Generic Taxonomy for Innovation Management

A Semantic Classification Scheme for characterizing Innovative Knowledge

Lamyaa EL BASSITI and Rachida AJHOUN

Learning and Research in Mobile Age (LeRMA),

ENSIAS, University Mohammed V – Souissi (UM5S)

Rabat, Morocco

{elbassitilamyaa,ajhoun}@gmail.com

Abstract:

In the increasingly competitive environment that characterizes the world today, the need to develop innovations quickly has become the key driver of growth for many organizations. To be able to respond more effectively to this new challenge, organizations would make best use of their corporate knowledge resources and memory. Managing heterogeneous and distributed knowledge sources available in different forms and rather weakly structured has become a challenging problem.

In this paper, we introduce taxonomy as one of the key technology for innovative knowledge management in an open context, we revisit and review, discuss and explore the existing classifications of innovation and we present a Generic Taxonomy for Innovation Management.

Keywords-component; *Innovation Management; Idea Management; Open Innovation ; CrowdSourcing; Knowledge Management; Semantic Technologies; Classification; Taxonomy*

I. INTRODUCTION

The literature of innovation management gained widespread acceptance that innovation management systems (IMS) are knowledge based creative entities where innovative knowledge is the key to their success. The main activities in an IMS are collective intelligence and collaborative learning. The nature of these activities involves intensive interactions and effective contribution to knowledge production. However, the knowledge per se does not assure the success of the innovation process [1]. It cannot be achieved without the capabilities of the innovation actors to manage their knowledge. These capabilities include creating innovative thoughts, articulating these thoughts into formal ideas (written, verbal or symbolic), adding comments, notes, explanations or formal judgment (revision, citation, classification, etc) to the contributions posted by others, etc. Moreover, if some piece of knowledge is ignored by most innovation actors, there is no way that this knowledge can be acquired by simply collaboration. So, it is the facility to link the three cornerstones elements of innovation - Ideas, Actors and Context- together and in an efficient way that is central to the continuous growth of the IMS.

The remainder of this paper is organized as follows. The next section highlights the arising relationship between Crowd-Sourcing and Innovative Knowledge Management through Semantic Technologies. In section 3 we describe a brief survey of existing classifications of innovation. Section 4 presents our Generic Taxonomy

for Innovation Management. Finally, we draw conclusions and indicate directions for future research in Section 5.

II. SEMANTIC KNOWLEDGE MANAGEMENT FOR OPEN INNOVATION

A. Open Innovation & Crowd-Sourcing

Wenger argues that the success of an organization depends on its ability to constitute itself as a collaborative learning system and to participate in learning systems of a larger geographic scope [2]. From an innovation perspective, this appears linked to a new innovation paradigm based on an open model called "Open Innovation" and also reported with another paradigm called „„Crowd-Sourcing"" enabled by new technologies to describe a novel form of collective intelligence. For Chesbrough, the Open innovation paradigm [3] requires organizations to open their innovation processes both upstream, by seeking outside knowledge and downstream, by capturing value with knowledge that does not directly fit their business model. "Crowd-Sourcing" as a special case of Collective Intelligence that leverages the wisdom of crowds [4] conveys the idea of opening the R&D processes to "the crowd". It is currently one of the most important ways to activate and leverage the integration of heterogeneous resources in a structured flow of work [5].

Such paradigms challenge traditional notions of knowledge generation by radically transforming the acts of writing, creating, and mapping. So, in an open context and with the diverse range of people coming together to combine their resources - knowledge, ideas, opinions, skills, etc - as volunteers from the crowd, there clearly needs to be some sense of what of these resources should be mapped. This is a fundamental ontological question at the heart of innovative knowledge management. A taxonomy of innovation management seems to be a good response to this challenge.

B. Innovative Knowledge Management & Semantic Tachnologies

Quintas, Lefrere and Jones state that Knowledge Management (KM) is the process of critically managing knowledge to meet existing needs, to exploit existing knowledge and to develop new opportunities. This indicates that KM has the potential to be a catalyst for innovation within organizations [6].

