BEST PRACTICES AND PROCESS IMPROVEMENT. AN APPLICATION FOR THE TRANSFER AND MANAGEMENT OF KNOWLEDGE TO THE TRANSPORTATION OF HYDROCARBONS IN ECOPETROL[1]

BUENAS PRÁCTICAS Y MEJORA DE PROCESOS. UNA APLICACIÓN PARA LA TRANSFERENCIA Y GESTIÓN DEL CONOCIMIENTO EN EL ÁREA DE TRANSPORTE DE HIDROCARBUROS DE ECOPETROL

BOAS PRÁTICAS E MELHORA DE PROCESSOS. UMA APLICAÇÃO PARA A TRANSFERÊNCIA E GESTÃO DO CONHECIMENTO NA ÁREA DE TRANSPORTE DE HIDROCARBUROS DE ECOPETROL

Julio César Acosta-Prado[2]
Jaime Andrés González Valencia[3]

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ABSTRACT
Knowledge's processes enrich the information bringing value to organizations. These formal or informal, processes increase the value of information and useful knowledge of people and organizations. Therefore, in order to identify good practices that promote the improvement of processes for the implementation of knowledge management in the area of transport hydrocarbon, this exploratory study was performed on ECOPETROL, Colombia's largest oil company. Due to its size, it belongs to 40 largest oil and gas companies in the world´s group and is recognized as one of the four major in Latin American. The study target the workshops developed within the Operations and Maintenance teams using the methodology of the Knowledge Assurance Guide. The results show positive impacts identifying best practices that support process improvement in the tactical, strategic and operational levels.
Keywords: best practices, process improvement, knowledge management.
Content: 1. Introduction, 2. Theoretical framework, 3. Methodology, 4. Case study, 5. Conclusions.

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2 Ph.D. in Management and Business Organization of the Universidad Autónoma de Madrid. Research Professor of the Universidad Externado de Colombia. Email: julioc.acosta@uexternado.edu.co
3 Magister in Business Administration of the Universidad Externado de Colombia. Email: jandresgonzalez@gmail.com

RESUMEN

Los procesos de conocimiento enriquecen la información dotándola de valor para las organizaciones. Éstos procesos estructurados o no, incrementan el valor de la información y el conocimiento útil de las personas y las organizaciones. Por tanto, con el objetivo de identificar las buenas prácticas que favorecen la mejora de procesos para la implementación de la gestión del conocimiento en el área de transporte de hidrocarburo, este estudio de naturaleza exploratoria se realizó en ECOPETROL, principal empresa petrolera de Colombia. Por su tamaño, pertenece al grupo de las 40 petroleras más grandes del mundo y es una de las cuatro principales de Latinoamérica. El estudio profundizó en las mesas de trabajo desarrolladas con los equipos de Operaciones y Mantenimiento, utilizando la metodología de la Guía de Aseguramiento del Conocimiento. Los resultados muestran impactos positivos al identificar las buenas prácticas que favorecen la mejora de procesos en los niveles táctico, estratégico y operativo.

RESUMO

Os processos de conhecimento enriquecem a informação dotando-a de valor para as organizações. Estes processos estruturados ou não, incrementam o valor da informação e o conhecimento útil das pessoas e as organizações. Por tanto, com o objectivo de identificar as boas práticas que favorecem a melhora de processos para a implementação da gestão do conhecimento na área de transporte de hidrocarburos, este estudo de natureza exploratoria realizou-se em ECOPETROL, principal empresa petrolera de Colômbia. Por seu tamanho, pertence ao grupo das 40 petroleras maiores do mundo e é uma das quatro principais de Latinoamérica. O estudo aprofundou nas mesas de trabalho desenvolvidas com as equipas de Operações e Manutenção, utilizando a metodologia da Guia de Garantia do Conhecimento. Os resultados mostram impactos positivos ao identificar as boas práticas que favorecem a melhora de processos nos níveis táctico, estratégico e operativo.

1. INTRODUCCIÓN

Since the second half of the XVIII century with the industrial revolution, new ideas, products, services and concepts have emerged; However, despite the changes and dynamics present in the world, especially in organizational and administrative field, techniques, practices, and methodologies have been developed and implemented with a skill´s development requirement, expertise and knowledge at all levels of the organization, in order to achieve the necessary skills to optimize the processes execution to improve time and costs, aligning company's goals to increase financial and organizational results.

These practices can be understood as an extension and improvement of flows and stocks of each person knowledge by finding a better way of doing things, either based on their experience, trial-and-error, knowledge formally gained and learned lessons from people who have developed the same tasks before, or simply because new alternatives are generated. This new knowledge, seeing as a benefit to the organization, is only valuable whenever can be reflected and repeated multiplying the profits and assuring its sustainability through time with the possibility to be improved.

In addition to the mentioned practices to increase and enhance the flows and stocks of knowledge, there is the support of technological tools, adaptable to the needs of each productive process, able to transform and learn from the development of tasks and decision-making. The efficient use of these technological tools applying the knowledge of the company to obtain the required outcomes could become a differentiating factor. Thus, improving the workers added value in order to achieve business goals.

Based on this, the study focuses specifically on the Operations and Maintenance area of the Vice Presidency of Transportation in ECOPETROL, in which a transition period has occurred, generated from the retirement of most of the tech-

nical and administrative professionals that used to developed activities for over 20 years. This situation led to the risk of losing the knowledge in the organization generated from workers' training and experience.

In this regard, the company has hunt to implement organizational performance methodologies such as Total Quality in order to structure management and process' development; however, the non formal implementation of these methodologies, has required to assure the workers' key knowledge. All these with the purpose to decrease the impact of a new workforce starting from zero in the learning curve, in turn, involves processes and procedures with high technical complexity and high risk due to the operating conditions implicit in the oil pipeline and national transportation of hydrocarbons systems. Besides the inherent risk of the transported products that can affect people and the environment.

