

Analysis and diagnosis of the current state of eco-innovation within the colombian paper industry

Análisis y diagnóstico del estado actual de la eco-innovación en la industria del papel en Colombia

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Resumen

El papel constituye un importante bien y servicio para el día a día, aun así, su proceso productivo requiere de altos niveles de consumo de energía, agua y fibra. En este momento Colombia está adelantando esfuerzos para alcanzar el desarrollo sostenible en la industria, para esto se encuentra trabajando bajo el marco del Programa de las Naciones Unidas para el Medio Ambiente (PNUMA), el cual propone abordar problemáticas ambientales mediante el replanteamiento de los procesos productivos y la incorporación de la eco-innovación como una herramienta al modelo de negocio. Este documento analiza el estado actual de la eco-innovación en la Industria de la Pulpa y el Papel en Colombia para después, a través de la revisión del proceso productivo del papel, identificar los pasos que siendo mejorados resulten en la reducción de costos de producción, consumo de energía, agua y fibras, teniendo como meta al mismo tiempo la reincorporación de los residuos producidos por este proceso a otras cadenas de producción, para generar un impacto positivo y valor agregado a la cadena de valor. La intervención de las fases de secado, formación y presa en el proceso de producción de papel, así como el uso del licor negro como materia prima para

Abstract

Paper constitutes an important good and utility of everyday life, however its productive process requires high levels of energy, water and fiber consumption. Colombia is currently forwarding efforts to achieve sustainable development within the industry, thus working under the United Nations Environment Programme (UNEP) framework, which proposes to tackle environmental issues through the re-thinking of productive process and the incorporation of eco-innovation as a tool to the core business strategy. This paper analyses the current state of eco-innovation in the Colombian Pulp and Paper Industry to then, through the reviewing of the paper production process identify the specific steps that could be improved, resulting in a lowering of costs, energy, fiber and water consumption while also striving to re-incorporate some of the produced wastes into other productive processes and generating a positive impact and added value to the productive chain. The intervention of the drying, press and forming phases of the paper production process as well as the use of black liquor to produce bio-fuels would prove a significant improvement of the overall process making it a less energy-demanding

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la producción de bio-combustibles probaría ser una importante mejora de todo el proceso productivo, convirtiendo a la industria en una que demande menos energía, mejorando la calidad del producto final y abriendo a la industria nuevos niveles de competitividad en el escenario nacional e internacional.

Palabras clave: Eco-innovación; sostenibilidad; negocios verdes, modelos de negocio; CANVAS; desarrollo sostenible; industria de pulpa y papel.

industry while also heightening the quality of the final product and opening the industry to new levels of competitiveness in a national and international scene.

Keywords: Eco-innovation; sustainability; green business; business model; CANVAS; sustainable development; pulp and paper industry.

Introduction

Key concepts like sustainable development, first defined by (Brundlandt Commission), have experienced several changes through the last 30 to 40 years; this developing concept therefore demands us to understand a sustainable enterprise, not as a steady state, but as a process that is constantly evolving and changing according to its environmental, economic and cultural demands (Hojnik y Ruzzier), while also requiring the capacity to adjust to ever-changing scenarios, circumstances, resource availability and approaches.

The need to achieve corporate sustainability has emerged from the ever-increasing pressure to produce better and cheaper products and services exerted by the consumers, the need to comply to national production regulations, to increase corporate competitiveness and to improve corporate image through new and innovative market ideas (Bonzanini Bossle, Dutra de Barcellos y Marques Vieira). Such output can be achieved by the reduction of waste production and through the implementation of cleaner and more efficient technologies (Roscoe, Cousins y Lamming), also by assessing the production process and evaluating each of the inputs and outputs generated throughout the value chain, keeping in mind the importance of incorporating industrial symbiosis to handle all the generated outputs (Hojnik y Ruzzier).

The Colombian industry is currently facing a decisive point in its history, since it finds itself facing international production policies, competitors and standards while also struggling to develop and maintain its necessary presence and support of the national economy. This

paper aims to analyze and assess the development of eco-innovation policies, firm initiatives and practices in order to create a grounded diagnosis of the industry's situation, more exactly in the paper industry scenario, which during 2014 generated around 80,000 jobs and produced 2.5% of Colombia's gross domestic product (GDP) through production, proving its importance as a participant of the national economy (ANDI: Asociación Nacional de Empresarios de Colombia), as to produce a set of recommendations and improvement possibilities to be applied throughout the paper-production chain and create an added value capable of enhancing the industry's opportunities to make its way into bigger international markets in which eco-innovation is not an option but a demand and a decisive point assessed by stakeholders and consumers (Garrido Azevedo, Brandenburg y Carvalho).

Reference Framework

International eco-innovation policies

On an international level, there are a lot of different issuing bodies responsible for the production and execution of cleaner production and eco-innovation policies that are to be applied throughout the territory they are concerned with, while also drawing a road map for each individual country to follow and adapt to the specific situation of each country (OECD).

The following table shows some of the most relevant policies that are being adapted throughout different regions of the world.

Tabla 1. International eco-innovation policies

POLICY	ISSUING BODY	GOAL
The EU Eco-innovation Action Plan (EcoAP)	The European Commission	To Achieve environmental objectives through innovation while targeting specific bottlenecks in any productive process and industry.
The Global Environment Research Fund	Japan's Ministry of the Environment	To promote global environment studies through interdisciplinary interaction among natural, social and political sciences (OECD, 2008).
EU2020 Strategy	European Union	To re-focus R&D and innovation policy on major challenges for our society like climate change, energy and resource efficiency, health and demographic change strengthening every link in the innovation chain, from 'blue sky' research to commercialization (Barsoumian, Severin , & Van der Spek, 2011).
Promoting Resource Efficiency and Eco-innovation in Developing and Transition Economies (REEDTE)	United Nations Environmental Programme	To engage SMEs in an eco-innovation process by addressing enabling conditions that are conducive to systemic innovation and developing local resources and expertise.

National Legal Framework

As for the national legal framework regarding eco-innovation, the leading issuing body is the Ministry of Environment and Sustainable Development, which in the year 2015 launched the *“Cooperation Project: Integration of the sustainable production and consumption policies to promote Eco-innovation in Colombia”* (Centro Nacional de Producción

Más Limpia), that has been one of the first national programmes to directly tackle eco-innovation in an effort to bring it forward in the product and service national industry.

The following is a compilation of programmes and regulations that, one way or another seeks to improve production and consumption trends while introducing eco-innovation to the industrial scene.

