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Pestel analysis in the current context of thermal lubricants in Latin America

Análisis Pestel en el contexto actual de los lubricantes térmicos en América Latina

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Abstract:

The goals of this research is focused on performing a PESTEL analysis of the use of lubricants in thermal engines in Latin America. It is necessary to identify the base information to complete each one of the factors that are evaluated in this type of research and following a methodology that is proposed for the step by step. In this document we will find the approach and formulation of the prob-lem, which will allow us to propose the basis of the problem we wish to analyze. Subsequently, the objectives are determined, both general and specific, allowing us to identify which are the points of the problem to be solved by this research. After defining the objectives to be fulfilled, the main reasons that justify the present research are analyzed, determining the bases that give rise to and guide where the research should be directed to build new information that will allow the devel-opment of future research in this field. In order to solve the needs of the project, it is necessary to use a methodology that summarizes the sequence that must be followed in the research, determining how the information to be used will be ob-tained and how the PESTEL analysis will be developed later on. Finally, the ex-ecution schedule of this research and the deliverables that will be obtained at the end of this project are determined.

Keywords: Technological, ecological, legal, Lubricants, Pestel Analysis, political, economic, social.

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Resumen:

Los objetivos de esta investigación se centran en realizar un análisis PESTEL del uso de lubricantes en motores térmicos en América Latina. Es necesario identificar la información base para completar cada uno de los factores que se evalúan en este tipo de investigación y siguiendo una metodología que se propone para el paso a paso. En este documento encontraremos el planteamiento y la formulación del prob-lema, que nos permitirá proponer la base del problema que deseamos analizar. Posteriormente, se determinan los objetivos, tanto generales como específicos, lo que nos permite identificar cuáles son los puntos del problema a resolver por esta investigación. Una vez definidos los objetivos a cumplir, se analizan las principales razones que justifican la presente investigación, determinando las bases que dan origen y orientan hacia dónde debe dirigirse la investigación para construir nueva información que permita el desarrollo de futuras investigaciones en este campo. Para resolver las necesidades del proyecto, es necesario utilizar una metodología que resuma la secuencia que debe seguirse en la investigación, determinando cómo se obtendrá la información a utilizar y cómo se desarrollará posteriormente el análisis PESTEL. Finalmente, se determina el cronograma de ejecución de esta investigación y los entregables que se obtendrán al final de este proyecto.

Palabras clave: Tecnológico, ecológico, legal, Lubricantes, Análisis Pestel, político, económico, social.

Introduction

Due to the large amount of petroleum-based lubricants available, one of the common practices in certain parts of the world is to dispose of them in wastewater and streams to avoid collection. This is particularly true in countries where environmental regulations and legislation for the use and handling of lubricants are not well established. As a consequence, a small amount of this pollutant can result in a large amount of water being wasted and, therefore, put into the aquatic animals and plants in the area in which it influences. This activity is extremely dangerous since it causes a chain reaction that would eventually affect humans in the long term, posing a high risk of contracting certain diseases. In this sense, as health, safety and environmental regulations in society and industry become stricter, there are still many deficiencies regarding the use of these chemicals, such as oil disposal, recycling regulations, drainage, among others. Considering that lubricants are required to be used for longer periods of time, it is essential to develop synthetic lubricants that minimize the impact on the environment. Although the initial cost of these lubricants is very high compared to conventional lubricants, the longevity is three to four times greater than that of conventional lubricants and can also increase the useful life of the machine where it is being used [1].

The effect of lubricating oil on emissions has been an aspect analyzed in many research studies, where the effect of its physicochemical characteristics, sulfur content, metal content, volatility and density has been observed. From a mechanical point of view, lubricants in engines help to improve vehicle efficiency, alt-hough they also have a high impact on pollutant emissions in the engine exhaust. Therefore, like many in-dustries, the automotive industry faces the challenge of improving fuel economy, both to conserve natural resources and to establish guidelines related to pollutant emissions and the production of greenhouse gases. This leads to the search for new materials and technologies to improve efficiency with low emissions [2].