In this order of ideas, one of the fundamental pillars of ECOPETROL is to protect the workers' live. Based on this statement and the operational excellence, it became necessary to develop activities that might reduce the risk associated with generational change and the key knowledge that would be lost with workers' retirement processes. In this regard, Knowledge Management itself is presented as an opportunity, which seeks to ensure the key knowledge and generate learning processes and practices that promote the reduction of operational mistakes due to not knowing an activity, both in terms of operational practices or human fault.

In response to the situation described, ECOPETROL has developed a corporate strategy for all business activities and has achieved the creation of Knowledge Management teams in all areas of the supply chain and support areas. To do this, we reviewed the main developed activities (workshops, working groups and key logging practices and disclosure, and its formalization and implementation), which have contributed to the improvement and reduction of operational incidents and accidents that were presented in the Operations and Maintenance activities.

From a structured framework and the description of the case study, the purpose of this paper is to provide guidance to the management of best practices and identify opportunities to improve processes that can contribute to the development and implementation of Knowledge Management in the Vice Presidency of Transportation in ECOPETROL

The methodological procedure used in the case study is qualitative applied, not experimental, both exploratory and descriptive. The results show the positive impact of the identification of best practices that promote the improvement of processes in the transfer and management of knowledge in the area of business that has being analyzed.

2. THEORETICAL FRAMEWORK.

According to Polanyi (1966) we know more than we can express. This makes visible the need for utilization of knowledge which is not expressed, and can be managed by best practices that support process improvement and gaining competitive advantages. In response to the above identified need in organizations, arises from the 1990 the Knowledge Management. Topic of interest and discussed by academics and entrepreneurs who have considered the creation of knowledge as a source of competitive advantage, to focus on the needs of knowledge workers and promote a learning environment that meets the demands of the information economy (von Krogh, Ichijo and Nonaka, 2001).

Knowledge management has been defined by different authors. Nonaka and Takeuchi (1995) defined it as the ability of an organization to create new knowledge, disseminate it throughout itself and put it in products, services and systems. To Sveiby (1998), is the art of creating value by leveraging intangible assets. According to Andersen (1999), manifests itself in recognizing the need to accelerate the flow of information that has value, from individuals to the organization and back to individuals so that they can use it to create value for customers. Davenport (2001) argues that it is the systematic process

of finding, organizing, filtering and presenting information in order to improve the understanding of people in a specific area of interest. Bueno (2002) states that it is the function that plans, coordinates and controls the flow of knowledge produced in the company in connection with their activities and their environment in order to create core competencies.

Finally, Davenport and Prusak (2001) argue that knowledge moves in organizations because they may sell it, find it, and apply it to generate work processes. Therefore, the creative knowledge companies are those that consistently create new knowledge, encouraging their distribution through the organization, and quickly incorporate these creations to new technologies and products (Terra, 2000).

A fundamental part of knowledge management is the creation of organizational knowledge must be understood as a process that expands knowledge and crystallized it as part of the organization's knowledge network (Nonaka and Takeuchi, 1995). The way to create this knowledge is a challenge, because it is necessary to extract the key knowledge in the people to be registered and capitalized, in order to achieve the replicate its application and get benefits and improvements in organizations.

Knowledge is a valuable resource for organizations that can be used as a competitive advantage of any organization (Porter, 1990). Knowledge is also a factor that can answer the following questions, needed to understand if a resource is a source of sustained competitive advantage, ¿Is the resource valuable? ¿Is it rare? ¿Is imperfectly imitable? ¿Are there substitutes for this resource? (Barney- 1991). Once you have answered these questions and analyzing the resources and products of the organization, is possible to infer that knowledge is a differentiating factor in the market, even in a resource-based approach (Wernerfelt, 1984).

Resource-based approach is a theoretical framework for understanding how competitive advantages are obtained from within the organization and how can they be sustainable (Barney, 1991; Nelson, 1991; Penrose, 1959; Peteraf, 1993; Prahalad y Hamel, 1990; Schumpeter, 1934; Teece, Pisano y Shuen, 1997; Wernerfelt, 1984). This approach focuses on the internal organization of firms, and therefore is a complement to the traditional emphasis of strategy on structure and strategic positioning as determinants of competitive advantage (Henderson and Cockburn, 1994, Porter, 1979)

The resource-based approach assumes that organizations can be conceptualized as a set of resources that are heterogeneously distributed and that differences in these resources persist over time (Amit and Schoemaker, 1993; Mahoney and Pandian, 1992; Penrose, 1959; Wernerfelt, 1984). When companies have resources that are valuable, rare, inimitable and irreplaceable, they can achieve a sustainable competitive advantage by implementing fresh strategies to create value that cannot be easily duplicated by competitors. (Barney, 1991; Conner and Prahalad, 1996; Nelson, 1991; Peteraf, 1993; Wernerfelt, 1984, 1995). This is where the knowledge of the organizations is placed, used through proper management.

Knowledge is the only unlimited resource and the only asset that increases with use (Rumelt, 1984). This is not applied to any other asset and makes clear the importance of the use and growth of this asset. To achieve this effective use, the organization must create conditions to facilitate the capture and propagation of knowledge, by including proper knowledge management in their strategic objectives defined by David (2003) as the specific outcomes that a company is trying to achieve to fulfill its core mission and that are essential for the success of a company. These should be challenging, measurable, consistent, reasonable and clear with a comprehensible and specific goal.

Another aspect about knowledge management is to create an environment and a sense of autonomy in workers for the development of their duties, this result in an increase of the probability of creation of new knowledge through creativity (David, 2003). Under this scenario of autonomy, new ideas are born, new ways to solve problems and a constant innovation that comes from each person.

Besides the above, fluctuations and natural chaos of organizations create a challenging condition for workers, and from these conditions that alter the established order and are involved with the processes governing a company, new ideas are presented arise from being recursive and the need to react against the disturbance in the comfort zone of each person by rethinking the established mental models.

Therefore, in the development of knowledge management in organizations is important to know where knowledge resides, so that once located, the organization can evaluate its value, since the attempt to codify the company knowledge is a huge nonsense effort (Valhondo, 2004).

