts and the possession of properties that are lost when the whole phenomenon is considered partially and isolated from its environment [Herrscher, 1993].

In order to define an object, in this case KM, as a functional system, a “decomposition” process should be utilized (Fig. 1), where the conceptualization of a system is constituted by a set of interrelated components-subsystems in a form, that the operation of each one, assures the functioning of the whole object [Jackson, 2005].

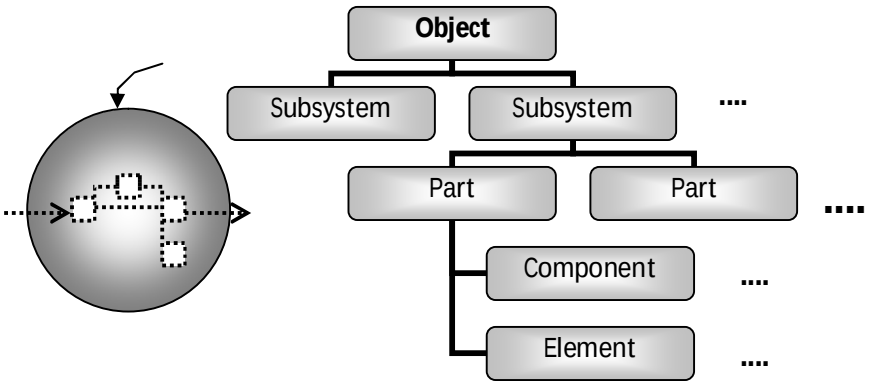

Fig. 1 Representation of the process of construction by decomposition [Rigaud et al., 2008]

The successive functional decomposition, depends on the considerate problem, thus, a subsystem can be divided in its parts, components, and so on.
Domain Analysis is also be used. This method aims to distinguish and classify KM core words, therefore, the possibility exists to identify representative authors, and identify fundamental functional KM frameworks for developing a comprehensive one (Fig. 2). Figure 2 presents a schematic representation of this process.

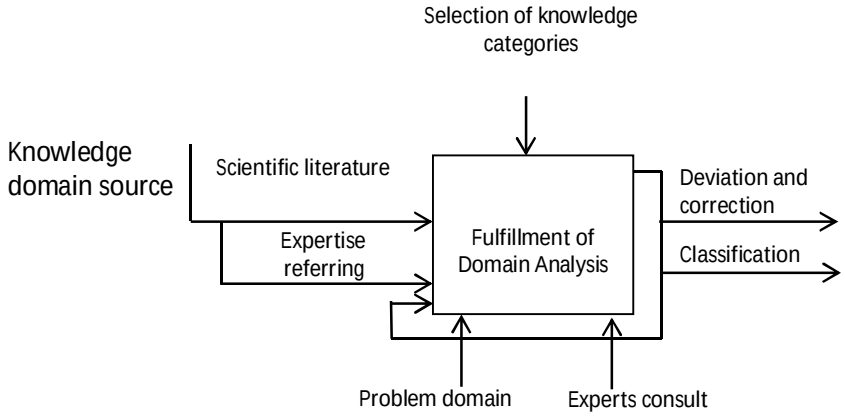

Fig. 2 Domain analysis method [Arango & Prieto, 1989]

Domain analysis is based on a multivariate analysis, which allows outlining the relationship structure for a particular discipline, considering different terminology shown in existent papers. Therefore, the bigger the number of cited papers then, the probability to find a thematic relationship between them is higher [Arango & Prieto, 1989].
Moreover, domain analysis is concerned with objects and actions in a class of similar systems in a particular problem domain. In order to identify and describe a domain, it is necessary to define metaconcepts in terms of entities, functions, events and behaviors [Kang et al., 1990]. The phases of the process are:

a. Selection of leading journals regarding the research field, through experts consults.
b. Extraction of keywords from leading journals. From the selected journals, keywords are extracted and stored in a database.
c. Selection and analysis of extracted words, statistics and visualization. Statistics are used to select the most important keywords measured by their frequency, and visualization is utilized to visually display the relations among the keywords, which provides a more direct and easier way to understand data, and to identify hidden complex patterns behind the data and relationships.
d. Map of keywords regarding the research field. In this phase, the aspects of entities, events, functions, behaviors, support technologies, objectives/targets and applications are explored. Experts' support is needed for discussing the meaning of each selected keyword from phase 2 and 3, and the aspects in the context of the research field.
e. Generation of a hierarchy structure for identifying relevant authors. In order to identify areas of development and support decision-making, in particular to initiate and strengthen areas of knowledge, through characterization, prioritization and optimization of the frameworks portfolio.