It is important to consider the fact that more than one-sixth of the problems affecting the environment caused by pollution are related to petroleum, especially products coming from tanks and pipelines [3]. Approximately 1% of the total consumption of mineral oils is used to formulate lubricants. Lubricant-

related environmental hazards fall into the same category as general petroleum contamination and, despite their smaller volume, are equally insidious due to their wide diffusion. Between 13% and 32% of all used lub-ricants return to the environment with more or less changed properties and appearance. The safety of the products for the consumer and the environment requires careful evaluation by exposure analysis, biodeg-radation and ecotoxicity testing [3].

The health problems currently posed by lubricants are mainly related to mist inhalation and skin contact. The production, application and disposal of lubricants have to meet the requirements of the best possible pro-tection of the environment [4].

Increased public awareness for a pollution-free environment has led to the increased use of bio-based consumer products, such as lubricants, and environmentally friendly technology. The aim of various measures taken by legislators and regulatory authorities is to protect the environment and increase the market share of biodegradable lubricants [5].

Research and use of lubricants prepared from vegetable oils have made great strides in recent years thanks to the implementation of strict government regulations and mandates in various parts of the world that en-courage greater use of renewable resources, particularly for sensitive areas such as forestry, mining, marine, agriculture, heavy industry, transportation, rail and shipping, pulp and paper mills, sawmills, dredgers, motorcycle chains, etc. However, technological advances have been more limited [6].

From any objective point of view, the substitution of petroleum-based lubricants by biolubricants has sig-nificant economic and environmental benefits. The possibilities for supporting the substitution of mineral lubricants are manifold and include (i) economic incentives for crop production; (ii) subsidies for the manufacture of lubricants from crops; (iii) subsidies for the development of innovative products and pro-cesses; (iv) creation of a regulatory environment; and (v) country-specific legal and market instruments that favor the application of finished products.

The Fuel and Lubricant Technologies Program [7] has had as its main objective to make emission control systems as efficient as possible, while meeting current and future emission and durability standards. It has also sought the possibility of reducing dependence on conventional petroleum-based fuels through direct fuel substitution with emerging, non-petroleum-based fuels. These activities have been undertaken to de-termine the impact of fuel and lubricant properties on the efficiency, performance and emissions of today's engines, as well as to enable the emergence of advanced internal combustion engines, and have been co-ordinated with the fuel and emissions activities of the Environmental Protection Agency (EPA) and its supporting entities.

On the other hand, handling lubricants as a business requires a broad understanding of the fact that there are environmental liabilities throughout its supply chain. Therefore, lubricant handling companies are respon-sible for providing training to their staff, including site personnel and any external waste contractors, and for communicating best practice procedures related to the management of used petroleum hydrocarbons to all individuals and organizations involved in business relationships [8].

Reconciling the interests of economic agents (companies) with the conservation of the natural and social environment where they

carry out their activities implies that they take responsibility for the impacts of their actions and minimize these negative effects, i.e. that they are truly socially responsible. There are many leading companies in Responsibility, Environmental Management and sustainability and many researches on the subject. The studies are based on ISO 14000 and this has sometimes caused a bias to emphasize en-vironmental issues, ignoring the relationship between economic performance, natural business environment and social development. Environmental management should be analyzed and evaluated with a multidi-mensional approach, so that it can be known to what extent economic activity influences the conservation of the natural and social environment where goods and services are produced. [9]

Several regulatory measures have been adopted in industrialized countries to protect the environment from the regular use of chemicals, including lubricants. More recently, the European legislative framework reg-ulating chemicals has been revised. Regulations are becoming increasingly restrictive with respect to the content, use and disposal of lubricants. There is increasing government pressure to establish environmentally sustainable products. Government policies and regulations that facilitate the introduction of biolubricants benefit from subsidies, mandates, preferential procurement, market introduction schemes and other pro-motional instruments. Voluntary (supra) national eco-label schemes that focus on toxicity, ecotoxicity and biodegradability help the consumer to make a rational product choice [10]-[14].

