

Knowledge Management as Tool for Environmental Management System Implementation in Higher Education Institutions

Natalia Marulanda Grisales

Abstract—The most significant changes in the characteristics of consumers have contributed to the development and adoption of methodologies and tools that enable organizations to be more competitive in the marketplace. One of these methodologies is the integration of Knowledge Management (KM) phases and Environmental Management Systems (EMS). This integration allows companies to manage and share the required knowledge for EMS adoption, from the place where it is generated to the place where it is going to be exploited. The aim of this paper is to identify the relationship between KM phases as a tool for the adoption of EMS in HEI. The methodology has a descriptive scope and a qualitative approach. It is based on a case study and a review of the literature about KM and EMS. We conducted 266 surveys to students, professors and staff at Minuto de Dios University (Colombia). Data derived from the study indicate that if a HEI wants to achieve an adequate knowledge acquisition and knowledge transfer, it must have clear goals for implementing an EMS. Also, HEI should create empowerment and training spaces for students, professors and staff. In the case study, HEI must generate alternatives that enhance spaces of knowledge appropriation. It was found that 85% of respondents have not received any training from HEI about EMS. 88% of respondents believe that the actions taken by the university are not efficient to knowledge transfer in order to develop an EMS.

Keywords—Environmental management systems, higher education institutions, knowledge management. training.

I. INTRODUCTION

THERE is a growing preference for the acquisition of goods and services that are environmentally friendly. This implies the fulfillment of a number of stages like identification, mitigation and treatment of environmental impacts. Those impacts are generated by several productive and service activities that use natural resources.

Consumer actions are also influenced by the process of organizational decision-making. The process must ensure an inclusive corporate environmental culture where every stakeholder of the company has a key role. Companies must develop communication mechanisms that facilitate knowledge transfer, knowledge exchange and knowledge access. This knowledge is required to develop activities in a sustainable way. It is based on a coordination mechanism between economic, social and environmental aspects.

HEIs act as agencies responsible of teaching processes. They must generate professional, social and sustainable

opportunities for comprehensive training of human beings [1]. These processes will only have effect if institutional knowledge is properly managed. Institutional knowledge consists of academia, culture, creativity and experience of each stakeholder.

HEIs should coordinate environmental management and KM. Also knowledge transfer facilitates empowerment and learning from the different stakeholders about strategies that must run for prevention, correction and mitigation of environmental impacts. Environmental impacts are produced in compliance with the missionary activities (Teaching, research and extension).

The rest of the paper is as follows: In the next section KM, EMS and the interaction between both of them are described. In the next section, the methodology is presented. Then the results of the study will be addressed. Finally, the respective findings of the research will be given.

II. KNOWLEDGE MANAGEMENT

It is considered that KM was born as a study area in 1990 resulting from developments in information technology and computing, the development of types of consulting and promotional campaign at conferences [2]. Moreover, the uncertainty conditions and constant changes on markets characteristics demanded the exchange of knowledge among all individuals and external stakeholders on an organization [3]. This allowed the development of KM in order to improve communication between individuals, document management, coverage of customer requirements, quality and organizational culture [4].

KM is the ability of individuals in a company to understand and use business information through the use of technology and knowledge transfer [5]. KM also coordinates a variety of data and information in order to encourage innovation and creativity of individuals [6]. Similarly, KM facilitates business management from the use of applications, processes and technologies [7]. At the same time, the main purpose of KM is to enhance the knowledge transfer from those who have it to the other members of the company who require it to meet its tasks efficiently. Therefore businesses require a correct communication platform to provide knowledge transfer either directly or indirectly [8]. However, there are some obstacles that restrict KM process such as information access, corporate hierarchical structure, governance, the secret as a cultural component and the fear of long periods of implementation [9].

In order to understand the concept of KM is critical to

Natalia Marulanda is a Research Professor at Corporación Universitaria Minuto de Dios, Seccional Bello, Colombia (e-mail: nmarulandag@uniminuto.edu.co).

understand the terms of tacit and explicit knowledge. These terms should be used together to perform a holistic KM. Those statements are going to be discussed below.