Proposed functional framework for Knowledge Management

Through the employment of Domain Analysis, abstracts and keywords of prominent journals, such as, Journal of Knowledge Management, Knowledge Management Research & Practice, Journal of Knowledge-based Systems, and International Journal of Knowledge and Systems Sciences have been analyzed. In addition, some particular papers were taken into consideration, which were published in a special edition from the Harvard Business Review on Knowledge Management.

The mentioned journals provided frequent keywords that were evaluated to determine their co-occurrence, i.e. to identify whether they appeared together in the keyword lists of one or more article. In this way, domain analysis permitted, for this particular case, to recognize different types of frameworks, and to distinguish early authors of various disciplinary schools who have contributed in the field of KM. The main findings are synthesized in Figure 3.

As can be seen, in Figure 3 a structured taxonomy on the aspect of entities is presented, which was further divided into five sub-aspects: *general, strategy-oriented, information-oriented, human-oriented,* and *process oriented.*

While general frameworks focus on broad management issues within an organization, strategy-oriented frameworks and building organizational capability to fulfill the firm's mission. Information-oriented is centered on managing the codified explicit content within an organization that can either be easily stored or transferred. Human-oriented ones focus on managing the intangible human capital within an organization that is difficult to articulate or transfer.

Aspects	Sub aspects	Typical research topics	Identified authors
Entities: Know what, What does KM deal with	General frameworks	Organization, knowledge, resources, knowledge-based organization, knowledge base	Wiig (1997), Leonard-Barton (1995)
	Strategically Oriented Frameworks	Organizational culture/corporate culture, organizational climate, corporate strategy, business strategy, organizational culture, leadership, strategic knowledge	Nonaka & Takeuchi (1995), Demerest (1997)
	Information oriented frameworks	Information, explicit knowledge	Choo (1996), Taylor (1996), Alavi (1999)
	Human Resources oriented frameworks	Intellectual capital, intangible assets, intellectual property, human capital, intellectual assets	Davenport (1998), van der Spek & Spijkervet (1997)
	Processes oriented frameworks	Knowledge process	Andersen (1996), Szulanski (2000), Bergeron (2003)

Fig. 3 Taxonomy of frameworks

Finally, process-oriented frameworks deal with managing the core business or innovation processes within a company.

A review of the frameworks in detail shows contributions to the field of KM, e.g. Wiig´s model proposes three pillars of KM based on a wide understanding of knowledge creation, manifestation, use, and transfer, while Leonard-Barton's framework summarizes four core capabilities and four knowledge building functions around core capabilities. In the case of the model of Arthur Andersen (APCQ's model), seven processes which operate from a corporation´s knowledge are introduced. Based on the Systems Approach, particularly in the decomposition process, the functions of KM have been defined as (Fig. 4).

Initiation- This function is concerned with the awareness of the need for knowledge, the development of strategic capabilities for managing knowledge. Some activities related to this function are the diagnosis of the organizations processes, the identification of knowledge requirements and core competencies, and the elaboration of KM strategies.
Generation- Knowledge can be generated through the identification of who owns it and the collection of data for further analysis, in a technological environment where learning is part of the corporate culture.
Modeling- This function deals with the organization of knowledge and its storage in repositories for future retrieval, as the business should record the generated knowledge in order to preserve the most critical information. Therefore, this function is concerned with justifying and structuring the generated knowledge.

Repository- In order to maintain the explicit knowledge and facilitate it for further sharing, this function aims to become a database for consulting all critical knowledge.
Distribution and Transfer- The objective of the function is making knowledge available to people, by establishing human interactive processes or information technology infrastructure.
Use- The value of knowledge can only be realized when it is applied for problem solving. The function deals with how to employ knowledge in order to produce economic value for the company.