To support effective innovation management, organizations must adopt a KM approach that can integrate dispersed resources into a coherent corpus of interrelated information. But, previous research in knowledge integration have largely focused on integrating heterogeneous databases and knowledge bases, which represent information in a highly structured way and most of the innovative knowledge consist of unstructured or semistructured content. Moreover, the continued rapid growth in knowledge volume makes it increasingly difficult to find, organize, access and maintain the information required by innovation actors. From the knowledge processing point of view, there exists a semantic gap between KM and innovation management in practice. To bridge this gap, the emerging semantic technologies have been proposed to provide efficient solution to support innovation process integration with heterogeneous knowledge sources.

A commonly used approach to cope with heterogeneous representations of knowledge is to use a taxonomy structure. The domain model implicit in a taxonomy can be taken as a unifying structure for giving knowledge a common representation and semantics.

C. Innovative knowledge Classification through Taxonomy

Taxonomy is the science of ordering things in a hierarchical manner. Originally developed for the classification of organisms, the term is now generalized and often used either as a synonym of classification or of systematics. Etymologically, taxonomy means to “put in order” and systematics means to “put together”. So when attempting to build taxonomies, one creates a special kind of classification that compares similarities between the objects of study, using systematics to make groups, based on the observed relatedness, and finally order them. Nickerson, Muntermann, Varshney, and Isaac define the taxonomy in information systems area as a set of dimensions each consisting of a set of mutually exclusive and collectively exhaustive characteristics that describe how the objects under consideration differ [7].

For an IMS, the use of taxonomy will offer an opportunity to significantly improve innovative knowledge access based on machine-processable semantics of data and heuristics that use these semantics, facilitate semantic services such as annotation and enable innovative actors to rapidly locate either the innovative knowledge or individuals whose have valuable knowledge.

III. PRIOR WORKS ON INNOVATION CLASSIFICATION

There have been numerous attempts at classifying innovation. Before defining a new classification scheme for innovation we have analyzed some of existing models as a reference. We started from the very origins of Schumpeter's innovation theories [8] and finished with the contemporary work on the topic [9].

A. Survey of Existing Innovation Taxonomies

Based on a number of works that tried to revise the state of the art on innovation models, an overview of the existing classifications of innovation is summarized in the table below.

TABLE I. OVERVIEW OF PRIOR INNOVATION CATEGORIEATION MODELS

Taxonomy	**Categories**	**Description**
Schumpeter (1934) [8]	Incremental, Radical	Describes the degree of novelty involved in the innovation.
Robertson (1967) [10]	Continuous, Dynamically Continuous, Discontinuous	Describes the extend to which the original technological and behavioural pattern of the innovator is changed.
Pavitt (1984) [10]	Supplier Dominated, Specialized Suppliers, Science-based,Scale-Intensive	Describes the behavior of innovating firms, to predict their actions and suggest a framework for policy analysis.
Abernathy and Clark	Niche Creation Architectural,	Describes the impact of innovation on the market knowledge and technological
Taxonomy	**Categories**	**Description**
(1985) [11]	Regular, Revolutionary	capabilities of the firm.

Henderson and Clark (1990) [11]	Incremental, Modular, Architectural, Radical	Describes the changes in the technical core concepts of the product and in the linkages between core concepts and technical components.
Kleinschmidt and Cooper (1991) [12]	Low Innovativeness, Moderate Innovativeness, High Innovativeness	Focus on the extent of the novelty to the focal organization and competitive actors.
Durand (1992) [10]	Technological Input, Competence Throughput, Perception of the Market, Strategic Output	Focus on technical change and introduces the micro radical innovations concept.
Tushman, Anderson and O˝Reilly (1997) [11]	Architectural, Major Product or Service, Incremental Product or Service or Process, Major Process	Describes the impact of innovation on market knowledge and technology.
Christensen (2000) [12]	Sustaining, Disruptive	Describes how new firms win the battle with incumbent firms through disruptive innovation.
Garcia and Calantone (2002) [8]	Radical, Really New, Incremental	Uses the level macro versus micro and marketing versus technology perspectives.
Betz [2003] [12]	Incremental, Next Generation, Basic	Describes the introduction of innovation into the marketplace.
Westerski and Iglesias (2013) [9]	Proposed, Trigger, Innovation, Object	Captures the characteristics of ideas published in an Idea Management System.