Several countries, especially in Europe, have pursued different policy strategies to promote the replacement of mineral lubricants with biodegradable lubricants. For example, since the 1980s, Germany has granted continuous support to R&D activities related to the industrial use of agricultural raw materials, including the development of biodegradable lubricants. This program has increased the market share of biodegradable lubricants in a large number of application fields without setting priorities. Austria introduced a legal ob-ligation to use biodegradable lubricants in forestry saw chains in 1991 (BGBl. No. 647/1990 ST0255), which has been largely complied with and has been quite effective. Similar regional and local regulatory measures (e.g., in national parks) are now being applied more frequently. France's economic incentive policy is based on differentiated taxation according to classification results (e.g., award of the eco-label) [14].

Mann [15] has argued that only a policy that prioritizes full substitution of mineral lubricants with biode-gradable substitutes in the applications with the greatest benefits can be effective. Regulations requiring substitution in certain areas may meet this criterion, whereas subsidies for production, processing, market introduction and research often do not meet the effectiveness criteria. The industry needs clarity on reliable long-term government policies on industrial crops, rather than the current rather volatile and ad hoc measures, and a stable supply of vegetable oils. The biodiesel experience is emblematic.

Due to the sharp decrease of approximately 20% in fuel consumption in the industry by 2020, mainly due to social isolation measures and the cessation of industrial activities, a significant growth in the liquid fuels industry and its derivatives has been projected for 2020. With the present situation, investments focused on the sector are expected to allow companies to allocate the improvement of the locative infrastructure and maintenance, directing

their contribution to energy transition projects, socio-environmental management and other activities in lubricants. This opens a window on how efforts can be focused on improving the industrial and manufacturing processes of lubricants for the industry. Due to the strong economic impact generated by the reduction in the use and application of lubricants in industry, it will allow new scenarios in public policy aimed at making regulation more flexible, guaranteeing supply and improving the quality and efficiency of processes to improve the socio-economic and environmental conditions of the industry that uses lubricants in its processes [16].

Another important consequence of the current situation is the negative impact on the economic environ-ments of 18 companies that commercialize these products and their derivatives, affecting the industrial ecosystem and essential activities; therefore, implementing economic models to restructure the lubricants market is necessary for the economic reactivation that must be faced due to the slowdown of the economy [17]. In Colombia, circular economy strategies are being managed, which promote initiatives related to a sustainable environment, focusing on aspects such as water reuse, energy efficiency and waste utilization, which will allow a sustainable development of the country's economy. The involvement of important companies in the sector plans to promote models of new sustainable forms with the premise of closing production cycles, which will lead to innovation in the efficient use of resources and the reuse and disposal of raw materials and waste.

Methodology

For the development of this study, the concept of science mapping was taken into account, the development of which is carried out using bibliometric methods to examine how documents from disciplines, fields, specialties or individuals are related to each other [18]. Therefore, two stages were followed: bibliometric analysis and network analysis. In the first, the WoS search was performed by analyzing the bibliometric indicators, to, in the second, with the documents obtained in the previous stage and their bibliographic references, build the network with R through co-citations analysis, using the tree analogy to classify the documents, finally, and identify the research perspectives

Bibliometric analysis

Based on the limitations and suggestions of previous reviews [19]-[40], WoS was used to search for documents under the parameters defined in [23].

Table I. Search criteria and results.

Search data	Web of Science
Time analyzed	2010-2020
Date of consultation	June 10, 2020
Type of documents	Articles, books, book chapters and conference publications
Type of magazines	All types of
Search field	Title, abstract, keywords
Search term	"Lubricants in engines".
Total publications	1654

Five bibliometric methods [18] are used to perform a performance analysis and scientific mapping: Citation analysis, Co-word analysis, Co-citation analysis, Co-author analysis, Bibliographical coupling analysis. The first one presents the history of publications, categorized by database, countries, journals and authors. The second shows the most reiterative words present in the Keyword plus of all documents. The third shows the network of co-citations and collaborations. The fourth shows the network of co-authorships, which rep-resents the collaboration between authors. The fifth connects the documents on the basis of shared refer-ences, making it possible to identify the emerging fields, in this case perspectives (Network).