A. Tacit and Explicit Knowledge

Tacit knowledge is acquired by performing daily tasks, but usually people are not aware of what they are learning [10]. Tacit knowledge is part of practical intelligence that is the individual's ability to learn from experience and replicate that knowledge in the acquisition of personal goals. Tacit knowledge is not codified. It is characterized by the know-how gained in formally through learning guidelines and procedures. It is not associated with specific research, technical or training programs [11]. In addition, tacit knowledge is manifested from the observation of the activities carried out by experts, learning and training, and learning by doing processes. However, the term of tacit knowledge has expressed some ambiguities [12]: It is both individual and group. It is obtained through experience even though it is innately in people. It can be obtained by contact with other individuals or not. It can develop behavioral routines. It always promotes innovation. It can be transformed into explicit knowledge or not.

Explicit knowledge is formal and systematic. It can be achieved through reading projects, equipment manuals and discussion [13]. It can easily be collected, documented, stored and retrieved independently of any individual through the media and technological systems [14]. In addition, explicit knowledge can be communicated, understood and shared without the presence of a subject or individual. It is easy to transmit and communicate through logical deductions and formal study [15].

B. KM Models

Nonaka and Takeuchi developed one of the most outstanding KM models. It is called SECI model which is comprised of four elements: Socialization, externalization, combination and internalization [16]. Socialization can transmit the new tacit knowledge by communicating experiences. Externalization formalizes the knowledge that is available to other individuals. Combination transforms explicit knowledge into more complex and systematic elements. Internalization added explicit knowledge into tacit knowledge that can be addressed by the individual again. However, this model has presented some detractors because it uses factors and variables that hinder the measurement of knowledge creation process [17]. It is a model that is based on the intuition that does not show a clear method study [18]. Combination and internalization phases are not clearly described and they include typologies that have not been demonstrated [19]. The overall process of knowledge creation is unclear because it is not clear who generates it [20].

Other models that describe business needs in a better way had been generated. The KIKI model has a customer-oriented view and it is based on collaboration, service characterization, training and knowledge implementation through new service ideas [21]. The knowledge transfer and creation model

presents a coordination mechanism of tacit and explicit knowledge. Its dissemination throughout the company takes place in four different stages: Individual, small groups, organization and external stakeholders [22].

The model of KPMG Consulting Group proposes knowledge unification in a complex hierarchical system of distribution, culture, leadership, learning elements, ability of individuals and teamwork. This happens from the use of elements that facilitate learning ability of the companies [23]. The company based on the information model presents three strategies that can be performed within companies [24]: First enterprises must convert information in clear and precise indicators. Then companies have to optimize business areas by removing or transforming those areas where is data repetition. Also the model presents project management in a way that the work is divided into specific tasks. At the same time, there is a model that brings together holistically phases of KM: Exploration and exploitation [25], [26]. The first is made up of acquisition, socialization, externalization, combination and internalization of knowledge. Meanwhile, these consider its integration, transfer and storage.

III. ENVIRONMENTAL MANAGEMENT SYSTEMS

There is growing interest in companies to generate actions aimed to implement sustainable business activities. These should be documented and transferred to all members of the organization. Therefore, the EMS were created. These include a number of business processes that were developed to achieve corporate goals. These ensure a proper use of natural resources and an effective treatment of adverse effects produced on the environment.

An EMS is a set of regulations in an organization in which policy interface is implemented. Mechanisms of planning and implementing actions to protect and improve the environment and the company itself are also generated [27]. The EMS are closely related to quality management systems and they are part of a systemic process and continuous improvement. They facilitate corrective actions and improvement of the impacts on the environment [28].

The International Organization for Standardization (ISO) developed an international standard that allows all kinds of organizations to design procedures that can help companies to anticipate environmental impacts and improve their behavior at an environmental level. Those procedures are called ISO 14000. The 2015 version provides organizations with a practical policy to promote environmental protection for the specific context in which each business operates. Among the most important changes is carrying out these assessments from the perspective of life-cycle assessment [29].

There are a set of common practices among some business when they are implementing a new EMS [30]. First of all, if companies do not have a specialized team in the implementation of EMS, managers tend to implement actions to mitigate environmental impacts in an empirical way. Secondly if companies have a formalized EMS, managers often do not know what to do with the results. For this reason, they waste processes and learning curves.

The United Nations Industrial Development Organization (UNIDO) proposed the Transfer of Environmentally Sound Technology (TEST) that is divided into three basic principles [31]. First, it has a preventive approach to ensure clean production processes. Secondly, this approach has to be managed properly and involve all stakeholders. Finally, corporate strategy must have social responsibility policies that facilitate the adoption of sustainable business strategies. For all this, UNIDO proposes combining TEST methodology with EMS, in accordance with the guidelines established the ISO 14000 standard.