B. ***Discussion***

The literature from innovation management area and works on classification of innovation provides more than a dozen taxonomies models. Therefore, the boundaries of the concept “innovation” have been differently defined to suit the purpose of the study at hand, which has led to many different conceptualizations of innovation. This has lead to problems for both academics and practitioners in the field of innovation management and because of the inconsistent classification of innovation no common understanding exists about what the meaning is of the many concepts of innovation. Consequently, there is little opportunity to build up shared innovative knowledge model. From a practical perspective, a semantic repository of innovative knowledge spanning multiple heterogeneous knowledge sources cannot be created.

Obviously, several researchers have attempted to solve this problem by comparing different categorizations and trying to make a universal classification scheme [8] or by trying to construct a classification scheme from a combination of literature reviews, case studies and integrating the perspective of the innovator

[13]. Except the Westerski"s work [9], these attempts did not result in a successful solution of the problem yet. Furthermore, the Westerski"s work seems not suitable to meet our innovation management approach that aims to deal with the emergent challenge of IMS which is to get "the right **idea** to the right **actors** in the right **context**". Dealing with this challenge requires seamless connections among ideas as innovation cores, innovation actors and innovation context. Such connections are required to support the emergence of vibrant communities that can exchange and effectively use the full range of data, information, knowledge and wisdom. In order to achieve this goal, a generic and new taxonomy that includes the various perceptions of innovation from the analyzed models and that provides innovative answers to their weaknesses was developed.

IV. GENERIC TAXONOMY FOR INNOVATIVE KNOWLEDGE MANAGEMENT

In the current section, we introduce our generic taxonomy that captures the characteristics of innovations. The choice of concepts that establish the taxonomy was based on our experience with different kinds of innovation management datasets. During our work, we gathered various datasets ranging from innovations for technology to products for mass consumer. Based on the analysis of these datasets, we enumerated the key characteristics of innovations that could be inferred from the innovation description and organized them into a hierarchy.

The Generic Taxonomy we propose is based on the statement: get "the right **idea** to the right **actors** in the right **context**". "Idea", "Actor" and "Context" are the main characteristics of an innovation that we established as the root for further taxonomy concepts which detail different aspects of the innovation characteristics.

TABLE II. INNOVATION TAXONOMY MAIN CONCEPTS.

Concept	**Description**
Idea	What are the achievements of the collective creativity and collaborative learning efforts?
Actor	Who are people involving in the innovation process?
Context	What are the contextual factors that impact the innovation process?

The explanation of this theoretical grounding of concepts per each taxonomy sub-tree is provided in the following subsections. Tables bellow summary the characters defined as main concepts identified on each innovation taxonomy sub-tree.

*A. **Sub-Taxonomy for Idea Management***

Table below summaries the characters defined as main concepts identified on Idea Management.

TABLE III. IDEA CATEGORIEATION SCHEME

Character	Description	Examples
Trigger	What kind of trigger that leads to the idea generation?	Customer Needs, Research Institutions, Social Media
Submission	How the Idea has been submitted?	Idea Contest, Brainstorming Session
Presentation	How the Idea has been formulated?	Text, Storytelling
Type	What is the type of the Idea?	Product, Service, Process
Originality	What is the scope of the Idea?	Incremental, Radical
Feasibility	Is the idea feasible?	High or Low on Operational, Technical or Economic level
Usefulness	What is the expected utility from the Idea?	Purpose, Issue
Target	What is the target Audience of the Idea?	Existing, New, Hybrid
Relationship	Are there any dependencies between the Idea and other Ideas?	Disjoint, Duplicate, Related
Process	What process runs on the idea to be developed?	Innovation Management Life Cycle [1], Stage Gate [1]
ProtectionLevel	What is the accessibility level defined for the Idea?	Private, Public

B. Sub-Taxonomy for Actor Management

Table below summaries the characters defined as main concepts identified on Innovation Actor Management.

