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Relation Analysis of Knowledge Management, Research, and Innovation in University Research Groups

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Abstract: Knowledge is a competitive advantage for companies. Knowledge Management helps to keep this competitiveness. Universities face with challenges in research, innovation and international competitiveness. The purpose of this paper includes studying Knowledge Management Models, and Innovation Models apply to Research Groups of Universities, through an analysis of relation in inter-organizational level. Some researchers and leaders of research groups participated in a survey about knowledge management and innovation. Here we show the relationship between knowledge management, innovation and research, including processes and operations performed by universities around these. We organize the results in three dimensions: Knowledge Management perception, the relationship between Knowledge Management and Innovation, and Strategic Knowledge organization. Too, we identify a generality of good practices, challenges, and limitations on Research Groups for Knowledge Management.

Keywords: knowledge management; innovation; research; research group; University.

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Introduction

Universities support innovation and science development with their scientific and technological capacities. Universities make efforts on research, knowledge production, and solutions for society problems in addition to teaching (Dalmarco, Dewes, Zawislak, & Padula, 2011; Gillian Ragsdell, Rathi, Given, & Forcier, 2016). Accordingly, universities play an essential role in the transformation process of society, because these are institutions that take place on a public stage for the advancement of knowledge which modifies and transforms the socio-economic dynamics (Ovallos-Gazabon, De-La-Hoz-Escorcia, & Maldonado-Perez, 2015). Education sector and universities face with knowledge production requirements, high-quality teaching, research, innovation, and extension. Researchers and professors work to fulfill these aims. Universities focus its efforts on projects development, research development, and products generation to fulfill high requirements on teaching, research, and innovation. However, in some cases, universities achieve success by sacrificing what they consider low-impact activities, such as Knowledge Management. According to Azagra-Caro (Azagra-Caro, 2004), universities have low participation in the socialization of knowledge management experiences. Knowledge Management accelerates the knowledge production and research results, especially for "higher-learning institutions in which the environment is essentially a collection of individual experts who constitute an accepted body of knowledge for many degree-granting areas" (Wei Chong, Yen Yuen, & Chew Gan, 2014).

In a broader context, Knowledge Management is "the organization and structuring of processes, infrastructures, and organizational mechanisms to create, store and reuse organizational knowledge" (Huang, Lee, & Wang, 1998). Knowledge Management provides answers to the needs of production, competitiveness, financing, and innovation to an organization in the business and industrial context (Honarpour, Jusoh, & Md Nor, 2012; Liao & Wu, 2010); also knowledge management enables the change of data and simple information into data with useful value to improve and increase competitive advantage (Lopes Ferreira & Pilatti, 2013). In this context, university role is to produce and disseminate knowledge. Also, studies show their necessity of Knowledge Management and its effect on innovation (Devi Ramachandran, Chong, & Wong, 2013). Campos et. al. (2003) concluded that knowledge and intellectual capital is a riches for universities and research groups. Knowledge management and innovation factors are "actually specific to the characteristics of a particular context and system". The same applies in the academic and research context (Matayong & Mahmood, 2013), hence in this study we show some dimensions and factors for Knowledge Management and Innovation in universities.

This paper includes the analysis of the relation between knowledge management, innovation, and research in the university context and inter-organizational level perspective, which are two important factors to investigate in Knowledge Management. In fact, there is little research on the subject (Patil & Kant, 2014). We identify good practices, challenges, and limitations of Knowledge Management in Research Groups. The paper is a contribution to fields of Knowledge Management and Education; here we enlarge the analysis into three variables: knowledge management, innovation, and research.

We organize the results in three dimensions: Knowledge Management perception, the relationship between Knowledge Management and Innovation, and Strategic Knowledge organization. The results show the relationship between knowledge management, innovation

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and research, including processes and operations performed around these by universities. The perception of researchers and the actions that they perform corroborates the relationship between knowledge management and innovation. However, it is necessary to have accurate and consistent strategies to ensure successful communication between all those involved in the research development. Results evidence the need to define and improve knowledge management policies, processes for storage and transfer of knowledge.

The structure of the remainder of the article is: the first section covers state-of-the-art models of Knowledge Management and Innovation. The second section describes the methodology. The third section presents the results and analysis. And finally, conclusions of the study are presented.

Definition of Knowledge Management and Innovation

Knowledge is a set of cognitive beliefs. These cognitive beliefs are experienced, confirmed and contextualized. Knowledge is often present in documents and databases but is also within routines, procedures, practices and standards of the organization. Likewise, knowledge is related to the processes of creation, transmission, use and information management (Ikujiro Nonaka, Kodama, Hirose, & Kohlbacher, 2014).