This knowledge must be identified to determine their class, if tacit (intuition of an expert ability to develop a manual labor) or if explicit (defined in rules or procedures) and from this process, choosing the appropriate management tools. This situation has allowed the study of knowledge management from different perspectives. Among them are distinguished the focus of content, formal processes, and collaborative capabilities (Plaz and González, 2004). For purposes of this case study, we used an integrated approach focused on identifying and developing best practices to address key issues for organizations, in components such as information and communication technologies, processes and methods, subjects and disciplines, people and competencies. This approach adopts an open and understanding systematic view of organizational processes where interactions, relationships and collaborative processes act as channels for the transmission and assimilation of new knowledge.

According to the above, the identification and development of best practices, is an improvement in organizations for the fulfillment of its mission and implementation of knowledge management. However, these practices are materialized by the generation of communities. Wenger (1998) was the first to use the concept of community of practice, as communities that bring people together informally –with responsibilities in the process– by common interests in learning, especially in the practical application of what they learned. McDermott (2000) has complemented the concept, noting that communities of practice are a group of people who share and learn from each other through physical or virtual contact with a goal or need to solve problems, share experiences, standard models or not, techniques or methodologies, all scheduled to consider best practices.

According to Wenger, McDermott and Snyder (2002), despite the many ways that communities of practice can take, we can consider three structural elements: The domain, which defines a subject of interest and a sense of common identity. A well-defined domain legitimizes the community stating its purpose and value to members and stakeholders. The community, that creates the social fabric knowledge. A strong community fosters interactions and relationships based on mutual respect and trust. Finally, the practice, which defines the framework, ideas, tools, information, styles, language, stories and documents shared by community members.

In this sense, people and their knowledge at any organizational level, must be understood and should also being able to understand others, acting not only as performers, but as specialists and exhibitors (Drucker, 1999). Information is available in abundance and in order to have some value generation, professionals of each area must absorb the knowledge, process it and expose it to others; this implies the learning process.

Communities of practice arise from the relationships and situations that involve people in the work environment, and exist in all organizations in an explicit or non explicit way, creating independent social groups from the formal structure defined by the organization table, and are effective tools in knowledge management. Therefore, communities of practice are groups of people who share a concern or a passion for something they do and interact regularly to learn how to do it better (Wenger, 1998, Wenger and Snyder, 2000; Wenger, McDermott and Snyder, 2002).

Probst, Raub and Romhardt (2002) complement this issue when discussing the meaning of sharing and distribut-

ing knowledge: It is not only the mechanical distribution of packaged knowledge, since knowledge is a commodity that is usually being transferred by personal exchanges between individuals. For the authors, according to the context, exchange knowledge can be driven, transferred and knowledge managed between individuals, communities of practice, network of experts and work teams.

According to the above and the proposed objective, we focus on identifying best practices that support the process improvement from the perspective of Knowledge Management.

3. METHODOLOGY

The study is a qualitative type; methodological procedures used were applied type, not experimental. The study was both exploratory and descriptive. Exploratory, because the objective was to identify best practices that support the process improvement in the Operations and Maintenance area of the Vice Presidency of Transportation in Ecopetrol, S.A. To do this, it was necessary that researchers were familiar with the phenomenon investigated to achieve a new understanding of it (Selltiz, Wrightsman, and Cook, 1974). And descriptive, by identifying best practices willing to improve knowledge management implementation processes. According to Yin (2001), this method is recommended when there are questions of how and why, and when the focus is on a contemporary phenomenon in a real life context.

The study further investigated the results of the workshops developed with teams of Operations and Maintenance of the Llanos area, specifically in the Casanare Department, using the methodology of Knowledge Assurance Guide, its records and the results implemented from these exercises. The documentation collected is owned by Ecopetrol SA and authorized its partial disclosure for purposes of the case study

Table 1. Basic differences between communities of practice, expert networks and work teams.

	Communities of practice	Expert networks	Work teams
NATURE	***Social***	***Non social***	***Non social***
¿What unites them?	Passion and interest in a practice, learning and build relationships	Experiences and expertise in a specific topic	A task with a defined objective
Objective	Build and share knowledge within the practice	Solutions to specific problems	To achieve a defined objective
Participation	Voluntary	Assigned	Assigned
Interaction	Flexible per participant, group interaction	Transactional: Delivery and provision of information	According to the work plan and all participate by assigned role

Source: own calculations

since the sources are public domain. The financial and economic figures reflected in the income statements and balance sheets are a public domain.

4. CASE STUDY

4.1 Origin and current state of ECOPETROL

In 1921 the Tropical Oil Company begins the oil activity in Colombia with the start up of the operation at the La Cira – Infantas oil field in the Rio Magdalena valley, located 300 km northeast from Bogota D.C, this company reversed their assets to the State of Colombia by the Concessión de Mares on August 25 in 1951, creating the Empresa Colombiana de Petróleos, currently known as ECOPETROL Established as a public-private company whose purpose is to develop in Colombia or outside Colombia, commercial or industrial activities related to the exploration, production, refining, transportation, storage, distribution, and marketing of hydrocarbons and their derivatives.

Ecopetrol undertook activities in the oil and gas chain as an Industrial and Commercial Public Company, responsible for Managing the hydrocarbon resources of the nation, growing as other concessions reversed joining its operation and increasingly consolidating the company as the most important in the country, as it is responsible for managing one of the nonrenewable natural resources with the best price in the domestic and international market.

Throughout the years, Ecopetrol has had many changes and adjustments that have caused major transformations, both in composition and in its structure and operation models. Table 2 summarizes the main facts of the company along its historical path is presented.

Table 2 Ecopetrol main historical facts.