Tabla 2. Cleaner production and consumption framework in Colombia

POLICY	ISSUING BODY	GOAL
National Policy of production and consumption	Ministry of Environment, Housing and Territorial Development	Direct the change of production and consumption patterns found in nowadays-Colombian society, towards environmental sustainability, contributing to the wellbeing of the people and the competitiveness of enterprises (Ministerio de Ambiente, Vivienda y Desarrollo Territorial).
National Plan for Green business	Ministry of Environment and Sustainable Development	Define guidelines and for pacification and decision making allowing the development, promotion and encouragement of both the supply and demand of Green and sustainable Businesses' throughout the Country, via the implementation of an adequate platform that provides the necessary tools, incentives, coordination and institutional articulation that will contribute to economic growth, job creation and the conservation Colombia's Natural Capital (Ministerio de Ambiente y Desarrollo Sostenible).
Regional Programme for Green Businesses': Central Region	Ministry of Environment and Sustainable Development	Define guidelines and provide the necessary tools for the proper pacification and decision making that allow the development and fomentation of Green and Sustainable Businesses', according to the potentialities and regional competitive advantages, generating economic and social growth and encouraging the conservation of natural resources (Ministerio de Ambiente y Desarrollo Sostenible).
RedES-CAR	Regional Autonomous Corporations	This program consists on enhancing competitiveness and environmental performance among companies in the product and service industry, through the incorporation of industrial symbiosis and eco-innovation to the core-business strategy of major companies in the country while also incorporating SME's and providers of raw materials; all under the framework of the cleaner production and consumption policy introduced by the Ministry of Environment and Sustainable Development (RedES-CAR; Universidad de Los Andes).
Cooperation Project: Integration of the sustainable production and consumption policies to promote Eco-innovation in Colombia"	National Centre for Cleaner Production	This program seeks to incorporate eco-innovation to the Colombian production policies while also aiming to carry out a number of pilot projects in 7 different organizations, to then establish a National Implementation Plan for eco-innovation (Centro Nacional de Producción Más Limpia).

Colombian Pulp and Paper Industry

The primary raw material used to produce paper comes mainly from recyclable and biodegradable materials that have their origins in renewable sources. This allows the extension of the paper's life cycle allowing it to prolong its use, and therefore reduce the rate of waste production (ANDI: Asociación Nacional de Empresarios de Colombia).

Furthermore, 63% of the fiber employed in the process of paper production in Colombia comes from waste recollection, while obtaining all the necessary virgin fibers from certified forest plantations and cane bagasse, a by-product that originates from the agro-industrial production of sugar and biofuels (ANDI: Asociación Nacional de Empresarios de Colombia).

When approaching the national industry, it is safe to say that the local markets are its primary costumers (ANDI: Asociación Nacional de Empresarios de Colombia). In 2015 alone, the Colombian pulp and paper industry managed to sell 85% of its paper and cardboard produce while also selling around 99,4% of its pulp production. Throughout recent years, this market has been evolving and seems to be developing a very favorable behavior in the Colombian industry scene.

During the year 2015, Colombia's paper and cardboard apparent consumption decreased by 1.4%, reaching an average consumption of 28 kg of paper per inhabitant, and although the average consumption of paper in the country is low when compared to the worldwide average consumption, 56,8 kg of paper per inhabitant in 2014, the Colombian pulp and paper industry aims to achieve higher production standards while also proving its importance in the national economy (ANDI: Asociación Nacional de Empresarios de Colombia).

Eco-Innovation

There is a wide range of definitions for eco-innovation that have been determined by different research groups, eco-innovation research facilities and key international policy groups (Hojnik & Ruzzier, 2016); regardless of this, almost any definition that exists seems to incorporate the environmental dimension and how its management

reflects upon costs, resource efficiency and the lessening of environmental adversities (Hojnik & Ruzzier, 2016)-.

According to the European Union a key figure in the development, promotion and application of sustainable development; eco-innovation can be defined as

“the production, assimilation or exploitation of a novelty in products, production processes, services or in management and business methods, which aims, throughout its lifecycle, to prevent or substantially reduce environmental risks, pollution and other negative impacts of resource use (including energy)” (OECD).

Some research facilities like the (Eco-Innovation Observatory 8) define eco-innovation as

“The introduction of any new or significantly improved product (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle”.

Another definition of eco-innovation is the one given by (OECD), which describes eco-innovation as

“The production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life-cycle, in a reduction of environmental risk, pollution and the negative impacts of resources use (including energy use) compared to relevant alternatives”.

According to (Horbach, Rammer y Rennings) eco-innovation is described as

“Any product, process, marketing, and organizational innovations, leading to a noticeable reduction in environmental burdens. Positive environmental effects can be explicit goals or side effects of innovations. They can occur within the respective companies or through customer use of products or services.

Other key strategic groups on a worldwide scale, such as the United Nations with its Environment Programme, defines eco-innovation as

“The development and application of a business model shaped by a new business strategy that incorporates sustainability throughout all business operations based on life cycle thinking and in cooperation with partners across the value chain. It entails a coordinated set of modifications or novel solutions to products (goods/services), processes, market approach and organizational structure which leads to a company’s enhanced performance and competitiveness” (UNEP).

Colombia, however, doesn’t seem to have a definition of eco-innovation, mostly adopting the one used by the United Nations.

Industrial Eco-products

An industrial eco-product is defined as any good that is able to prove that during its production process, said good produces less of a negative environmental impact when compared to other products of the same nature; or that because of the inner characteristics of the good, its utilization or its production process, has the capability to generate environmental benefits (Ministerio de Ambiente y Desarrollo Sostenible).

Green Business

A “Green business” is defined by the Colombian Ministry of Environment and Sustainable Development as a business that contemplates economic activities in which any offered product or service generates a positive environmental impact while incorporating good environmental, social and economic practices with a life-cycle approach, contributing to the conservation of the environment as natural capital that supports the development of the territory (Ministerio de Ambiente y Desarrollo Sostenible).

Sustainable Development

Also known by the United Nations Thesaurus as “*Eco-development*” or “*Environmental sustainability*”, sustainable development refers to any sound develop-

ment that is capable of meeting the needs of the present without compromising the ability of future generations to meet their own needs. Eco-innovation is known to be linked closely to the term “sustainable development” as the first one constitutes an important tool in the achievement of environmental sustainability (Pansera).

Methods

Information Sources

To obtain information regarding environmental, social, economic and productive indicators, several sources will be consulted. Primary sources will be constituted by interviews with some of the industry’s stakeholders in order to acquire the point of view on the matter of eco-innovation, the industry and the relationship between the two. As for secondary information, different sources will be consulted such as sustainability reports, sectorial reports papers regarding the industry’s behavior, its social, economic and environmental performance and so on.

CANVAS

The business model CANVAS, developed by (Osterwalder, THE BUSINESS MODEL ONTOLOGY A PROPOSITION IN A DESIGN SCIENCE APPROACH) is a strategic method usually employed when looking for the potential of improvement or innovation in a company and/or a specific productive process, enabling an operational, management and strategic focus, this model provides a visual representation of the current state of a company its management state and its specific processes, allowing those in charge of developing a project access to key information vital when aiming tackle and further develop a potential business venture (UNEP).

This model consists of nine (9) “building blocks” each featuring an important element or aspect that helps to capture and describe a specific business model (UNEP). The first block or “customer segment” aims to define the various stakeholders, costumers and interested parties that come into contact with the firm; and, depending on the nature of the firm, might target a mass market, a niche market or a diversified market, each of them having different needs and different approaches concerning the

production, distribution and the possibility of customizing the goods according to each and every customer (UNEP).