Knowledge-management discipline emerged around 1995 and since its inception has been many definitions found in the literature. L. Chen & Mohamed (2007) state that knowledge management is "a process that focuses on knowledge-related activities to facilitate knowledge creation, capture, transformation, and use, with the ultimate aim of leveraging organizations' intellectual capital to achieve organizational objectives". Knowledge Management is the process of identifying, acquiring, using, and creating data, information, and knowledge, with internal and external organizational-relevance, to improve both efficiency and effectiveness of the company, and ensure their permanence in the competitive scenario. These definitions indicate that knowledge management is mostly related to its application in the business sector organizations.

Also according to (Groff & Jones, 2012) "Knowledge management (KM) refers to a set of organizational activities to achieving organizational objectives by making the best use of knowledge". Knowledge Management is essential for organizational learning. The knowledge management processes (i.e., knowledge capture, sharing, and apply) can support organizational processes involving collective learning and individual learning in university research groups.

Moreover, considering the university as a company into the concept of Nonaka & Takeuchi (1995), knowledge management is the capacity to create new knowledge, disseminate it within the research groups and incorporate it in all research processes.

The innovation and technological change are associated, however, Schumpeter (1934) referred to the innovation of all kinds. Innovation "represents a new way of doing things resulting in a positive change". Innovation includes any transformation based on knowledge that creates or adds value in a market. The innovation processes revolutionize economic structure from within, renewed by the destruction of old, and continuous creation. This process called creative destruction "is the essential element of capitalism" (Joseph A. Schumpeter, 2013). According to OECD Frascati Manual (2002), innovation is the transformation of an idea into a marketable product or service, a manufacturing process or operational distribution, new or improved, or a new method of providing a social service.

Models of Knowledge Management and Innovation

There are multiple models of knowledge management in the state of the art (Coukos-Semmel, 2003). Each with common characteristics and particular emphasis.

The Wiig Model identifies conditions and organizational elements: businesses, customers, resources, and skills. It consists of four steps: Construction, storage, disposal and application. The Wiig model is composed of elements and activities and is applicable in business organizations where resources are significant, as people and capital.

Gopal and Gagnon Model is a transformation model of knowledge from tacit to explicit, organized into three areas: knowledge admin, information admin, and learning admin. But, it is limited to the transformation of knowledge from tacit to explicit.

The KPMG model is divided into four phases: a) purchase, b) indexing, filtering and bond, c) distribution, and d) application. The KPMG model aims at improving customer service in financial organizations. However, other contexts show that it can extend its application (Lindenhall, Väisänen, Soriano, & Miguel, 2014).

Another model, KMAT, has four factors: leadership, culture, technology, and measurement. KMAT has seven stages: capture, identify, create, share, apply, organize, and adapt. The KMAT model allows evaluation and diagnosis of knowledge management model. The KMAT model used for diagnostic and evaluation of knowledge management models.

The Meyer and Zack Knowledge Management Model bases on the physical products development cycles. This model divides into five stages: acquisition, refining, storage and retrieval, distribution, and presentation. Meyer and Zack define a model according to Knowledge Management elements. It recognizes as a generic model with the potential to be adapted to different types of organizations.

The Model of McElroy set up with knowledge production and knowledge integration processes, feedback loops to the organization's memory, claims or incidents, and environments business process. The McElroy Model makes a clear description of knowledge evaluation and support decision-making. It focuses on identifying knowledge with value to an organization and its members.

The 10-Steps Road Map Model organizes in four phases and ten steps. It aims to implement a knowledge management model in business organizations. It is a life cycle for the implementation of a knowledge management model in a business organization. It is an explicit model and therefore extensive.

Recently, Nonaka, Kodama, Hirose, & Kohlbacher (Ikujiro Nonaka et al., 2014) established a knowledge management model that integrates the exploration and exploitation of knowledge dynamically; this model is named dynamic fractal organization. They state that "there are no pure forms of exploration and exploitation, just as there are no pure forms of tacit or explicit knowledge and knowing". According to them, the dynamic fractal organization is a "new organizational model to foster innovation through sustained knowledge creation". Indeed, the dynamic fractal organization shows an apparent relationship between the innovation and knowledge management.

Also, in the field of innovation models, a set of recognized models is observed. Among these, some similarities with knowledge management models are appreciated.

The Linear Model of Innovation starts with basic research, continues with the applied research phase, technological development and finally, the marketing. However, this model can be considered rigid with an absence of feedback. On the other hand, the Demand-Pull Model is based on the Linear Model, sets market needs or customers as the first stage, and Inherits most of the limitations of the Linear Model of Innovation (Godin & Lane, 2013).

The Triple Helix model integrates university, industry, and government. This model is the key to improving innovation conditions in a knowledge-based society. It describes the interaction between the helix in society but not describes an innovation processes or phases (Leydesdorff & Etzkowitz, 1998).