YEAR	RELEVANT FACTS
1921	The oil industry in the country begins with the opening of the first well in the Cira - Princesses by troical Oil Comapny
1951	The "Empresa Colombiana de Petroleos" is born from the reversion to the government of "Mares" Concession
1961	The "Empresa Colombiana de Petroleos" takes over Barrancabemeja Refinery
1974	Ecopetrol purchases Cartagena's oil refinery
1983	"Caño Limón" oilfield is discovered in association with OXY. Reserves of 1250 million barrels
1986	Colombia is an oil exporter country again
1991	"Cusiana" field is discovered with reserves of 750 million barrels
2003	"Ecopetrol S.A" is born as a public joint stock company transforming the whole scheme of the company becomes
2004	Best historical financial results are obtained with 2.1 BillionCOP
2005	From the new structure of Ecopetrol 68 Million barrels are discovered and net profit raises to 3.25 billionCOP
2006	Ethanol sales in the country is implemented, the barrel number 1 Million of Cusiana and Cupiagua fields is achieved. Net profit 3.39 Billion cop

YEAR	RELEVANT FACTS
2007	The model of Corporate Social Responsibility is approved, Ecopetrol enters to the Stock Exchange of Colombia. Propilco (Propylene Production) is purchased. Net income of 5.18 billion cop
2008	On September 18 Ecopetrol enters the Stock Exchange of New York. Acquires two exploration blocks in the Gulf of Mexico and works in the Basin field in Brazil. Net Income of 11.6 Billion
2009	Ecopetrol SA initiates an expansion process . ODL pipeline starts construction. Net 5.25 Billion cop
2010	The strategic framework of the organization is created, defining the goals of 1Mbpd (Million barrels per day) in 2015 and 1.3Mbpd in 2020. Bicentenario pipeline subsidiary is created. 4 new patents are awarded to the organization. Net income 8.14 Billion cop
2011	Ecopetrol starts the strategy of heavy crude transportation in the country, seismic exploration is done at 5516 km, the stock reached its highest point with 4215 cop/share. Net income 15.4 Billion cop
2012	CENIT, 100% subsidiary Ecopetrol is established to manage the transportation and logistics for the company. Discoveries are made in blocks of the Gulf of Mexico. Stocks reach the highest point of the closing in May 2 to 5,850 cop/share. Cop 14.77 Billion Net Profit
2013	Sale of gas produced in the Guajira, Cusiana and Cupiagua contracts of 1 and 5 years is ensured. 12 new patents are obtained. Continued consolidation CENIT. Net profit 13.35 Billion Net cop

Source: own calculations

In the same way, throughout its history, the organization has made discoveries that expanded the amount of hydrocarbon reserves in the country, leveraging the operation and growth of as shown in table 3.

Table 3. Main oil discoveries.

Nombre	Año de Descubrimiento	Reservas Millones de Barriles
La Cira-Infantas	1918	800
Tibú	1940	270
Casabe	1941	300
Velásquez-Palagua	1946	300
Yariguí	1954	200
Provincia-Payoa	1960	300
Río Zulia	1962	140
Orito	1963	240

Nombre	Año de Descubrimiento	Reservas Millones de Barriles
Castilla	1969	320
Chuchupa	1972	7 Terapies cúbicos de gas
Apiay-Suria	1981	215
Caño Limón	1983	1250
San Francisco	1985	150
Cusiana	1989	750
Cupiagua	1993	510
Guando	2000	130
Gibraltar	2003	630 Gigapies cúbicos de gas 15 Millones de barriles

Source:http://www.ecopetrol.com.co/contenido.aspx?catID=532&conID=76464

From these discovers and the main activities and facts presented, the organization has established itself as a world-class company, rising its profits continually since 2003 when the organization structure and composition was also to became a public corporation known as ECOPETROL, as outlined in table 2.

Thanks to investments in exploration and production that have led to continued discoveries, although they have not been big in recent last years, the organization has continually renewed its six years in the horizon of proven reserves.

Despite its continued growth, the organization had a strong fall as a result of the global situation in late 2008 and early 2009, a period of global financial crisis unleashed in the United States by the financial market that brought among its result a sharp drop in oil prices, falling to values of $ 86.49 us/bl in 2008 and $ 38.60 us/bl in early 2009 as seen in Figure 2.

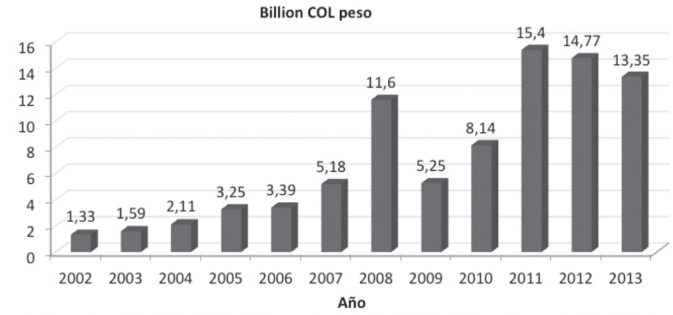
This fall in oil prices, led the Organization of Petroleum Exporting Countries (OPEC) to an extraordinary ministerial meeting on December 17, 2008 and establish a production cut of 2.2 million barrels per day, expecting to stabilize the price of crude oil.

This situation affected all Oil companies in the world, including ECOPETROL, with a net income decreased in 2009 by the global financial crisis and also for making investments in that period by 13.57 billion Colombian pesos. 5.08 Of these due to acquisitions and the remaining 8.49 billion pesos in growth investments that affected its financial indicators.

The company has also been affected by the public order situation in the country. The groups outside the law have historically attacked the oil pipelines and infrastructure, especially the Caño Limón Coveñas pipeline, which collects crude oil from areas of the departments of Meta, Casanare and Arauca, transporting the crude to the Coveñas marine terminal in order to be exported. And before getting to the final destination supply refineries located in Barrancabermeja and Cartagena.