This way, each block is filled with information regarding the way the firm works and what it hopes to achieve and provide to its customer, covering elements like value propositions, channels, customer relationship, revenue stream, key resources, key activities, key partners and cost structure (UNEP).

This model will be adapted and filled with information regarding the productive process of paper manufacturing, then by identifying the key steps of the processes that, if modified, would allow a higher rate of production while lessening the environmental cost of the process, all of it falling under the framework established by the Eco-innovation manual: Tools instruction (UNEP), employed by the United Nations Environmental Programme “*Promoting Resource Efficiency and Eco-innovation in Developing and Transition Economies (REEDTE)*” which targets the global network of Resource Efficient and Cleaner Production issuing bodies, entities, business and providers particular to each country involved, while also encouraging small and medium enterprises to partake in the development and application of eco-innovation by providing them with economic support, knowledge, experience and business contacts, heightening the rate of success (UNEP).

The following diagrams show the research method that will be used to analyze the production process of paper in Colombia to then proceed to propose a CANVAS business model that will aim to create added value to the overall process and final product. The first step to follow is to select a specific production process within the paper industry, the next step consists on reviewing each step of the selected process, collecting information regarding the needed levels of energy, water consumption, waste production, GHG emissions, raw materials so on. Once the data from each step has been collected, analyzed and compared the step to follow consists on identifying which specific step has negative outcomes that have the potential to be improved in a way that reduces costs, environmental resources and waste production.

Once a specific productive process has been selected and analyzed based on the information collected, the

CANVAS model is filled out. The following step consists on evaluating the proposed CANVAS in order to identify a possible eco-innovative solution and the outcomes of its application to the productive process; to finally measure the rate of success of the business model and estimate if the provided solution creates added value to the overall process, formulating a set of recommendations to take into account in future eco-innovative ventures in the Pulp and Paper Industry in Colombia.

Results and Analysis

State of the Art

Eco-innovation in the World

Currently the European Union (EU) holds the highest rate of eco-innovative small to medium enterprises (SME's) in the world (Triguero, Moreno-Mondéjar y Davia), this being due to the fact that the EU production policies and markets demand from enterprises a set of regulations that must be fulfilled in order to carry out any sort of business venture (Triguero, Moreno-Mondéjar y Davia). The before-mentioned may be considered as the main driver of eco-innovation among European SME's, that while fulfilling market demands, also take advantage of them to boost their marketing strategies, improve their image and become more competitive when compared to other business that offers the same or a similar product, achieving a higher business performance when introduced into new markets (Lee & Min, 2015).

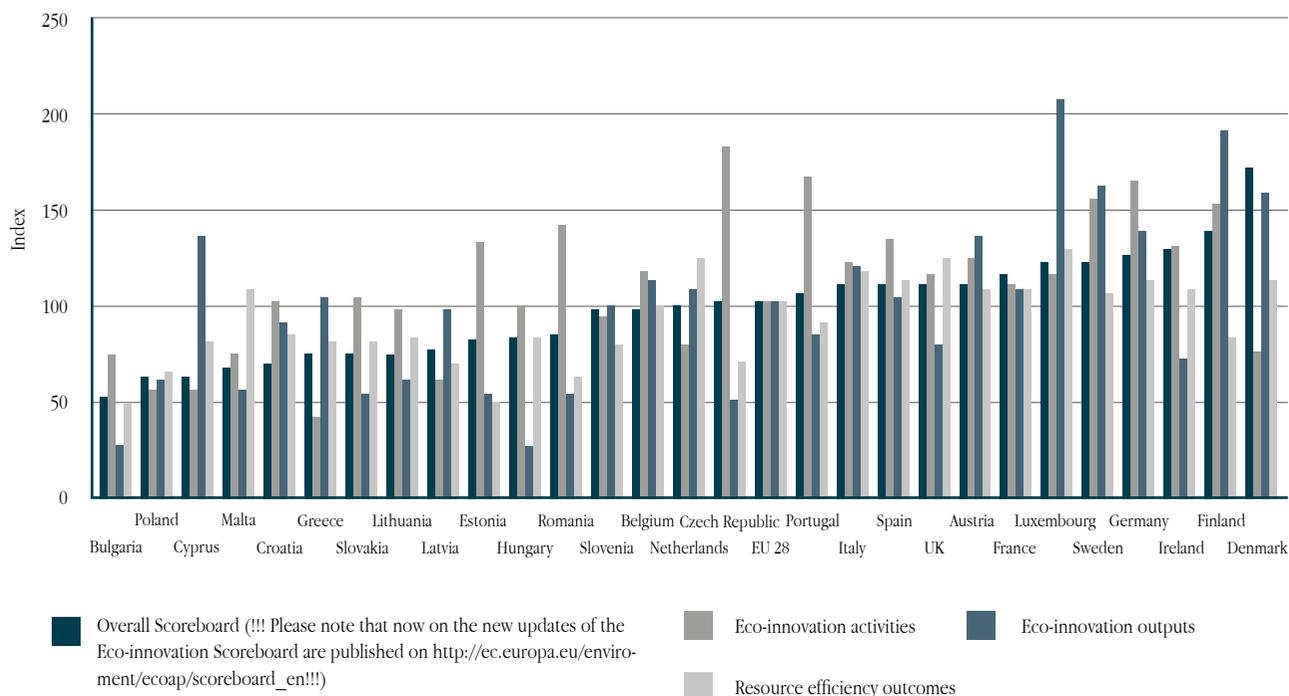
With the aid of policy-issuing bodies and research institutions like the (International Union for Conservation of Nature IUCN) or the (Eco-Innovation Observatory), the European Union is equipped with the necessary sources to closely report on any eco-innovative strategies applied within the Union's country members; as stated before, the “*Eco-innovation Scoreboard*” is comprised by five (5) dimensions or categories and each category is then composed by a set of indicators. The first of the five dimensions is known as “*Eco-innovation inputs*” and it measures the amount of investment, whether it'd be a financial, human or a technical investment provided by the government, an enterprise, or an organization to set an eco-innovative activity in motion (European Commission).

The second dimension is called “*Eco-innovation Activities*”; and it is defined as any effort directed towards the development of any new or improved products and services, the modification of business models and the introduction of eco-management to companies and organizations (European Commission). The third dimension is referred to as “*Eco-innovation outputs*” and it is measured through the number of immediate results of eco-innovation activities, and the extent to which knowledge can help and relate to developing eco-innovation (European Commission). The next dimension, “*Resource efficiency outcomes*” evaluates how an eco-innovation can have a positive impact on resource efficiency therefore increasing the generated economic value, while also decreasing pressures and negative impacts on natural resources and the environment (European Commission).

Finally the fifth dimension measures “*Socio-economic outcomes*”; this dimension encompasses both the benefits and disadvantages of applying eco-innovation through a company or a productive process, it can range from number of jobs created and eliminated, changes in competitiveness (positive or negative), revenues, expenses of companies and acquired profits (European Commission).