	FUNCTIONS						
Comprehensive framework	**Initiation**	**Generation**	**Modeling**	**Repository**	**Distribution & Transfer**	**Use**	**Retrospect**
Wiig (1993)	Exploring knowledge		Governing knowledge				Appraise and evaluate
Leonard-Barton (1995)		Shared & creative problem solving importing and absorbing technologies		Implementing and integrating new methodologies and tools		Experimenting and prototyping	
Nonaka & Takeuchi (1995)	Sharing tacit knowledge	Creating concepts	Justifying concepts		Cross leveling knowledge	Building an archetype	
Arthur Andersen (1996)		Identify, collect, create	Organize		Share	Apply	Adapt
Choo (1996)	Sense-making	Knowledge creating				Decision making	
Szulanski (1996)	Initiation				Implementation	Ramp- up	Integration
Taylor (1996)	Knowledge development (created knowledge)			Knowledge use (storing, distributing, applying, review)			
Alavi (1999)		Acquisition	Index, filtering, linking		Distribution	Application	
Bergeron (2003)		Identify, create	Capture, select	Store	Share	Apply, sell	
Demarest (1997)		Construction			Disseminate, embodiment	Use	
Van der Spek (1997)	Conceptualize, reflect				Act		Retrospect
Davenport (1998)	Determine require	Capture			Distribute	Use	

Fig. 4 Functional framework for KM

Retrospect- It is concerned with reviewing the performance of each function, and evaluating the impact of the whole KM initiative.

From this conceptualization, the KM artifact could be divided into diverse functional subsystems. These functions do not necessarily follow a sequential process, and each of them should contain either controls or feedback cycles, if the operation of the entire KM program is to be successful.

To sum up, the functions have the main role of managing the corporation's knowledge by means of a systemic and organizational specified process constituted by several stages such as: initiation, generation, modeling, repository, distribution & transfer, use and retrospect, for acquiring, organizing, sustaining, applying and renewing tacit and explicit knowledge. As a result, not only can employees enhance the organizational performance but also create value.

With these ideas in mind, a case study is now presented where their application is illustrated.

CASE STUDY WITHIN THE CONSTRUCTION INDUSTRY IN MEXICO

The present case study has been carried out in a multinational construction company which headquarters is located in Mexico. The study has the objective to retrieve actionable information that could be used to make recommendations for improvements, thus, the analyzed case allows illustrating the identification of KM strategies, through the employment of the functional KM framework previously discussed.

Data has been collected through document analysis, observation, and using secondary data from the company's technological development records. It was also carried out by interviewing stakeholders that might respond differently to organizational change, reflecting different values and beliefs, and showing different motivational attributes.

The company was founded in 1947 in Mexico City, and throughout the years, it has had a continuous development becoming the biggest engineer and construction firm in the country. Additionally, it is present in Puerto Rico, Panama and Spain, where it has participated in the construction of industrial buildings, public infrastructure, airports, concessions and housing, to name a few.

However, in 2009, the organization was exposed to constant changes in technology and workload, which were translated into a series of economic losses. Under these circumstances, the company's top management initiated a diagnosis and implemented diverse policies, being one of them the elaboration of a knowledge program. In the event the above mentioned functional framework was used to support the strategic objectives of the firm.

One of the first steps was to define critical elements and link them together. Consequently, it was necessary to explore beyond basic ideas of vision/strategy, leadership, measurement and analysis, resources and infrastructure, structure and processes to identify what was entailed in each of these areas and to provide a holistic visualization of the KM intervention schema (Fig 5).

According to such a schema, it was possible to define four KM strategic objectives within the firm: (i) to explode the knowledge from specialist engineers working in the Department of Technological Development (DTD), for solving the most critical infrastructure construction problems; (ii) to involve DTD's personnel in the design and planning of projects with high difficulty level; (iii) to identify, evaluate and select design subcontractors on the basis of their previous performance and expertise; and (iv) to detect internal best management practices to incorporate them in the enterprise's departments.

The defined objectives allowed the identification of both precise organizational units and the KM challenges that the firm faced. In addition, a preliminary team was formed to lead the KM initiative. After showing the initial results to the firm, the necessity to organize a formal committee and define their responsibilities, attributions and functions, became evident. As a result it was integrated, being its main role to observe the correct operation of the knowledge community, to organize specialized courses for the organization's

collaborators, to identify talented human resources, and so on.

Another challenge was related with KM modeling, i.e., the means to structure generated knowledge. Basically, the firm required to define criteria for structuring its knowledge. Having discussed it, it was possible to develop effective and useful knowledge systems to deliver information not only to internal groups but also to specific stakeholders.

In fact, these knowledge systems have now been used to provide interested people with information regarding the organization's performance and to allow individuals to obtain information on recent scientific construction breakthroughs.

It was also found that the Distribution and Transfer of Knowledge in the enterprise became fundamental to share knowledge.