A. Environmental Certifications

Environmental certifications were introduced as tools that allow companies to organize their internal management taking into account their environmental impacts and the measures to prevent and reduce them. Standards accepted by the academic and business community in terms of HEIs are: "Eco Management and Audit Scheme (EMA)" [32] and ISO 14001 [29]. However, there are some differences between both standards (see Table I).

TABLE I
MAIN DIFFERENCES BETWEEN ISO 14001 AND EMAS REGULATION

ISO 14001	EMAS
International	European Union
Technical standard	European Regulation
Imposes a commitment to implement current legislation	It requires companies to full compliance with current legislation
Audits in order to check compliance with the requirements through an accredited institution	It requires compliance verification
Environmental initial review is recommended but not audited it	Initial environmental review is mandatory and verifiable
Design and maintenance of EMS is a manager's responsibility	It requires the active participation of employees in the design and maintenance of the EMS
The publication of environmental information is a management decision	It requires the publication of an environmental statement (Annual report) that is validated by an independent expert

Source. Own elaboration

Despite all, the interest of this research focuses on EMS that has been implemented in HEIs. This will be addressed in the next section.

B. EMS at HEIs

In this area, several outstanding alternatives have been developed. EMS applied to institutional mission processes (Teaching, research and extension) were transformed into actions that make universities sustainable institutions. EMS were no longer a physical or digital document. This was transformed into concrete actions involving all stakeholders of the institution [33].

In the United States, the first institutions interested in applying EMS in their missionary activities were: University of South Carolina, The Medical University of South Carolina and Clemson University. These organizations developed the initiative "Sustainable Universities of South Carolina" (SC-SUI) [34]. The Osnabrück University (Germany) developed the "Environmental Management Osnabrück Model for

Universities". It is based on the EMAS [35].

Subsequently, a model was developed for the implementation of an EMS in all Universities and HEIs in the United States. It is based on an adaptation of the ISO 14001 and the recommendations of the US EPA [36]. In the case of Colombia, an EMS model was proposed. It takes into account the actions of each institution. It is made up of an appropriate and safe treatment of solid waste and hazardous materials [37].

Other HEIs that have implemented EMS are: Newcastle University, The University of Bristol, The University of British Columbia, and University of Bremen. In Colombia appear: Industrial University of Santander, Universidad del Valle, Universidad de los Andes, National University of Colombia, Pontifical Javeriana University, Universidad Libre de Colombia and Corporacion Universitaria Minuto de Dios.

IV. KM AND EMS

HEIs are transforming their certification processes into sustainable activities. However, this transformation requires a combination of resources and capabilities that can be tangible and intangible. Also it requires the commitment of all stakeholders of the institution. Among these resources is knowledge with its tacit and explicit components. HEI should ensure forums for participation, communication and learning among different stakeholders in order to achieve sustainability. The required knowledge in the implementation of an EMS is [38], [39]: Policies, regulations and environmental certifications; environmental knowledge and skills to manage knowledge. Also it requires methods and techniques to assess and monitor different levels of impact.

Knowledge about products, services and their impact on the environment is required. Theoretical and practical knowledge of design, integration and implementation of an EMS is required. Therefore, KM not only increases the productivity of the organization, but also improves environmental operations. HEI should establish coordination mechanisms between KM and EMS can improve technological development, management efficiency and firm performance at the same time [40]. However, EMS would be more effective, if they have more community involvement. Also, it is necessary to include tacit knowledge, creativity and culture. Besides education and training become essential elements for the development and implementation of an EMS in any institution [41].

V. METHOD

The methodology is qualitative. Also it has a descriptive approach. It is based on literature review about KM, EMS and the relationship between them. When the relationship between the components of interest was obtained, we proceeded to perform a case study at Corporación Universitaria Minuto de Dios, Seccional Bello. We carried out the primary information by designing a form. Then we conducted a survey with 266 representatives of the university community, including teachers, students and administrative staff.

The form is made up of open and closed questions. The

form is divided into four sections (see Table II).