When analyzing the image below, it can be seen that countries like the Czech Republic, Portugal and Germany, are the most engaged in “Eco-innovation activities”, while Denmark, Finland and Luxembourg report the highest rate of “resource efficiency outcomes”; and out of the 28 member countries, Luxembourg, Finland and Denmark have the highest rate of “Eco-innovation outputs” respectively (Eco-Innovation Observatory).

Illustration 1. The Eco-innovation scoreboard EU per member country (Eco-Innovation Observatory)



One of the most outstanding examples of the corporate benefits of eco-innovation in an industrial setting comes from the Finish industry; that has incorporated life cycle assessment to their industrial core business strategy producing a cost reduction of at least 17% and a 15% reduction of energy usage during the manufacturing phase in the construction industry alone since 2008 (Ortiz, Castells y Sonneman).

At the same time, eco-innovation in Asian countries seems to be experiencing an accelerated growth, more so in developed countries like Japan, Korea, Singapore and China, this being due to the fact that enterprises settled in developing countries face the challenge of creating and applying eco-innovative ideas, technologies or policies without the support of the government or research facilities, and therefore relying on less resources directed

towards research on the matter (Jo et al., 2015) side effects such as resource exhaustion, environmental pollution, and social injustice have begun to appear. As a solution, eco-innovation has received a great amount of attention from European countries and as a result, many efforts to analyze the development of eco-innovation quantitatively have been made. This study aims to evaluate the validity of an eco-innovation index developed to support the sustainable development goal. For this purpose, four factors of eco-innovation capacity, supportive environment, activity, and performance were applied to three categories of the Triple-Bottom-Line (TBL).

One of the most successful cases of eco-innovation in Asian countries is the one carried out by (CellMark) in which they managed one of the most harmful by-products of the paper industry, black liquor, a thick, dark liquid composed of lignin and hemicellulose left over by the conversion of pulp into paper.

(CellMark), A Chinese paper company that roughly produces 5.2% of China's paper based products, proposed a partnership with RenFuel, a Swedish company that produces biofuels; together they carried out a series of tests and trials to turn the black liquor into lignin oil, the raw material needed to develop biofuels through a conventional refinery reducing carbon emissions and production costs while also providing a holistic solution to a waste management issue that constituted one of the greatest environmental issues in the Chinese Paper Industry (CellMark).

In their study of the Brazilian Industry, (Jabbour, Neto, Gobbo, Ribeiro, & De Sousa Jabbour, 2015) the goal of this research was to analyse how certain human critical success factors are related to specific low-carbon eco-innovation projects in leading companies in Brazil operating in some of the most sustainable supply chains in the country. As a consequence, this study qualitatively analysed three cases of low carbon eco-innovation discussing the necessary human critical success factors (HCSF identified that the top ten leading companies that had in some level achieved the introduction of eco-innovation to their productive process, had relied on the support of the higher management, that in most cases showed some concern regarding the fulfilment of new policies that concerned the reduction of greenhouse gas emissions introduced to the industrial scene around the

year 2009; this type of policies seemed to have a great impact upon the development of eco-innovative initiatives that would then propel those involved with the industry to go as far back as to re-design already existing products, lessening resource usage, energy consumption and production costs while heightening revenues, improving corporate social image and improving the over-all business strategy (Jabbour et al., 2015) the goal of this research was to analyse how certain human critical success factors are related to specific low-carbon eco-innovation projects in leading companies in Brazil operating in some of the most sustainable supply chains in the country. As a consequence, this study qualitatively analysed three cases of low carbon eco-innovation discussing the necessary human critical success factors (HCSF).

One of the most successful cases of how the development of new business models to tackle environmental issues, is the one described by (Matos & Silvestre, 2013), that analyzed how the Brazilian energy sector switched their targeted production developed through fossil fuels to the production and promotion of renewable energies, not only addressing the issue of carbon emissions but also integrating the social dimension by obtaining the majority of the needed raw material (oil seeds for biodiesel) from impoverished communities and farmers. Currently when comparing the former business model applied by the industry to the one developed in 2010, significant advantages in the environmental, social and economic dimensions can be clearly identified (Matos & Silvestre, 2013).

It has been reported that in recent years, the European Paper Industry has partaken in the efforts to implement eco-innovation through the introduction of nanotechnologies that enhance the amount of ink removal allowing a higher rate of fiber recycling and dematerialization, thus obtaining a more efficient process and cheaper raw materials whilst using less virgin fiber (OECD).

While the technological improvements have proven to be more effective on a shorter-term scale, many researchers have argued that the importance of policy introduction must be taken into account for longer-term solutions, such policies will ensure that any enterprise in the market is constantly evolving and engaging in the research and development of new ways to lessen the negative impacts that their products/services may have on the environment (Chiappetta Jabbour, Saturnino Neto y Alcides Gobbo).

Eco-innovation in Colombia

Through the introduction of the RedES-CAR Programme in 2013 endorsed by the Regional Autonomous Corporations, the UNEP Programme “*Promoting Resource Efficiency and Eco-innovation in Developing and Transition Economies (REEDTE)*” in 2014 and the “*Cooperation Project: Integration of the sustainable production and consumption policies to promote Eco-innovation in Colombia*” in 2015, the country seems to be adopting eco-innovation as its main business and development strategy in the effort of both lessening the environmental impacts provoked through industrial performance and appealing to wider international markets. Currently, the results of this Programme have not been reported by the UNEP.

With this in mind, the Nation has set in motion a number of case studies in which the life-cycle thinking is applied to an already existing corporation mainly in two different industries; the Hotel Industry with 7 on going case studies (Díaz Mateus, Higuera Quintero y Abadía Aguirre), the Chemical Industry with on-going cases in 5 Small to medium enterprises (SME's) (UNEP Regional Office for Latin America and the Caribbean); this effort has been made in an attempt to introduce eco-innovation as a viable business strategy that will produce an important added value in a medium to longer term (Centro Nacional de Producción Más Limpia).

Some examples of this can be seen in the chemical industry that has partaken on different eco-innovative ventures, such as the introduction of a business strategy that targets chlorinated and non-chlorinated solvents; in this case the industry decided to offer the service of metallic surface cleaning accompanied with the management of the produced slug and waste instead of selling the solvent and letting the client manage the outcomes of the cleaning process (Centro Nacional de Producción Más Limpia); this is an example of how policies are a viable way of improving a business model while also reducing an important environmental impact.

Although this cases in the Colombian Industry are scarce, there seems to be a growing trend among other productive processes that want to adopt eco-innovation to their core business strategy, falling in line with the different legislations that concern cleaner production and there-

fore amplifying the interest of corporations, consumers and suppliers to fulfil this market demands (Centro Nacional de Producción Más Limpia). However, the lack of a national reporting organization has not allowed the creation of a database of any successful cases of applied eco-innovation.

Pulp and Paper Industry in the world

The Pulp and Paper Industry has a significant importance on global economy (ANDI: Asociación Nacional de Empresarios de Colombia), with presence in over 100 countries in the world and providing jobs for more than 3.5 millions of people through the manufacturing of 268,551 thousand tonnes per year mostly in countries like the United States, Canada, Japan, China, Finland, Germany and Brazil, leaders on pulp and paper production on a world wide scale (International Labour Office).