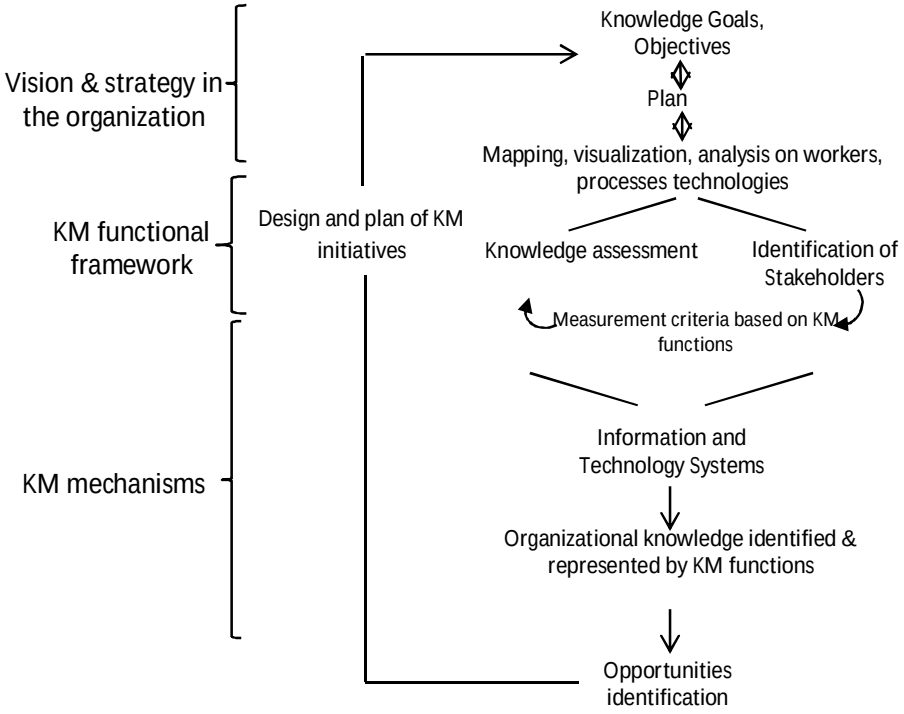

Fig. 5 Intervention schema

One effort that has been utilized by the firm is the implementation of a technological platform. Among the electronic mechanisms dedicated to the distribution and transfer of knowledge there are: a specialized software called SharePoint, blogs, and a web page, which help to share procedures, constructive processes, projects' lessons and departments' references.

The enterprise has also built an internal electronic site which holds information about quality assurance, environment and security practices, based on the respective certifications. These examples of data are shared by means of *hard devices* such as knowledge basis, emails, multimedia, and data mining. Other means are *soft* such as meetings, workshops, practice communities, and mentoring sessions.

In the firm, the function of KM Transfer is based on the use of IT and the access to repositories. One example is referred to monthly magazines, where experiences are reported, as well as technical information sheets, articles, technological reports, and conference memories. It is important to mention that employees are encouraged to document tacit knowledge, in order to translate it into explicit knowledge, and then keep it in a repository. Finally, one of the best practices within the firm is to make knowledge available to clients and suppliers timely, along the construction process, leading to raise the projects' efficiency.

CONCLUSIONS

Synthesizing the insights gained from a year research study involving numerous data, statistical methods, collections of functional frameworks and a case study, the paper has provided a whole picture of general functions in a framework for KM, and a set of design principles for an intervention strategy.

It is considered that the identification of various knowledge management practices is not adequate guidance to organizations interested in promoting and fostering their knowledge capability. A holistic organization-wide vision and strategy are required to meet this need, and as noted, Systems Approach, as an integrated and holistic methodology, has provided the support for building and managing knowledge-based organizations.

The use of such approach enables the definition of subsystems, in this case general functions for KM, which permit channeling the necessary information to evaluate the efficacy and efficiency of the decisions made and activities executed. This in turn helps to update the plans and to improve the decision making process.

However, there are challenges for the future; specifically the efforts necessary to develop both an effective science portfolio and an effective pipeline of projects, recognizing the tradeoffs between overlap and efficiency. Moreover, work is needed for developing systems that adequately capture the state of knowledge in various scientific domains, which could be easily utilized. Then, there is a need for future research not only on the efficacy of the revised, functionality focused design principles, but also on design principles that guide the KM development framework. Finally, the objectives set at the outset of this research have been achieved and it is hoped that this paper will be beneficial to researchers and organizations to encourage future studies in the KM field.

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