TABLE II
CODING QUESTIONS

Codification	Chapter
PI1, PI2, PI3, PI4, PI5, PI6, PI7, PI8, PI9, PI10, PI11	Environmental management Perception in the HEI I (Actions taken by members of the academic community)
PII1, PII2, PII3, PII4, PII5, PII6	Environmental management Perception in the HEI II (Actions taken by the directors of the institution)
A1, A2, A3, A4, A5, A6	Actions to be implemented (Findings on a set of proposals that could be incorporated in the HEI)
Comments	Additional comments (Respondents can express their general assessments and proposals for implementing an EMS in HEI)

Source. Own elaboration

Secondary information was obtained through literature review in databases, Institutional Repository, files, reports and

journals in the field. Then, a diagnosis was made in the HEI. It was intended to identify the very particular traits of EMS and KM. The findings are going to be presented below.

VI. RESULTS

Governance and management in HEI should be based on a set of strategies and alternatives that involve all stakeholders and missionary activities. This involvement is generated from the creation of communication between stakeholders. However, these actions are insufficient. It is necessary to generate real empowerment in all individuals.

Communication, empowerment, dialogue and involvement of all stakeholders are essential components of KM and EMS. Therefore, based on the review of the literature, common areas of interest between GC and SGA (see Table II) were obtained.

TABLE III
COMMON ASPECTS BETWEEN KM AND EMS

	KM	EMS
Culture	It facilitates learning ability in companies. It should be considered in the process of resistance to change.	It facilitates the learning capacity of the policies and requirements in terms of sustainability and environmental protection.
Creativity	It encourages innovation in individuals and company.	It encourages innovation and development of new techniques, tools and alternatives for management of renewable and nonrenewable resources.
Teamwork	It allows the exchange and transfer of data, information and knowledge.	It allows the transfer of data, information and environmental knowledge among stakeholders.
Empowerment	Organizational growth for all members based company access to decision-making.	It allows internalize and implement environmental management strategies. Also it facilitates changes in organizational culture.
Interaction and communication	Between internal and external members to meet market demands.	Among the various stakeholders to bring forward joint actions to use renewable and nonrenewable resources.
Customer orientation	It can capture and meet the requirements of customers.	---
Training	Power individual and collective learning. Promotes the correct execution of daily activities. Promotes decision making and business management.	It promotes individual and collective learning on commitments and responsibilities to implement the environmental management process.
Knowledge transfer	It generates economic value to companies.	It allows the adoption of environmental knowledge required in the EMS.
SECI	It facilitates the transfer of knowledge based on motivation, leadership and involvement of the entire hierarchical structure.	It promotes the involvement of all stakeholders in environmental management of institutions.
Knowledge storage	It retains the essential knowledge for organizational operation.	It retains the essential knowledge for organizational operation in environmental terms.
Knowledge Integration	It allows abbreviate and understand the new working methods.	It allows abbreviating and understanding the new environmental management methods.
Technological development	It can solve problems based on applied research and best practices. This improves productivity and organizational competitiveness.	It allows designing and developing tools, products and services that facilitate environmental management.
Learning curves	It improves productivity and competitiveness of individuals and organizations.	It allows controlling and monitoring of environmental knowledge required in the SGA.

Source. Own elaboration

The Corporación Universitaria Minuto de Dios has a non-formalized Environmental Management structure. This looks for the proper use of natural resources and environmental protection. This structure is led by the Administrative Group of Environmental and Health Management (GAGAS), which was reactivated in March 2016. However, the strategies adopted by the GAGAS have had little impact among members of the university.

The above information was obtained based on 266 surveys of students, professors and staff. 250 surveys were validated. For analysis was taken into account coding questions by considering their distribution in the four functional groups of the form. In the case of environmental management perception in the institution I (see Fig. 1), participants (87.2%) are taking

care of natural resources and the preservation of the environment. However, they have not received training or training sessions have not been recurring, as 75.6% of respondents said.

The alternatives conducted by the case study organization have not favored individual and collective learning. These alternatives do not allow the involvement of different stakeholders in the administrative processes for the appropriate use and conservation of natural resources and the environment. This has created a general perception about the nonexistence of environmental management in the different missionary activities of the institution (teaching, research and extension).