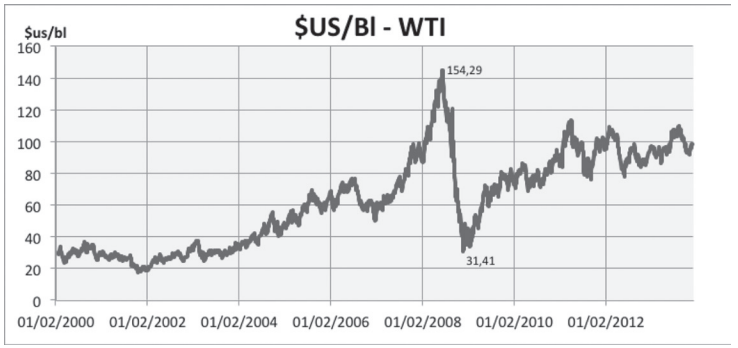
Next in Figure 1 is shown the behavior of the annual net profits of ECOPETROL from 2002 to 2013 comparing in

Figure 1. Ecopetrol Net profit 2002 - 2013.



Source: Adapted from http://www.ecopetrol.com.co/contenido_imprimir.aspx?conID=37630&catID=200

Figure 2. Price behavior for the WTI Oil barrel 2000 - 2013



Source: https://www.grupoaval.com/portales/jsp/historicoindicadores.jsp

Figure 2 the historical price for WTI crude oil, which is the main reference in the organization for its principal commercial transactions.

After successfully completed the global financial crisis, the company tried to restart its course of continued growth, taking advantage of the rise in the price of oil, which led ECOPETROL to the 114 position in the list of the 2000 world leading companies, according to the annual ranking by Forbes magazine in 2013, with a market valuation of USD 116,200 million.

Supported by the growth represented in financial results and market conditions, the organization took advantage of the positive financial times to expand its operation in the local and international market from this situation Ecopetrol S.A has gotten and increased its involvement in private oil transportation systems, and has joined international markets.

Since late 2013 Ecopetrol S.A has been established as a business group that has affiliates and subsidiary companies in the country to the develop its value chain, from exploration, production, transportation, refining, to marketing also including the development of new technologies that were born from his research and development center. These technologies are optimizing the transportation of oil by heating methods and the use of derivate petroleum products to improve the properties of the product to be transported.

The business group includes overseas subsidiary companies, responsible for developing some specialized activities such as purchase processes or exploration in the Gulf of Mexico or Peru. Next, in table 4 is presented the consolidated companies in the business group:

Table 4. Ecopetrol S.A business group

	SUBORDINATE COMPANIES	% SHARE	SHAREHOLDING	% SHARE
EXPLORATION AND PRODUCTION	Equion	51	Offshore International Group	50
	Hocol	100		
	Ecopetrol Peru	100		
	Ecopetrol Brasil	100		
	Ecopetrol America	100		
	Ecopetrol Germany Gmbh	100		
TRANSPORTATION	Cenit	100	Serviport	49
	Oleoducto Bicentenario	55,97	Transgas de Occidente S.A	10,2
	Ocensa	72,65		
	Oleoducto de Colombia (ODC)	73		
	Oleoducto de los Llanos (ODL)	65		
REFINING	Reficar	100	Sociedad Portuaria de Oleofinas y Derivados S.A	50
	Propilco	100	Zona franca de Cartagena S.A	9,79
	Comai	100	Sociedad Portuaria del Dique	0,51
NEW ENERGIES	Bioenergy	91,43	Ecodiesel	50
	Bioenergy Zona Franca	91,43		
FINANCIAL AND INVESTMENT VEHICLES AND OTHERS	Black Gold Re	100	Invercolsa	43,35
	Andean Chemicals	100	Concentra	7,19
	Hocol Petroleum Limited	100	Energía de Bogotá	6,87
	EPI - Ecopetrol Pipelines Int.Ltd	100	ISA	5,32
	Ecopetrol Capital A.G.	100		
	Ecopetrol Global Energy SLU	100		
	Ecopetrol Global Capital SLU	100		
	Santiago Oil Company	51		
	Colombia Pipelines Limited	51		
	ODL Finance S.A	65		
	Amandine Holdings corp.	91,43		
	Los Arces Group Corp	91,43		

Source: Adapted from http://www.ecopetrol.com.co/contenido.aspx?catID=532&conID=41705

4.2 Experience and knowledge assurance

In more than 60 years of operation, the organization has generated key knowledge in practices that have evolved over time, along with quality and safety standards for construction, operation and maintenance of oil transportation infrastructure in the hydrocarbons sector.

This knowledge exists tacitly in workers, who for more than 20 years of work have managed to optimize processes and generate new solutions to everyday problems, from the extensive knowledge of the operation or the external conditions that affect the transport area.

However, the provision of such knowledge was affected by the age and retirement programs, for compliance of legal worked time by early workers leading to legal retirement, which put at risk of losing the knowledge either available or generated, as much of this knowledge is tacit and had not been converted into explicit, due to the lack of standardized tools for capturing, securing and replicate into workers with minor worked time.

Therefore, the identification of relevant knowledge and its management, has resulted in best practices generated from the experience and training of workers in favour of processes improvement, in order to assure organizational knowledge by implementing knowledge management in the area of Operations and Maintenance (O&M) of the Vice President of Transportation (VIT) in ECOPETROL

4.3. Transportation operations.

In each pumping plant, it is necessary to be aware that each type of product requires special operating conditions; transporting oil requires a detailed control of the viscosity, specific gravity of the fluid and the water content. In addition, pressures that are used in these systems are high and may reach 1,800 psi (pounds per square inch). The capacity of the pumping units should respond to high flow rates and mentioned conditions, as some plants require pumping dispatch capabilities up to 400,000 barrels per day.

On the other hand, transportation of refined oil products such as regular gasoline, premium gasoline, diesel and Jet fuel requires low pressures to be handled (compared to the oil pipelines) of about 400 psi, pumping units are designed according to the maximum admissible operating pressures and therefore their associated auxiliary systems (water, air, measuring instruments, control signals) are lower than those used in crude oil transport capacity, but in contrast, the technical complexity and quality control of these products have very high which make the operation very delicate and a high-care operation.

Any mix of products can damage large quantities of product, is the case of Gasoline and Diesel, if a gallon of gasoline (1/42 barrel) is accidentally mixed with a tank of 50,000 barrels of diesel, the latter will lose the chemical properties related to the sulfur content, making it impossible to commercialize it in the country because it would accomplish current legal regulation limiting the parts per million (ppm) of sulfur allowed.