Over the past century the Pulp and Paper Industry in the world has reported an exponential growth (Szabo , Soria y Forsstro). Currently regions like North America, Europe and Asia consume 90% of pulp and paper based products, accounting for 360 million tonnes of consumed goods while regions like Oceania, Africa and Latin America consume less than 8% of the overall produced goods (Szabo , Soria y Forsstro).

Past years have demonstrated that the world Pulp and Paper Industry faces a growing trend in production and consumption, reaching growth levels of up to 2.1% per year in the Eastern European region, Asia and Latin America, with developing regions experiencing a growth of 4%/yr and between 0.5-1% in developed countries (Szabo , Soria y Forsstro).

Eco-innovation in the Pulp and Paper Industry in the world

Since 1990 the (Confederation of European Paper Industries) has reported the reduction of CO_2 emissions encompassing those produced by transport, direct emissions and emissions produced by purchased electricity; going from 60 million tonnes of CO_2/yr in 1990 to 49 million tonnes CO_2/yr in 2015, and aiming to reduce

them to 12 million tonnes of CO_2/yr for the year 2050. This and other confederations of paper industries like the (Confederation of Paper Industries) and (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) have expressed their commitment to the cause of reducing the rate of CO_2/yr emissions and energy consumption in order to decarbonise the process and become a bioeconomy that supports the 2030 Climate and Energy Framework.

Some of the most effective eco-innovations reported in recent years in the pulp and paper industry have come from policy shifts in production, provider networks and the investment in research and development (Confederation of European Paper Industries). By specifically targeting key aspects like ensuring wood mobilization from sustainably managed forests, creating a strong recycling network to ensure raw materials at lower economic and environmental costs, designing cost-effective decarbonization plans for electricity, ensuring an optimal use of transport networks, developing research and development programmes and facilities to identify breakthrough technologies and investing on skills and education relevant to the needs of the industry and the constant engagement of stakeholder groups the industry has managed to carry out and comply to the standards of different market scenarios (Confederation of European Paper Industries).

Cases of successful eco-innovation in the Pulp and Paper Industry on a global scale can be found mainly in countries that are leaders in this industry. Finland for example has found that the potential of eco-innovation in the Pulp and paper industry relies heavily on material flow and energy intensity proving that small improvements on efficiency for both categories and use of by-products can have a significant impact on resource savings (Eco-Innovation Observatory). Countries like Sweden have also applied eco-innovation in their Pulp and Paper Industry, mainly focusing their efforts on the development of chlorine-free technologies, managing to reduce water pollution and enhancing environmental competitiveness when compared to Pulp and Paper Industries from other regions in the world (OECD).

Other examples of eco-innovations in the Pulp and Paper Industry can be found in the Chinese Industry, which in recent years has excelled on the management and treat-

ment of toxic by-products generated in pulp and paper mills focusing mainly on black liquor (OECD). There are a couple of cases in which the Chinese Pulp and Paper Industry has developed environmentally sustainable uses of this toxic material. One such case developed by Giant Hemu Technology Co., Ltd (Giant Hemu) a Chinese pulp and paper company that relies on the use of black liquor as a multi-element organic compound fertilizer that combats desertification and reduces CO_2/yr emissions by 420 000 tonnes per year; the development of this eco-innovation resulted on a zero discharge pulping process that enables a comprehensive use of renewable sources in the Pulp and Paper Industry in China (OECD).

All the afore-mentioned cases have something in common, and that is the need of constantly creating products that meet the high environmental standards set by each country, improve the company's social standing and image and finally to comply with international regulations, allowing said company to approach new markets, reduce costs for the client and generate added value to their productive process (OECD).

Colombian Pulp and Paper Industry

The Pulp and Paper Industry in Colombia has been, since 1992, represented by the Chamber of Pulp, Paper and Cardboard as a member of the Colombian National Business Association (ANDI); the Chamber is currently made up by nine companies, that make up 67% of paper producers in the Country; this nine companies roughly produce 89% of the cardboard and paper production and 100% of the overall pulp products available in the Country. This strategic alliance has as its main goal to provide an accurate representation of the Industry and its value chain while continuously seeking to achieve highly competitive and sustainable development, providing high quality products and services to their stakeholders, shareholders and customers (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Due to the industry's nature, it is closely linked to ANDI's Sustainable Development vice-presidency, furthering the efforts of the industry to demonstrate to the general public that the production, distribution and use of pulp, paper and paper-based products benefit the economy, are not harmful to the environment and have a positive

impact upon the communities involved with the production process (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón)

The nine-affiliate companies that take part in the continuous development of the Pulp and Paper Industry in Colombia are as follow:

- Cartones América S.A
- Carvajal Pulpa y Papel S.A
- Corrugados de Colombia Ltda.
- Empaques Corrugados S.A
- Fábrica de Bolsas de Papel UNIBOL S.A
- Grupo Familia-Productos Familia S.A
- Kimberly Clark
- Papeles y Cartones-Papelsa S.A
- Smurfit Kappa-Cartón de Colombia S.A

Through this alliance the Industry has managed to establish a holistic and inclusive strategic approach for the industry to carry out its business, ensuring a progressive approach to the productive process, the well-being of their workers and remaining competitive when compared to other industries in the country (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Each of the affiliated companies has different approaches to sustainable development and the way to carry out their businesses and productive process; the Chamber allows a constant interaction between all of them in order to develop a conjoined vision of sustainability through the sharing of business experiences, resources, policies, technology and so on.

The leader of sustainability out of the nine companies present in Colombia is Smurfit Kappa-Cartón de Colombia S.A, part of the American branch of the Dutch based company that currently owns 103 FSC certified forest plantations in Latin America only, and is present in 34 different countries worldwide with presence in 21 countries in Europe and 13 countries in the Americas; this particular company has a strong commitment with environmental causes and sustainability, publishing sustainability reports under the GRI framework ever since 2012 and has set for itself a number of goals in seven main components to ensure the implementation

of different evolving sustainability practices in the chain of custody, CO₂ emissions, waste management, water, health and security, sustainable supply and presence and participation in all involved communities (Smurfit Kappa Colombia).

During 2015 this company reported that through its productive process 325,329 tonnes of paper were produced through the use of five (5) paper mills, generating 875,032 million COP, while auto producing 71% of their energetic demands, utilizing 40% of biofuels, recycling 94,005 tonnes of paper, reporting 9 million tonnes of CO₂ removed from the atmosphere thanks to 41,000 Has of company-owned forest plantations and securing a 100% of FSC certified processes and goods (Smurfit Kappa Colombia).

Other companies like Grupo Familia-Productos Familia S.A, a Colombian based company founded in 1958 who's main line of business relies on the production, distribution and sales of paper-based hygiene products and packages, have engaged in the compromise of publishing sustainability reports and other environmental performance activities since 2013 (Grupo Familia), sharing their recent accomplishments in terms of economic, social and environmental performance; for 2015 the company was able to generate 1'158,441 million COP in revenues, saving 220.897^{kWh}/_b of energy throughout their productive process, reducing water consumption to 2,343 m³ and reducing 9.94 tonnes of CO₂ emissions; investing a total of 16,385 million COP on environmental performance and sustainability (Grupo Familia). Through this reports the company was able to communicate the environmental profile of their processes and products to their stakeholder groups, ensuring the fulfilment of national and international environmental regulations, setting and reviewing the long-term environmental goals set by the company and reduce the negative environmental impact that may come as an outcome of the organization's performance (Grupo Familia).