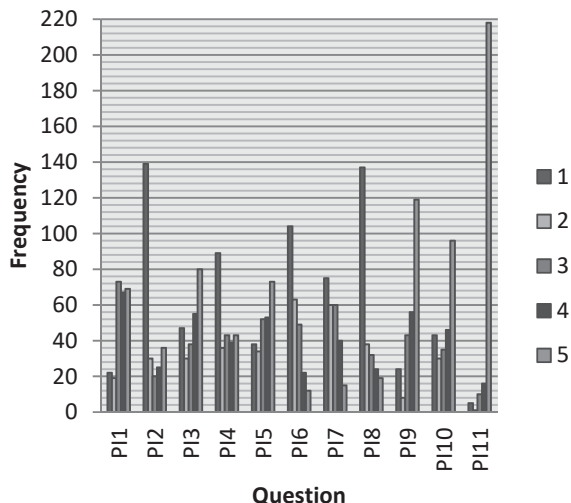


Fig. 1 Environmental management Perception in the HEI I

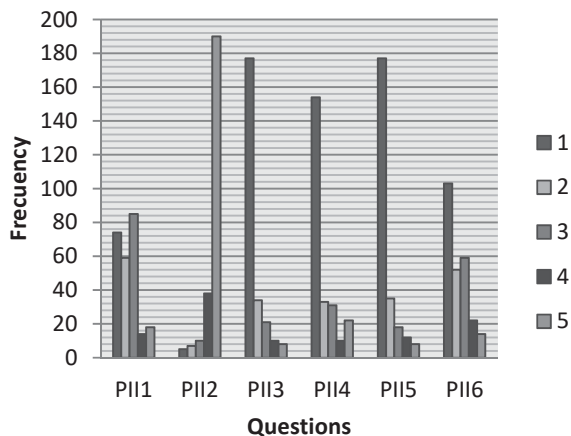


Fig. 2 Environmental management Perception in the HEI II

In section “Environmental management Perception in the HEI II” (see Fig. 2), 88% of respondents indicated that the actions taken by the institution for the knowledge transfer for environmental management have been little insufficient. For this reason, the care of the environment is not efficient. Everything should start by the visibility of GAGAS, which is little known or completely unknown for 92.8% of the participating individuals. This organizational structure will support for different strategies and alternatives that managers brought forward in environmental management. These alternatives involve all stakeholders.

Participants were also asked about their preferences for six possible actions to implement an EMS in the institution. The strategies that received better rating were (see Fig. 3): Development systems for the collection and reuse of rainwater. Generate agreements for the collection of electronic waste. Generate production projects based on recyclable material. The less acceptance campaign was single daily glass

because it does not involve all stakeholders.

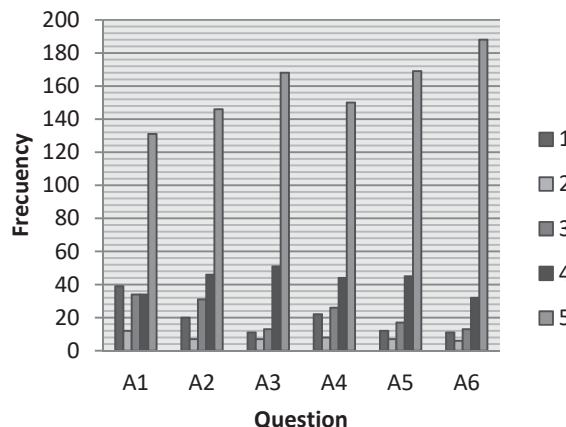


Fig. 3 Actions to be implemented

A space for additional comments was also provided. The most frequent comments were: Uniminuto has to promote and transmit the whole environmental activities to all stakeholders. Also, Uniminuto has to carry out training and communication campaigns. Besides Uniminuto has to optimize the use of paper and water and Uniminuto should design and implement ecopoints and vertical gardens.

VII. CONCLUSION

KM and EMS in HEIs promote decision-making, organizational strategies adoption and internalization of new procedures by the different stakeholders. This is achieved by empowering individuals from good environmental management practices in missionary activities (Teaching, research and extension). However, this process requires monitoring and evaluation plans to the curves of individual and collective learning.

EMS also includes the management of intangible resources such as the tacit knowledge of individuals. In order to convert this tacit knowledge into explicit knowledge it is necessary to ensure collaboration opportunities, dialogue and communication, as an essential component of organizational culture. This allows a real and sustainable empowerment by different stakeholders.

It is not enough to create hierarchical structures that support the EMS in HEIs, if there is no a real commitment of organizations. EMS not only involves the standardization of procedures and the allocation of an internationally recognized certification. SGA should focus on environmental requirements and characteristics of each of the stakeholders.