TABLE IV. INNOVATION ACTOR CATEGORIEATION SCHEME

Character	Description	Examples
Type	Of what type is the actor?	Internal Collaborator, External Customer
Qualities	What are the qualities of the actor?	Knowledge, Expertise, Skills
Roles	Which roles can the actor have?	Leader, Reviewer
Character	**Description**	**Examples**
Team	Which teams can the actor belong to?	Design, Test, Marketing
Activities	Which actions are performed by the actor/team?	Selection, Implementation
Access Control	What access rights are allowed for the role?	Read, Write

C. *Sub-Taxonomy for Context Management*

Table below summaries the characters defined as main concepts on Innovation Context Management. TABLE V. INNOVATION CONTEXT CATEGORIEATION SCHEME

Character	**Description**	**Examples**
Type	Which type of context impacts the innovation?	Internal, External
Aspects	Which are the aspects of the innovation context?	Strategy, Environment
Goals	Which are the goals defined by the context?	Object, Viewpoint
Policies	Which policies are defined by the context?	Consultative decision making, Flat Hierarchy
Constraints	Which constraints exist in the context?	Financial, Ethical
Resources	Which resources are available within the context?	Space, Time
Learning	Which learning are available in the context?	Knowledge, Competencies

V. CONCLUSION AND FUTURE TRENDS

Classification through taxonomy can play an important role in the success of innovation management process. Bailey states that the classification as an aid to description can help to reduce complexity, enable comparison, be used as the basis for the identification of similarities and differences and can contribute to the study of relationships [13]. Classification is then, not an end in itself but has some instrumental purpose. Consequently, although the main contribution of this research is the development of a new taxonomy of innovation, its instrumentality will be demonstrated by its application in the context of innovation management and its relationship to innovation artefact.

In this paper, we have proposed a generic taxonomy for innovation management that aims to help innovation actors accessing, providing and sharing valuable knowledge in machine understandable form. We perceive this contribution as strong basis for the development of an efficient innovation management framework that aims to orchestrate collective intelligence and collaborative learning in a multitude of contexts.

In terms of future work, we plan to experiment our taxonomy, continue its improvement to reflect innovative knowledge as best as possible and use it to implement automated services such as annotation, similarity retrieval and recommendation on IMS.

REFERENCES

[1] L. El Bassiti, R. Ajhoun, “Toward an Innovation Management Framework: A Life-cycle Model with an Idea Management focus”, Int. J. Innovation, Management & Technology, vol. 4, no. 6, pp. 551-559, 2013.

[2] E. Wenger, “Communities of practice and social learning systems,” Organization, vol. 7, no. 2, pp. 225246, 2000.

[3] H. Chesbrough, “Why companies should have open business models,” MIT Sloan Management, Review, vol. 48, no. 2, pp. 21-28, 2007.

[4] J. Surowiecki, The wisdom of crowds. Why the many are smarter than the few and how collective wisdom shapes business, economies, societies, and nations, 1st ed., Doubleday, New York, 2004.

[5] P. Trompette, V. Chanal, C. Pelissier, "Crowdsourcing as a way to access external knowledge for innovation: Control, incentive and coordination in hybrid forms of innovation," in Proc. 24th EGOS Colloquium, 2008.

[6] R. McAdam, "Knowledge Management as a Catalyst for Innovation within Organizations: A Qualitative Study," Knowledge and Process Management, vol. 7, no. 4, pp. 233-241, 2000.

[7] D. Geiger, S. Seedorf, T. Schulze, R. Nickerson, M. Schader, "Managing the Crowd: Towards a Taxonomy of Crowdsourcing Processes," in Proc. 17th AMCIS, Detroit, Michigan, 2011.

[8] R. Garcia, R. Calantone, "A critical look at technological innovation typology and innovativeness terminology: a literature review," Journal of product innovation management, vol. 19, no. 2, pp. 110-132, 2002.

[9] A. Westerski, C. A. Iglesias, "Gi2MO Types: A Domain Independent Idea Categorization Schema for Idea Management Systems," in Proc. LSID workshop, 2013.

[10] M. Coccia, "Classifications of Innovations - Survey and Future Directions," Ceris-Cnr, Working Paper, no. 2, Turin, 2006.

[11] S. Popadiuka, C.W. Choo, "Innovation and knowledge creation: How are these concepts related?," Int. J. Information Management, vol. 26, no. 4, pp. 302-312, 2006.

[12] L. Miller, R. Miller, "Classifying Innovation," Int. J. Innovation and Technology Management, vol. 9, no. 1, pp. 1250004-1-1250004-18, 2012.

[13] R. Adams, "Perceptions of innovations: exploring and developing innovation classification," PhD thesis, Cranfield University School of Management, 2003.