Recently, Grupo Familia-Productos Familia S.A and Papeles y Cartones-Papelsa S.A have engaged in a research project with the floriculture sector to evaluate the use of carnation stems as raw material for the production of paper and cardboard boxes, this inter-industrial alliance has proven to be beneficial for all the engaged

parties since it provides alternative raw materials for the Pulp and Paper Industry at a lower cost while also reducing the cost of waste management of the floriculture industry in Colombia, making this venture one of the first recorded and successful cases of eco-innovation in Colombia that have continuously generated higher revenues, environmental and environmental advantages in the industry (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Paper production process

The production of paper starts with the harvesting of virgin fibers; that in the case of Colombian Pulp and paper Industry mainly comes from Pine trees, sugar cane bagasse and eucalyptus; this step is followed by the de-barking and chipping of the collected wood that is to be sent to the chemical pulping step in which the lignin and hemicellulose are removed producing black liquor, a highly polluting material that has degrading impacts on soil and water quality as well as producing a number of health issues ranging from damage to the respiratory system to skin burns and eye irritation (Weyerhaeuser), on the communities affected by its presence.

The chips are then sent to the mechanical pulping process that consists of the separation of fibers by grounding the chips from the previous step (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) (International Labour Office).

Meanwhile, a secondary raw material necessary for the paper production process comes from recycled fibers that are obtained through the process of pulping to separate component fibers to then move on to the de-inking phase, to remove any adhesives and ink from the fibers. From this point on, both the virgin and recycled fibers are blended together (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) (International Labour Office).

Following the mixture of both virgin and recycled fibers, the mix goes through a cleaning step in which the fibers are washed, screened and dried. After this step the resulting pulp is ready to used, but for the purposes of producing white paper it must go through a bleaching phase to then move on to a head box; a machine that squirts the mixture of water and fiber through a thin horizontal slit that carries the pulp to the wire section; during

this step, the water is removed from the mixture, allowing the remaining fibers to be spread and consolidated into a thin mat that then goes on to the press section (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) (International Labour Office).

Once the web of paper reaches the press section, it is squeezed in order to lower its water content up to 50%, this phase will allow the paper to go on to the dryer section that is made up of a series of cast-iron cylinders that are heated to temperatures up to 100°C for the sheets of paper to roll through and finish drying. The following step consists on coating and moving on to a calender, a device with two or more rollers that compresses the paper while applying heat, giving the paper a smooth and glossy appearance. Finally the paper moves on to be converted into reels and/or sheets for use and distribution (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) (International Labour Office).

Throughout the process of paper production, each step requires certain inputs such as energy, fuel, water, fibers, steam, chemicals and so on. According to (Laurijssen , Faaij y Worrell, Benchmarking energy use in the paper industry: a benchmarking study on process unit level) the average rate of energy used in the stock preparation phase for virgin and recycled fibers is of 3.0 Gj/ton and 3.15 Gj/ton respectively, the de-inking step is up to 3.25 Gj/ton of regular paper produced, the forming phase having an average energy consumption of 0.5–3.0 Gj/ton paper while the drying section reaches 3.6-6.2 Gj/ton of energy used, mainly by water removal, making this step the most energy-consuming of the overall process; with this in mind, the following part of this paper targets this production phases, aiming to reduce energy consumption costs while improving the quality of the finished product taking into account that energy consumption on the production process of paper can add up to 18.6 Gj/ton (Cristini S.p.A).

Eco-innovation in the Colombian Pulp and Paper Industry

Currently there are no more than a couple of recorded cases of applied eco-innovative ventures in the Pulp and Paper Industry in Colombia; however, the latest sustainability report for this industry launched in 2017 sets a number of challenges that the Industry is currently facing

in order to remain competitive in the national and international scene (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Some of the before-mentioned challenges include the offering of products with an added environmental value while also forming entrepreneurial links with sustainable enterprises, and then creating a new operational cost structure that allows higher competitiveness on a global context. Reducing Green House Gas emissions in the overall productive process through the investment in innovation, its development and research, and finally to strengthen the links between research facilities that may introduce new and cleaner technologies to the productive chain, as well as a number of policies that allow better products at a lower environmental and economic cost (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

This mind-set accompanied by the current efforts that are being forwarded by the government in regards of cleaner production, consumption and eco-innovation may very well boost the role of the Pulp and Paper Industry that has reported a yearly production of 881,000 tonnes of recycled paper (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón), 55.9 million m^3/yr of water consumption (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón), 55.00 million m^3/yr of waste water discharge (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón), an energy consumption of 2396 TJ/yr and 561.38 Ton/yr of waste production (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) in Colombia as a leading participant in developing eco-innovation on a national scale.

Pulp and paper industry CANVAS

The following CANVAS model describes the business model that is currently being carried out in the Colombian Pulp and Paper Industry, encompassed by nine (9) different companies that represent the 67% of the overall Pulp and paper industry in Colombia; this business model was filled out by the author of this paper with the aid of all available sources, mainly constituted by secondary sources since the disclosure of information relevant to the nine affiliated companies to the Chamber of Pulp, Paper and Cardboard Industry from the Colombian National Business Association (ANDI) is strictly forbidden by all members.

The “*Customer Segment*” in the current business model caters to national markets on an 88% of the overall production reported by the Chamber, mainly providing inputs to small and medium enterprises, banks, public and private offices, large-scale service providers while also catering to international markets on a 12% of the chamber’s production, mainly exporting to countries in Latin America but also carrying out businesses with India, Turkey and Japan (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón). In regards to the “*Value Proposition Segment*”, the Chamber offers to its customers a product that ensures that its raw materials originate from sustainably managed forests, that its productive process is constantly improving in order to produce less GHG emissions and that each of the nine engaged companies take responsible care of the waste production that results from their operations (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

As for the “*Channels*” segment, the Pulp, Paper and Cardboard Chamber primarily utilizes the “Two Sides” initiative, a collaborative project between the Pulp and Paper Industries present in 13 different countries; this initiative has as its primary objective to dispel common misconceptions about the industry by providing trustworthy information on why paper is a sustainable, practical and important way to communicate and connect (Two Sides Initiative). As for other channels of communication, the Chamber has started the initiative to put out a bi-annual sustainability report while continuing to support and manage the operation of the “Recycling Newsletter” with the support of the Colombian National Business Association (ANDI) and its Recycling Committee (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

The “*Customer Relationship*” segment is currently targeted towards securing that all interested parties involved with the Paper Industry are properly protected, while also striving to attain a satisfactory fulfilment of their customers’ expectations when carrying out businesses with any of the nine affiliated companies (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón). Revenues that come from the sales of socially responsible paper as well as deforestation-free products and all the available products that have the Colombian Environmental Seal (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón) comprise the following segment, “*Revenue Streams*”.