REFERENCES

[1] L. Trivella y N. K. Dimitrios, «Knowledge Management Strategy within the Higher Education. The Case of Greece», en *Procedia - Social and Behavioral Sciences*, 2015, vol. 175, pp. 488-495.
 [2] P. Lambe, «The unacknowledged parentage of knowledge management», *J. Knowl. Manag.*, vol. 15, n.º 2, pp. 175-197, abr. 2011.

- [3] B. Nooteboom, «Learning by Interaction: Absorptive Capacity, Cognitive Distance and Governance», *J. Manag. Gov.*, vol. 4, n.º 1-2, pp. 69-92, mar. 2000.
- [4] M. R. Mehregan, M. Jamporzmei, M. Hosseinzadeh, y A. Kazemi, «An integrated approach of critical success factors (CSFs) and grey relational analysis for ranking KM systems», *Procedia - Soc. Behav. Sci.*, vol. 41, pp. 402-409, 2012.
- [5] S. Dutta y A. DeMeyer, «Knowledge Management and Business Model Innovation», en *Knowledge management and business model innovation*, Y. Malhotra, Ed. Hershey, PA, USA: IGI Global, 2001, pp. 384-401.
- [6] Y. Malhotra, «Deciphering the knowledge management hype», *J. Qual. Particip.*, 1998.
- [7] D. Gurteen, «Knowledge, Creativity and Innovation», *J. Knowl. Manag.*, vol. 2, n.º 1, pp. 5-13, jun. 1998.
- [8] K. Mahesh y J. K. Suresh, «What is the K in KM Technology», *Electron. J. Knowl. Manag.*, 2004.
- [9] M. E. Burke, «Knowledge sharing in emerging economies», *Libr. Rev.*, vol. 60, n.º 1, pp. 5-14, feb. 2011.
- [10] R. J. Sternberg, *Practical Intelligence in Everyday Life*. Cambridge University Press, 2000.
- [11] J. Howells, «Tacit knowledge, innovation and technology transfer», *Technol. Anal. Strateg. Manag.*, vol. 8, n.º 2, pp. 91-106, ene. 1996.
- [12] S. Gourlay, «Towards conceptual clarity concerning tacit knowledge: a review of empirical studies», *Knowl. Manag. Res. Pract.*, vol. 4, n.º 1, pp. 60-69, 2006.
- [13] Z. Shao, Y. Feng, y L. Liu, «The mediating effect of organizational culture and knowledge sharing on transformational leadership and Enterprise Resource Planning systems success: An empirical study in China», *Comput. Hum. Behav.*, vol. 28, n.º 6, pp. 2400-2413, nov. 2012.
- [14] D. Delen, H. Zaim, C. Kuzey, y S. Zaim, «A comparative analysis of machine learning systems for measuring the impact of knowledge management practices», *Decis. Support Syst.*, vol. 54, n.º 2, pp. 1150-1160, ene. 2013.
- [15] M. Polanyi, *The Tacit Dimension*. University of Chicago Press, 1966.
- [16] I. Nonaka y H. Takeuchi, *The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation*. New York: Oxford University Press, 1995.
- [17] T. Andreeva y I. Ikhilchik, «Applicability of the SECI Model of knowledge creation in Russian cultural context: Theoretical analysis», *Knowl. Process Manag.*, vol. 18, n.º 1, pp. 56-66, feb. 2011.
- [18] L. Martin y D. Root, «Knowledge creation in construction: The SECI model», en *25th Annual ARCOM conference*, 2009, pp. 7-9.
- [19] S. Gourlay, «The SECI model of knowledge creation: some empirical shortcomings», vol. 4th European Conference on knowledge management, 2003.
- [20] Q. Zhang y M. Kosaka, «SECI model and KIKI model on knowledge creation», en *2013 10th International Conference on Service Systems and Service Management*, 2013, pp. 102-106.
- [21] Q. Zhang, M. Kosaka, K. Shirahada, y T. Yabutani, «A Proposal of B to B Collaboration Process Model based on a Concept of Service and its Application to Energy Saving Service Business», *IEEJ Trans. Electron. Inf. Syst.*, vol. 132, pp. 1035-1040, 2012.
- [22] G. Hedlund, «A model of knowledge management and the N-form corporation», *Strateg. Manag. J.*, vol. 15, n.º S2, pp. 73-90, jun. 1994.