A similar case is presented to Jet Fuel and Diesel, in which case the Jet Fuel will be outside of the limits for the Anti Knock Index (AKI), necessary to assure the proper air transportation operation in the country. The implications of the inappropriate use of the products have a high impact on the organization, as products outside of specifications have no commercial value and cannot be sell to dealers. Additionally, the recovery process involves product over cost and delays in its delivery to clients, affecting the overall turnover of the company.

It highlighted the importance of having trained personnel with adequate knowledge to manipulate, operate and maintain the systems that carry products that contribute directly to the country progress and development.

The scope and main responsibilities in the area of Operations and Maintenance (O&M for short within the organiza-

tion) of VIT is to operate and maintain in optimal conditions the transport infrastructure of hydrocarbons in the country, taking in their scope, pipelines and pumping stations, where water pumps are the main element of the system that are responsible for boosting the oil to be transported to the final destination sites (refineries, ports of export, wholesale distributors), product storage tanks and associated electronic control systems for the operation of these pumping units, security systems that protect against fire and other auxiliary systems that are responsible for functions necessary for proper operation.

4.4. Responding to the risk and complexity associated.

For more than 60 years the company has developed practices that generate key knowledge in the industry. Taking into account the age of the company there is a risk of losing the knowledge due to generational changes or restructuring of plant personnel.

Knowledge Management has been proposed in order to response to this risk, and its application in the organization has been framed in the PDCA cycle (Plan, Do, Check, Act) with two major fronts of application:

- Strategy and policy
- Incorporation, assurance and knowledge transfer through initiatives

VIT developed the second front according to the schema for Knowledge Assurance Initiatives, shown in figure 3.

ECOPETROL includes in its Balanced Scorecard indicators one that measures the implementation of Knowledge Assurance Guide, providing corporate support to the implementation of the insurance scheme of knowledge.

The Guide to Knowledge Assurance in Ecopetrol S.A defines the tools to ensure key organizational knowledge; one of these tools is to create communities of practice, which is established as a fundamental link to make operable the process of knowledge assurance for the company personnel.

In communities of practice are conceived and validated practices learned from the academy or experience, ideas are generated and knowledge organized and from collaborative and team work that allows shortening the learning cycle of professional and technicians and other employees of the organization.

These communities of practice consist of teams and the creation of networks of experts who are guided by the knowledge management process of ECOPETROL

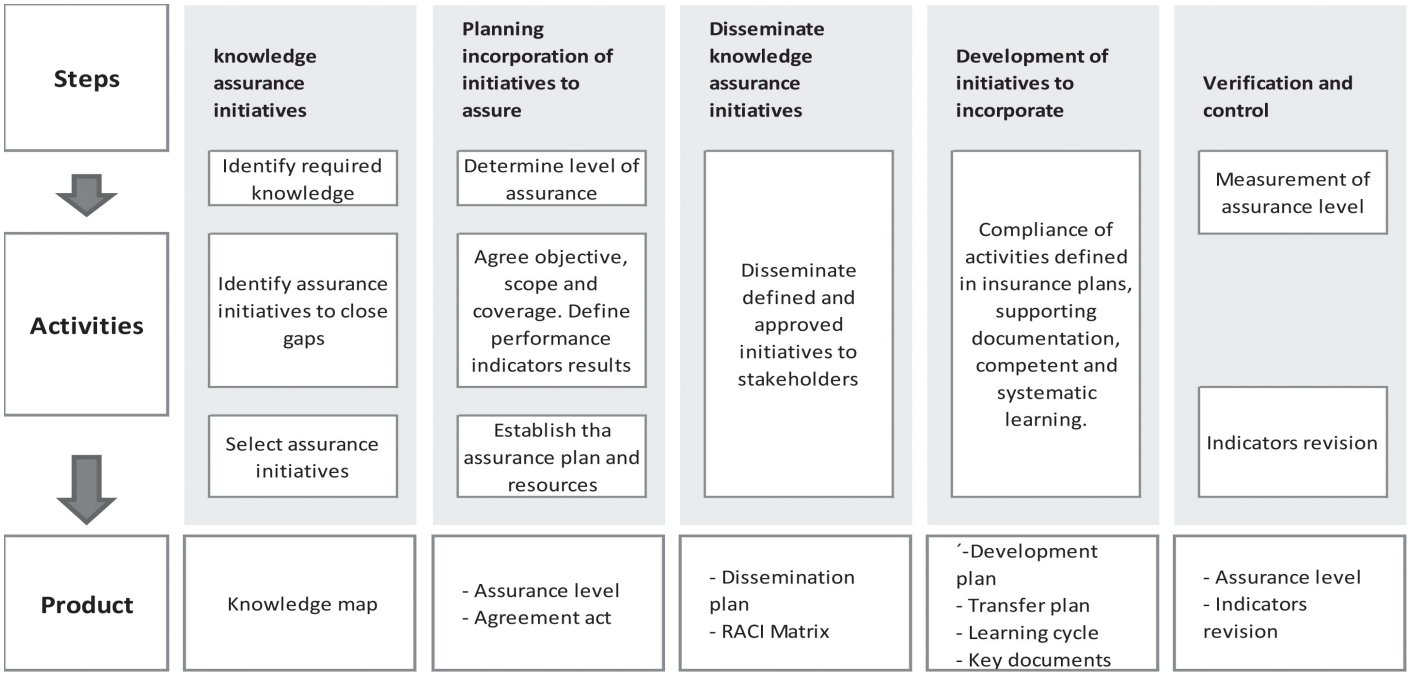
The implementation of knowledge management in the organization has developed through processes associated with practice as defined in the Guide to Knowledge Assurance set out in figure 3.

An important factor in the creation of communities of practice is that people called for these communities have common expertise on the subject to be discussed, can even be defined as pre established social networks because of the proximity of some pumping stations and common tasks develop by employees.