The Marquis model establishes the idea as a fundamental point of innovation. The idea can come from any part of the organization, not only of demand or basic research (Myers & Marquis, 1969). However, the Marquis Model can be considered a rigid model, and lacks flexibility for real innovation processes.

The Kline Model: Chain Linked Model consists of three innovation areas: research, knowledge, and innovation as the central process allowing interaction among areas. It maintains linearity in innovation area and is very complete. However, it can take a long time to apply. The Chain Liked Model focuses on innovation description, without addressing inside knowledge about processes and research (Kline & Rosenberg, 1986).

This analysis of knowledge management models and innovation models supports the determination of variables, dimensions, and indicators of interest. Next, the methodology section describes them.

Method

This study is a survey with a predominantly quantitative approach. A population sample of researchers and leaders of research groups in a university on Colombian Caribbean Region participate in the study.

Table 1. Population and non-probability sampling for research.

Item	Quantity
Colombian research groups on Engineering and Technology	650
Engineering Research groups in Barranquilla, Colombia	24
Engineering Research groups included in study	5
Total researchers included in study	16

The target population corresponds to twenty-four engineering research groups in Colombian Caribbean Region. A non-probability sample was selected. A multistage sampling driven by roles, group member, researching expertise, among others.

The instrument consists of interest variables, dimensions, and indicators, which was peer reviewed. The dimensions and indicators base on literature review and analysis of the research problem.

Table 2. Variables, dimensions and indicators of survey design.

Variable	Dimension	Indicator	Total Items
Knowledge Management	Knowledge Management Perception	Understanding of knowledge management. Commitment to knowledge management. Perception of knowledge management work.	9
	Relationship between Knowledge Management - Innovation	Implementation of a knowledge management plan. Maturity and control of knowledge management plan.	7
	Strategic Knowledge Organization	Storing knowledge Knowledge socialization Use of Information and communications technologies (ICT) Strategic knowledge organization Information quality	19
Innovation	The relationship between Knowledge Management - Research - Innovation	Relations with the business environment. Innovative leadership Perception of knowledge management Innovation relationship	8

Results and discussions

The results are in Table 7. It uses the following Likert scale for the response options:

Table 4. Likert scale used in the survey.

5	4	3	2	1
Totally agree	Moderately agree	Neither agree nor disagree	Mildly disagree	Strongly disagree

The analysis of variables, dimensions, and indicators uses descriptive statistics. The interpretations of measures and variability are defined as follow:

Table 5. Scales for responses category.

Range	Interval	Responses category	Interpretation
5	$4.21 < x \leq 5$	Very High	Respondents agree highly with the item statement
4	$3.41 < x \leq 4.2$	High	Respondents agree with the item statement
3	$2.61 < x \leq 3.4$	Middle	Respondents do not disagree or agree with the item statement
2	$1.81 < x \leq 2.6$	Low	Respondents disagree with the item statement
1	$1 < x \leq 1.8$	Very Low	Respondents disagree highly with the item statement

Table 6. Scales for dispersion category.

Range	Interval	Dispersion Category	Interpretation
5	$1{,}60 < DE \leq 2{,}00$	Very High Dispersion	Respondents have very different opinions regarding the item statement
4	$1{,}20 < DE \leq 1{,}60$	High Dispersion	Respondents have different opinions regarding the item statement
3	$0{,}80 < DE \leq 1{,}20$	Mid Dispersion	Respondents have different but similar opinions on the item statement
2	$0{,}40 < DE \leq 0{,}80$	Low Dispersion	Respondents have similar views on the item statement
1	$0{,}00 < DE \leq 0{,}40$	Very Low Dispersion	Respondents have the same views on the item statement

Table 7. Survey results.

Variable	*Dimension*	*Indicator*	*Average*	*Category*	*Standard deviation*	*Category*
Knowledge Management	Knowledge management perception	Understanding of Knowledge Management	3,94	High	1,10	Mid dispersion
		Commitment to Knowledge Management	3,55	High	1,17	Mid dispersion
		Perception of Knowledge Management work	3,75	High	1,09	Mid dispersion
		Variable	3,75	High	1,13	Mid dispersion
Knowledge Management - Innovation	Relationship between Knowledge Management and Innovation	Implementation of a Knowledge Management plan	3,25	Middle	1,15	Mid dispersion
		Maturity and control of Knowledge Management plan	3,51	High	1,19	Mid dispersion
		Variable	3,36	Middle	1,17	Mid dispersion
Knowledge Management	Strategic knowledge organization	Storing knowledge	3,00	Middle	1,15	Mid dispersion
		Knowledge Socialization	3,47	High	1,23	High dispersion
		Use of Information and communications technologies (ICT)	3,04	Middle	1,27	High dispersion
		Strategic knowledge organization	3,76	High	1,11	Mid dispersion
		Information quality	3,82	High	1,01	Mid dispersion
		Variable	3,42	High	1,21	High dispersion

Dimension: Knowledge management.