Currently only one of the nine-affiliate companies has earned the national seal, while another one is in the process of acquiring the certification.

The next segment of the current business model “*Key Resources*” mainly consists on policy implementation, revision of National manufacturing policies and shareholder backup; the chamber heavily relies on shareholder back up when it comes to the instauration of new competitiveness challenges and market-growth oriented strategies (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Moving on to the “*Key Activities*” segment, the Pulp and Paper Industry regards the disclosure on product information and the incorporation of policies and state of the art technologies to the core of the productive process as its primary way of improving the business and the industry

in general (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón). As for the “*Key Partnerships*” segment, there are a number of imperative groups that are currently a vital part of the development of the business model; mainly it targets recycling guilds, providers of raw material, for the companies that don’t own wood plantations, distributors guilds, the Ministry of Environment and Sustainable Development and finally the Organization for Economic Co-operation and Development (OECD) (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Finally, the “*Cost Structure*” segment currently relies on a 32% reduction of costs from fossil fuel consumption on the overall productive process that has been measured throughout the last five years; a 1,54% reduction of GHG emissions and a 2% increase in the consumption of natural gas (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Illustration 2. Colombian Pulp, Paper and Cardboard Industry business model (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón, 2017)

The Business Model Canvas

<p>Key Partners</p> <ul style="list-style-type: none"> Recyclers Raw material providers Distributors Government OECD Ministry of Environment and Sustainable Development 	<p>Key Activities</p> <ul style="list-style-type: none"> Disclosure of production info. Incorporation of cleaner technologies 	<p>Customer Segments</p> <ul style="list-style-type: none"> National (88%) and international (12%) markets Business that use, distribute and sell paper SME's Banks Offices Public and private organizations 	<p>Channels</p> <ul style="list-style-type: none"> Two-sides initiative Accountability/sustainability report Recycling newsletter 	
<p>Key Resources</p> <ul style="list-style-type: none"> Patents Shareholders backup Policy implementation 	<p>Value Propositions</p> <ul style="list-style-type: none"> Low-carbon emission paper Deforestation-free paper Waste management 	<p>Customer Relationships</p> <ul style="list-style-type: none"> Customer protection Customer satisfaction 	<p>Cost Structure</p> <ul style="list-style-type: none"> 32% reduction of fossil fuel consumption in 5 years 2% increment of natural gas consumption 1,54% reduction of GHG emissions in 5 years 	<p>Revenue Streams</p> <ul style="list-style-type: none"> Sales of socially responsible paper Sales of deforestation-free paper

Business model proposal

Through the last 15 years, this industry has strived to achieve higher rates of production while also reducing the environmental costs that come from pulp and paper production, however the lack of eco-innovative research and development, both in the country and the industry have become an impediment to this initiative. The

following business model was constructed with the aim of targeting some of the industry’s main environmental issues, specifically reducing energy consumption which currently is at 2396 TJ/yr and poses the biggest environmental issue of the industry since it is one of the most energy-demanding processes of the industrial scenery consuming up to 15% of all the energy used in the manufacturing sector worldwide (Laurijssen, Energy use in the

paper industry), largely contributing to climate change, CO_2 emissions that are reported to be of 1300 Tonne/yr; water consumption that in 2015 was reported to be of 55.9 millions m^3/yr and the cost of waste water management that has been reported to be of 126'000, 000 COP/yr (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

Through the implementation of “Advanced Sensing Technologies for Paper Production (A.S.T.E.P.P)”, a new technology that was developed under the European Commission’s Environmental Initiative, which specifically targets environmental impacts from the paper production process. This proposal consists on the installation of monitors to the paper production machinery; these monitors are to be installed in the forming, pressing and dryer sections of the pulper machine (Cristini S.p.A). Through the application of this technology different results can be achieved, mainly the optimization of the fiber refining, dewatering, conditioning and manufacturing processes.

One of the main energy-consuming phases of paper production is the press and dryer section which require certain amounts of steam to dry the paper; the monitor installed in this section of the paper machine controls the amount of moisture of the pulp entering the dryer section. According to (Cristini S.p.A) a 1% increase in the overall moisture signifies a reduction of at least 4% of the steam needed to carry out an adequate drying process, which at the same time will affect the efficiency of the next two steps of the paper-production process; the forming and pressing of the final product ultimately lowering the energy levels required to carry out this procedure. A close monitoring of the moisture levels will allow the use of any corrective measures that not only will result in the reduction of steam and energy consumption, but will also have a positive effect on the quality of the final product (Cristini S.p.A).

The (European Commission) has reported that through the implementation of this monitors, a reduction of 5.5% of GHG emissions is accomplished; when applying this results to the Colombian Pulp and Paper Industry, it would signify a reduction of 71,5 tonne GHG emissions per year. In regards to water usage, it is reported that there can be a decrease of at least 3.7% on the overall process resulting on 2.1 Millions m^3 less water needed per year in the Colombian case; finally, when it comes to energy consumption the constant monitoring of the

production process would result in a reduction of 306.7 TJ/yr of the figure reported on 2015 by (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón).

As for the matter concerning waste management, the industry has stated that one of their biggest issues comes from the production of black liquor that as stated before comes from the removal of lignin and hemicellulose during the stage of converting of pulp into paper. Currently the Industry is using this specific waste to help produce the energy required for the functioning of paper mills, mainly generating the energy needed for the engines on rotatory devices, while also producing part of the steam needed on the drying phase (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón), however, the repercussions of any mishandling of this material that could result on its spilling would have severe negative effects on the health of the workers and communities near the paper mills, generating a high rate of soil and water pollution mainly due to the presence of caustic soda and sodium sulphide, and the high corrosion and combustion potential of the black liquor (French ministry for sustainable development).

With this in mind and taking into account that thanks to the Colombian National Business Association (ANDI), the Pulp and Paper industry in Colombia has a close link to the National Federation of Biofuel Production, therefore a symbiotic relationship could be constructed by following the case study presented by (CellMark). This relationship would not only benefit the Pulp and Paper Industry in Colombia, both in economic, social and environmental regards, but would also allow the growth of the Biodiesel Industry in Colombia, ultimately boosting the conversion from fossil fuels to biofuels and lessening the country’s overall rate of carbon emissions at a much lower price and with the same refining equipment available in the country (Pettersson y Harvey) (CellMark).

The business model that would be the outcome of applying the proposed changes approaches the “Customer Segment” with the aim of increasing the reach of the industry to bigger international markets from a 12% to a 40% through the implementation of policies and technologies that enhance and are able to reach the environmental sustainability standards demanded by markets like the European Union, while still providing inputs to the National markets, and its customers. This would represent a decrease of

the presence of the Pulp and Paper Industry in national markets going from a 88% to a 60%; this however would not mean that less paper based products are being made and sold by national companies, but that there would be an increase in production that would allow the industry to keep fulfilling the national demands while also catering to international markets of high production standards.