Since the formal implementation of Knowledge Management in ECOPETROL, workshops were created in the Operations and Maintenance (O&M) of the Vice President of Transportation (VIT), organizing these communities of practice for the following subjects: internal corrosion, external corrosion, instrumentation and control, electricity, general mechanics and mechanical repairs, maintenance and shipping.

Key issues of the operation and maintenance of the systems were treated in these workshops, generating modifications that improve existing processes or creating new procedures and regulations to ensure the execution of the work in a safe and standardized way for optimizing results.

Figure 3. Steps for Knowledge assurance Initiatives.



Source: Adapted from Anexo 31 Guía de aseguramiento del conocimiento de Ecopetrol (2011)

4.5. Assurance practices that encourage process improvement by implementing knowledge management

There are success stories of this identification of knowledge in specific areas of operation and maintenance. One of this is represented in the repair of centrifugal single-stage pumps and multistage, despite of the fact that this is a highly technical subject of the oil industry, for the purposes of this paper it is emphasized that for over 20 years this work was executed without standards or protocols and was particular for each pump station.

One of the results of the Mechanical Repairs workshop was a structured instructive that support the proper and safe performance of the work, identifying the skills required of personnel performing the task.

For the before mentioned case, the execution should be only carried by Operators, Technicians, Mechanics and Control Technicians intervening together in such repairs. The establishment of the periodic cycles of revisions for pumping units, was conditioned on standardized factors classified according to the condition of the stations, the tools and equipment needed for the activity was clearly defined according to the detailed description for the type of pump, also are defined all risk and their respective control analyzed from a risk matrix.

From the implementation of these workshops and knowledge management in the Operations & Maintenance, structured procedures with clearly defined scope were developed to prevent failures in implementation. In addition, specialized training was offered to key personnel in the area of Op-

erations and Maintenance, an example of this application is the development of learning programs in welding by specialist from renowned and highly specialized firms in the field of the development and production of materials for carbon-steel welding used in oil transportation industry, as well as certified by the "American Welding Society".

From the Internal Corrosion in pipelines workshop, documents were generated in order to assure knowledge, standardize processes and strengthen the competencies of the organization. In this workshop were generated among others, protocols to respond to the needs of maintenance and operation that are general to any system of oil transportation in the world, such as:

Internal cleaning for mechanical pipelines

Corresponds to the internal cleaning of hydrocarbon transportation lines as preventive maintenance to control internal corrosion and contribute to the mechanical integrity of pipelines, availability and quality of the products transported.

Solid and liquid sampling from internal cleaning of pipelines

Document and standardizes the procedures to take, keep and preserve samples of material displaced by the inner duct cleaning and shows liquid and solid residues obtained in the process of removal and installation of monitoring systems of internal corrosion in order to determine the chemical nature and composition of the waste deposited in the interior of the line.

Table 5. Best practices and process improvement in the Vice Presidency of Transportation of ECOPETROL

	BEST PRACTICES				IMPACTS
PROCESS IMPROVEMENT	Results from communities of practice	Generating lessons learnde	Corporate university	Especialized training programs	
Development and continuous improvement of operating manuals and standards of construction.	X	X			By generating lessons learned, the organization avoid mistakes recourse, ideas and knowledge are generated and collaborative work is encouraged. From communities of practice were developed and validated the practices, procedures and standards that currently apply. As a result manuals and appropriate standards are obtained for the effective operation and maintenance of infrastructure
Profesionalization / Specialization of personnel			X		The key knowledge gained from the experience of professionals with high seniority in the organization and from the specialist expertise, has been put to the service of the employees of the organization by Corporate University platform and offer Virtual Classroom Training and transmitting especializad knowledge on industry issues
Knowledge transfer and support to new employees of the organization			X	X	It has been compiled the expertise of professionals and members of the company with high seniority and skills in key tasks of the operation, out of this compillation was structured a training program for new professionals entering the Vice President of Transportation. Due to this program, it was possible to shorten the learning curve for new employees who will have the ability to develop key tasks of the organization.
Socialization of success stories	X	X			Collecting registered situations to solve problems in different areas of the organization and its disclosure, has been an educational tool for disseminating knowledge in workers of the organization, guiding them in solving similar problems
Registration of documentation, manuals, standards and corporate instructional	X	X	X		There is a corporate virtual tool which is updated with versions of the guidance documents for the execution of work in the organization

Source: Own elaboration

Monitoring of internal corrosion of pipelines

Procedures are documented to evaluate the corrosiveness of the fluid by the physicochemical and microbiological characteristics of the water associated to it, to determine the corrosion rate and quantification of bacteria. It is applicable to oil pipelines, whether or not they have chemical treatment.

Internal cleaning for atmospheric storage tanks

Instructions for cleaning and safely evacuate solid and liquid waste in atmospheric storage tanks for hydrocarbons in order to contribute to the mechanical integrity of the tank, maintain the storage conditions and products quality requirements. It can be used as a basis for a preventive maintenance guide for atmospheric tanks according to Integrity plans established for each individual case, depending on environmental and operating conditions.

Besides the above mentioned documentation, it was established the protocols and manuals for personnel training in the area of Operations and Maintenance with the criteria of acceptance for repairs and the accepted methods for performing these repairs based on the standards set by the API (American Petroleum Institute) and accepted in the organization as well as the rules of the ASME (American Society of Mechanical Engineers).

4.6. Knowledge transfer to the new generations

The positive impact of knowledge management in the organization, resulted in the creation of standards and corporate documents that reduced failure rates and accident rates in the activities of the transportation of hydrocarbons in the Casanare Department and other departments of the country, giving support to the organization to undertake an initiative to replicate the key knowledge gathered in the Vice-presidency of Transportation in ECOPETROL This initiative involved the planning, structuring and implementation of a structured program to respond to training needs.

This type of program was historically performed in the organization, but was stopped in 1990, its last year. Graduates from this program are those who nowadays occupy many of the senior positions such as managers, superintendents and other officers of the operating areas.

Figure 4. Seniority of personnel in VIT at 2012.