59% of researchers have clarity about what is knowledge management and apply some action to them in their processes. Additionally, knowledge management processes are considered a fortress to innovation. Though, there is no consensus on an exact knowledge management concept. Similarly, multiple concepts of knowledge management are in the state of the art.

Unlike small and medium-sized enterprises, academic institutions and research groups have greater clarity about the concepts involved in knowledge management and a better perception of the benefits of knowledge management.

There is a research center running some knowledge management strategies. However, research groups lack a plan or program for the implementation of projects and budgets for knowledge management.

Researchers say that the commitment of the organization with knowledge management is high. However, an average of 3.55 shows that many aspects need to be improved. Obeidat, Masa'deh, & Abdallah (2014) establish that high levels of knowledge worker commitment are critical to knowledge creation.

Strategies and knowledge management work become more important in different contexts such as small and medium enterprises, education, and medical. In universities and research groups, activities of knowledge management work are typically carried out by researchers individually. Researchers do not perform collaborative work in knowledge management. The success of knowledge management strongly depends on the acceptance and commitment of people involved in this process. At this end, research team collaboration and participation is required to underpin an efficient knowledge transfer.

The relationship between Knowledge Management and Innovation.

Some economic domains such as the service sector, have studied the relationship between knowledge management with different business objectives, like competitiveness, innovation, among others (Farzin, Kahreh, Hesan, & Khalouei, 2014). From the perspective of multinational companies, innovation requires the acquisition of knowledge and highlight the participation of leaders in innovation. The results show a strong relationship between knowledge management and innovation, particularly in research groups and academia.

Researchers apply some knowledge management activities independently, to organize documents related to projects. However, there are no institutional knowledge management plan neither strategies to provide previous knowledge to new members. Define a knowledge management plan is critical for involving research and innovation into a dynamic convergence in university research groups. In fact, a growing demand for researchers with skills in knowledge management is expected.

Research groups have tacit strategies for control, monitoring, and availability of information. They lack knowledge management indicators because they have an early plan documented. The level of efficiency increase when a knowledge management plan exists. The relationship with innovation is the product of a knowledge management plan with maturity. Oliveira & Pedron (2014) define three strategic benefits of maturity models for knowledge management: absorptive capacity, innovation, and organizational performance.
Strategic knowledge organization.

The researchers make use of technological resources individually, as computer equipment and cloud computing to store organized documents. However, they lack information systems to storage their knowledge, and a budget for knowledge management (implementation of repositories, storage, etc.). Repositories is an essential tool for systematic storage of knowledge, especially to transform tacit knowledge.

Research Groups socialize knowledge and result internally among themselves. There are gaps of knowledge socialization among research groups: lack internal reporting, communication ways or strengthening of knowledge acquired, developed project information, and other research actions. Jabbary and Madhoshi (2014) state that "organizations with innovation-supporting cultures are more likely to implement Knowledge Management system, so that information sharing is facilitated through internal norms, which encourages individuals to share their knowledge". However, "many faculty members consider knowledge as proprietary and something that is not shared freely" (Wei Chong et al., 2014).

Researchers used available and easily accessible resources. Organization should ensure continuity of services such as electricity, the internet, information repositories and other technological tools for knowledge management.

The advances in Knowledge Management based on Information and communications technology (ICT) provide important means to increase productivity and achieve the effectiveness of the research team since it provides methods and tools for sharing, understand, reuse, and facilitate knowledge access by research team to create. ICT can be used to systematize and enhance knowledge management in organizations such as university research groups.

As for the organization, groups are strategically organized to generate knowledge and provide solutions. It should expand the organization to higher levels, involving the deanship, its researchers, and groups.
Researchers ensure the quality of the information used and generated by their research. There are no indicators or a system for monitoring and evaluating of information quality. There is no information platform to record companies with partnership opportunities.

Conclusions

Without a Knowledge Management Model, incorporation of new teachers and researchers is more difficult because the lack of guidelines to provide knowledge of the institution and previous researchers to the new team. Further disadvantages are due to the absence of procedures regarding communication protocols, internal disclosure, knowledge strengthening, research projects developed, or products obtained. Consequently, locate historical information on projects is difficult, especially project leader left the institution. On these conditions, Knowledge production is slow down.

There are many Knowledge Management Models and Innovation Models, most of them aimed at business organizations. On theoretical grounds, this study is a contribution to the knowledge management literature concerning to Research Groups and Colombian Researchers. Research groups accept the importance of knowledge management and its relationship with innovation. However, the processes of Knowledge Management is nascent and weak in the research groups studied, its effect on innovation is small in practice.

In institutions with immature Knowledge Management processes a strong management commitment is required. This commitment is on a Budget Plan, Knowledge Management projects, and a system supporting them. We suggest the analysis of integrated models Knowledge Management and Innovation.

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