- [23] B. Tejedor y A. Aguirre, «Proyecto Logos: investigación relativa a la capacidad de aprender de las empresas españolas», *Bol. Estud. Económicos*, n.º 164, 1998.
- [24] P. F. Drucker, «The coming of the new organization», *Harv. Bus. Rev.*, 1988.
- [25] R. M. Grant, *Contemporary Strategy Analysis: Concepts, Techniques, Applications*, 4 edition. Malden, MA, USA: Wiley-Blackwell, 2002.
- [26] M. J. Donate y F. Guadamillas, «Gestión del conocimiento organizativo, innovación tecnológica y resultados. Una investigación empírica», *Investig. Eur. Dir. Econ. Empresa*, vol. 14, n.º 2, pp. 139-167, ene. 2008.
- [27] C. Camacho, «Propuesta de implementación de un sistema de gestión ambiental para campus universitario», *POLIANTEA*, vol. 2, n.º 3, jul. 2013.
- [28] H. Roberts y G. Robinson, *ISO 14001 EMS manual de sistemas de gestión medioambiental*. España: Paraninfo, 1999.
- [29] ISO, «ISO 14001:2015 Environmental Management Systems», 2015. <https://www.iso.org/obp/ui/#iso:std:iso:14001:ed-3:v1:en>. 23-may-2016.
- [30] E. Alonso-Pauli y F. J. André, «Standardized environmental management systems as an internal management tool», *Resour. Energy Econ.*, vol. 40, pp. 85-106, may 2015.
- [31] C. Jasch, «Governmental initiatives: the UNIDO (United Nations Industrial Development Organization) TEST approach», *J. Clean. Prod.*, vol. 108, Part B, pp. 1375-1377, dic. 2015.
- [32] F. Testa, F. Rizzi, T. Daddi, N. M. Gusmerotti, M. Frey, y F. Iraldo, «EMAS and ISO 14001: the differences in effectively improving environmental performance», *J. Clean. Prod.*, vol. 68, pp. 165-173, abr. 2014.
- [33] Á. M. Parrado y H. F. Trujillo, «Universidad y sostenibilidad: una aproximación teórica para su implementación», *AD-Minist.*, n.º 26, pp. 149-163, jun. 2015.
- [34] P. Barnes y P. Jerman, «Developing an environmental management system for a multiple-university consortium», *J. Clean. Prod.*, vol. 10, n.º 1, pp. 33-39, feb. 2002.
- [35] P. Viebahn, «An environmental management model for universities: from environmental guidelines to staff involvement», *J. Clean. Prod.*, vol. 10, n.º 1, pp. 3-12, feb. 2002.
- [36] S. M. Savelly, A. I. Carson, y G. L. Delclos, «An environmental management system implementation model for U.S. colleges and universities», *J. Clean. Prod.*, vol. 15, n.º 7, pp. 660-670, 2007.
- [37] M. I. R. Marín, «Modelo de sistema de gestión ambiental para formar universidades ambientalmente sostenibles en Colombia», *Gest. Ambiente*, vol. 14, n.º 1, pp. 151-161, 2011.
- [38] D. Puente-Rodríguez, D. Giebels, y V. N. de Jonge, «Strengthening coastal zone management in the Wadden Sea by applying 'knowledge-practice interfaces'», *Ocean Coast. Manag.*, vol. 108, pp. 27-38, may 2015.
- [39] I. Herghiligiu, L. M. Lupu, y B. Budeanu, «Research regarding the informational system (Information and Knowledge) required for an environmental manager», en *Proceedings of the 14th European Conference on Knowledge Management: ECKM 2013*, Lituania, 2013, pp. 896-904.
- [40] S. Chen, C. K. Liu, L. L. Iao, y H. H. Chen, «The impact of learning effects of environmental management system on performance of renewable energy firms», *Environ. Prog. Sustain. Energy*, vol. 34, n.º 4, pp. 1106-1112, jul. 2015.
- [41] I. Gavronski, R. D. Klassen, S. Vachon, y L. F. M. do Nascimento, «A learning and knowledge approach to sustainable operations», *Int. J. Prod. Econ.*, vol. 140, n.º 1, pp. 183-192, nov. 2012.

Natalia Marulanda has a Master degree in Industrial Engineering (2015) from Universidad Nacional de Colombia. Also she holds a degree in Industrial Engineering. She currently works as a Researcher Professor at Corporación Universitaria Minuto de Dios, Bello, Colombia.