As for the “*Value Proposition*” segment, this model offers to increase the rate of low-energy, low carbon emission and low water usage produced paper resulting in a reduction $306.7 \frac{TJ}{yr}$, $71.5 \frac{Tm}{yr}$ and 2.1 millions m^3/yr respectively; meanwhile maintaining and improving the already existing value propositions of the Industry, such as deforestation-free paper and waste management responsibility. Through the accomplishment of these goals, the industry will be capable of starting the certification process to earn European eco-labels, earning a higher social standard among its groups of stakeholders without having the need to increase the selling cost of their products.

In regards to the “*Channels*” segment, the business model strongly suggests the widening of communication channels by allowing the costumers access to detailed information on raw material sources and providers, energy consumption per step of the paper making process and finally by constantly releasing sustainability reports that measure the development of the industry. On the other hand, the “*Customer Relationships*” segment is to be carried out by continuing to put forward a relationship in which customer protection and satisfaction is the Industry’s primary concern.

The “*Revenue Streams*” segment is to be directed not only towards the production and sale of environmentally sustainable products, it must also take into account other tools like the conformation of a industrial symbiosis network in which all the involved industries have as a common goal the production of high quality products at lower economic, social and environmental costs, ensuring the re-introduction of by-products into other production processes. As for the “*Key Resources*” segment, it is important for the industry to push forward and support the development of research and technology that benefit the sustainable growth of the industry, the introduction of patents to the process and the implementation of policies that push the industry towards a more efficient productive process.

The “*Key Activities*” section must mainly be focused on the introduction and application of eco-innovation into the core business strategy proposal; this will mean that the industry is acquiring a compromise with its stakeholders and other interested parties to have open communication channels, providing full disclosure of the benefits that come from incorporating new eco-innovative policies and technologies, shaping symbiotic relationships with other industries to provide and obtain cheaper raw materials, energy sources and other outputs, reducing the environmental damage of the industry as a whole and re-introducing outputs to other productive processes.

When it comes to the “*Key Partnerships*” segment the main change would be to consolidate close relationships with organizations like research facilities since they would be the main contributors of “know how” and the equipment needed during the developing stages of new research concerning the industry, universities as they would provide the “human resources” necessary to carry out research and development of new eco-innovative technologies and polices, non-governmental organizations, the United Nations Environment Programme and international policy regulators to further develop the industry to the needs and demands of international markets and regulations, while also contributing to the adjustment of the industry when it comes to the fulfilment of more strict and ever-evolving environmental standards; all this partners would ensure that the industry is positively contributing and constantly evolving towards sustainable procedures and a cleaner industry.

Lastly, the “*Cost Structure*” segment should produce an outcome of the following nature: a reduction of 5.5% of GHG emissions per year, a 3,7% reduction of water usage per year, a 12.8% reduction of energy consumption costs per year and a 37% reduction of waste management costs throughout the full extent of the paper production process (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón); it is important to take into account that the waste management cost percentage is based on the Chinese case that requires the black liquor to be transported from China to Finland signifying a higher cost of production that would be much less significant in the case of the Colombian industry.

Illustration 3. Business model proposal

The Business Model Canvas

<p>Key Partners</p> <ul style="list-style-type: none"> Recyclers Government International policy regulators Raw material providers NGO's UNEP OECD Distributors Research facilities Universities 	<p>Key Activities</p> <ul style="list-style-type: none"> Eco-Innovation Disclosure of env. benefits Incorporation of cleaner technologies and policies (monitors) Industrial symbiosis 	<p>Value Propositions</p> <ul style="list-style-type: none"> Low-energy produced paper (306.7 TJ/yr less) Low-carbon emission paper (reduction of 71.5 ton/yr) Same priced paper Deforestation-free paper EU approved paper (eco-label) Waste management Low water usage (2.1 millions m³/yr less) 	<p>Customer Segments</p> <ul style="list-style-type: none"> National (60%) and international (40%) markets Business that use, distribute and sell paper SME's Banks Offices Public and Private organizations 	
<p>Key Resources</p> <ul style="list-style-type: none"> Patents Research and development Shareholders backup Policy implementation "know how" 	<p>Channels</p> <ul style="list-style-type: none"> Eco-labeling Detailed info on raw material sources & providers Info on process (now&then, sust. reports) 	<p>Customer Relationships</p> <ul style="list-style-type: none"> Customer protection Customer satisfaction 	<p>Cost Structure</p> <ul style="list-style-type: none"> 5.5% reduction of GHG emissions per year 3.7% reduction of water usage per year 12.8% reduction of energy consumption per year 37% reduction of waste management costs 	<p>Revenue Streams</p> <ul style="list-style-type: none"> Sales and promotion of environmentally sustainable paper Industrial symbiosis Conversation from sales of paper to the providing of a service

Conclusions

This paper aimed to analyze the state of eco-innovation in the Colombian Paper Industry, to then identify any plausible opportunities to create value along the paper production chain with the aid of the tools provided by eco-innovation, life-cycle thinking and industrial symbiosis.

In order for the industry to evolve in a competitive manner, Eco-innovation must become the core of the business strategy, this will then allow the paper production process to develop simultaneously to any eco-innovative practices and become a more flexible and competitive industry that may take on the challenges set by the international markets, policy issuing bodies, market pressures and stakeholder influences.

Taking into account that the process of paper production requires large amounts of energy and water usage of up to 18.6 GJ/ton and 58.7 Millions m³/yr respectively to (Laurijssen , Faaij , & Worrell, 2013) (ANDI: Cámara de la Industria de Pulpa, Papel y Cartón), and also regarding the fact that this issues affects the industry's image in

a negative way, posing a strategy to directly tackle this problems seemed a sensible way of ensuring that the industry would improve its performance on a national and international scale while at the same time enhancing the benefits of the paper production process and its environmental outcomes.

While defining the state of the art of eco-innovation in Colombia, more precisely in the Pulp and Paper Industry, the main setback came from the lack of information on the subject. Taking into account that the matter is still fairly new in the country and that just 7 years ago it became a member of the REEDTE Programme endorsed by the UNEP and only 3 years ago it started the first application of case studies with some corporations that have not yet reported results, the information on the matter is very limited, still lacking precise information of the outcomes, recommendations and conclusions. However, the country is striving to develop itself under the eco-innovation framework to remain competitive and ensure the wellbeing of the environment.

As stated before, eco-innovation mainly believes in making small changes to productive processes in order to create a significant outcome in resource efficiency, lowering the cost of production and reducing negative environmental impacts. By introducing eco-innovation to the “*key activities*” segment in the CANVAS business model of the Colombian Pulp and Paper Industry one can positively affect all the other segments of the business model, this would result in the expansion and growth of the industry under the sustainable development framework in Colombia and also securing a pathway to international markets.

Even though the Industry is constantly trying to evolve in an environmentally sustainable way and so far it has accomplished a lot, the productive standards held in wider international markets demand even higher resource and energy efficiency; the development of a CANVAS business model derived from the introduction of Advanced Sensing Technologies to the productive process in the Colombian Pulp and Paper Industry would allow a clear overview of the advantages and results of this technologies and the rate of investment and return of investment, allowing an easier decision making process based on the comparison of both the current and future business strategy of the Industry.

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