Source: Adapted from Informe Responsabilidad Social (2011)

This program was taken in 2012 in order to replicate and assure knowledge at critical positions that requires specialized and comprehensive technical knowledge in the transportation of hydrocarbons with high probability to obtain own knowledge based on the development of their function.

This training program was justified on the identified need of transfer key knowledge to the new generation of professionals who joined the Vice Presidency, at December 2012, from 100% of the personnel in the VIT, 54% had las than 5 years in the company, 36% out of this 54% with low seniority, belonged to the operational areas.

According to staff data from 2012, approximately 10% of Maintenance and Operations staff have projected their retirement in late 2014 generating gaps in the staff, affecting the implementation of key procedures and in addition to this, growth forecast for the personnel plant is an additional 15%.

From this projection, was required to be perform a structured approach to accelerate the learning curve for new personnel, assuring knowledge transfer to minimize the probability of incidents and accidents caused by human mistakes, achieving the corporate goal of producing clean barrels, with zero accidents, zero damages to the environment and in harmony with the communities. From this program the organization was able to reinforce technical skills of professionals VIT on different subjects such as operation, maintenance, marketing and logistics, generating greater competitiveness against the market, being aligned with the new strategy of the Vice President to be recognized as excellent operators and maintainers.

The advanced training program took more than 14 months and consisted of several modules which achieved and adequate knowledge transfer to key professionals assigned to this training program, an example of some of these modules are: Context of Industry; Technical principles; Measuring, recording and balance of hydrocarbons; Asset Management; Design and construction; Operation of transport infrastructure; Infrastructure maintenance; Development and implementation of projects; Complementary modules; internships and pumping plants.

Instructors of these modules were professional with high antiquity, and even retired professional called to teach class on these courses, or active company personnel with a high level of expertise in technical tasks related to the industry and daily operation of the transportation system.

With these two models of application of Knowledge Management in the Operations and Maintenance area results have been achieved on indicators of training and knowledge transfer, but have really impacted the organization's effectiveness in implementing processes, cost savings by optimizing standards, organizational agility by having clear roles and responsibilities for the technical tasks that were born from the same staff executing the tasks, and especially the greatest impact has been the reduction of the indicators of accidents, incidents and unsafe conditions that have contributed to enforce corporate policy of zero accidents.

A significant impact of the implementation of knowledge management has been the legacy left to the present generation with low term in the company, gaining the knowledge of people who developed key industry practices for more 20 years and recorded his experience to be replicated and improved increasingly from optimizations that arise from new technologies or new models or standards and industry practices.

4.7. Acknowledgements to the implementation of Knowledge Management.

Implementation of Knowledge Management in ECOPETROL has been recognized internationally by been included among the list of nominees for the MAKE award (Most Admired Knowledge Enterprises).

The MAKE program was created in 1998 in order to identi-

fy leader organizations in transforming enterprise knowledge into shareholder value. It is developed and administered by Teleos, an independent knowledge management and research of intellectual capital firm and "The KNOW Network "a cooperative network of knowledge created to help organizations improve their performance through the development of "know how", and skills that are comparable to those used by world-class companies. Among the companies that are part of this network are Apple, ConocoPhillips, Deloitte, Microsoft, Schlumberger, Worley Parsons, among others. Ecopetrol was nominated for the first time as a finalist in the global ranking in 2010, ranking among the 51 global companies nominated and has repeated his nomination in 2011, 2012 and 2013. In 2012, ranks among the winners of the MAKE Award Americas.

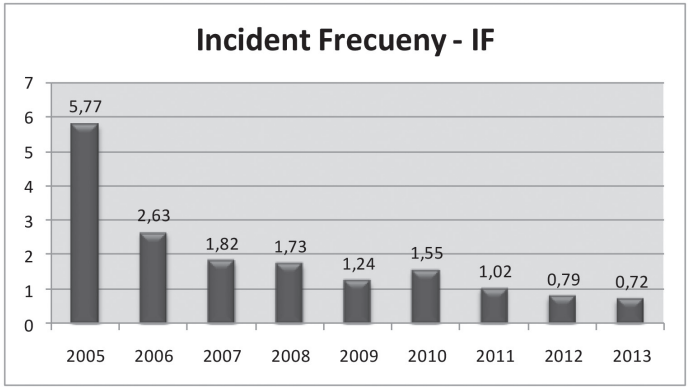
5. CONCLUSIONS

Identifying best practices that support process improvement in the Vice Presidency of Transportation in Ecopetrol S.A has revealed the scope and challenge of implementing Knowledge Management in the organization. In order to achieve the objective of the study, was necessary to review the actions taken to transfer knowledge to new generations of workers and the alignment of these with the corporate strategy of commitment with life and operational excellence.

One of the visible results of the implementation of Knowledge Management has been the creation and continuous improvement of standards, manuals and procedures that compile lessons learned experience and knowledge of experts, impacting positively on improving time and cost for the processes of maintenance and operation.

The greatest impact has been reflected in the improvement of indicators for incidents of industrial safety in the transportation systems of the Casanare region, as shown in figure 5, directly related to the overall policy of commitment with life, by reducing the probabilities of fatalities.

Figure 5 Lost-time Incident Frequency Indicator.



Source: Adapted from Reporte de sostenbilidad (2011)

The implementation of knowledge management has also made a strong impact in socializing key knowledge collected in the repository of corporate information, making the process of internalization in the new Vice Presidency professionals through structured learning programs, in order to train these professionals for positions of high technical and administrative requirements. In this way, the organization manages to adapt its human resources to meet the needs of the environment and gaining quick experience through these training programs.

Moreover, keeping the PDCA cycle path and its alignment with Knowledge Management is a major challenge for the organization, which promotes continuous improvement that has been evident since the identification of best practices in the area of Operations and Maintenance for the Vice Presidency of Transportation. Upon recognition of these practices and their positive impact on process improvement (as outlined in table 5), its implementation is recommended in other areas such as: Project Development, Engineering, Commercial and New Business. All with the purpose of exploiting synergies that can arise when implementing communities of practice that link these areas and expand the knowledge base of the Vice President.

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