Results and discussions

Analysis of publications by year

Figure 1 shows the growth of research on the use of lubricants in engines between 2010 and 2020 as can be seen in Figure 1, allowing to analyze the increase of the trend in the publications obtained, showing an in-crease of approximately 70% of the volume of publications and showing that 2020 is the year with the highest record to date in the publication of this subject. The present study is not taking into account the behavior of the trend for the year 2020, in the expectation of future research that will allow observing the behavior of the present year. Due to the growth policies in the organizations and the current characteristics, the trend of the present topic will continue to increase during the next years, proposing more specific methods that contribute to the development in this field of research.

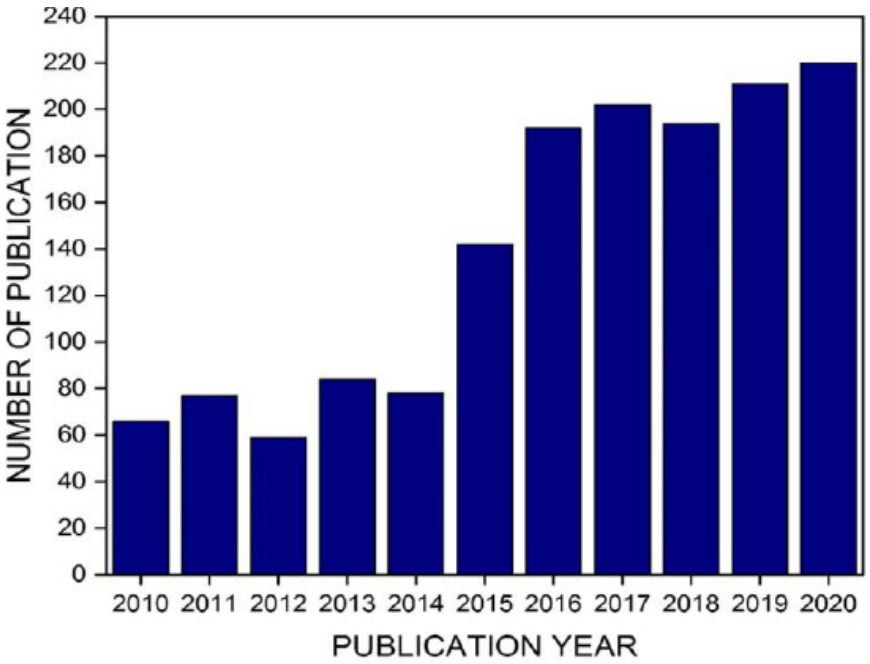

Figure 1. Representation of the number of publications according to the year of publication.

Author analysis

In order to evaluate the impact of the publications on this topic, an analysis focused on the top 10 authors with the highest number of publications, allowing the h-index of each of the authors to be evaluated through the impact of their research and the number of citations presented by the authors with their published ar-ticles, as shown in Table II. The research obtained that the two authors with the most publications are Rahnejat (23) and Hemmat Esfe (20), but they are not the authors with the highest number of citations. On the other hand, the authors with the highest impact of their publications are Masjuki (h-index = 84) followed by Hemmat Esfe (h-index = 63), evaluating the impact generated by their publications with respect to the number of times cited.

Table II. Analysis of the scientific production of the 10 authors with the most publications.

Author	Number of publications	Number of citations	H-Index	University	Country
Rahnejat, Homer	23	1377	21	University of Central Lancashire	England
Hemmat Esfe, Mohammad	20	8982	63	Imam Hossein Univ	Iran
Masjuki, H. H.	19	21755	84	University Malaya	Malaysia
Spike, Hugh	17	4990	41	Imperial College London	England
Ali, Mohamed kamal Ahmed	15	1280	19	Minia University	Egypt
Kalam, M. A.	15	11272	62	University Malaya	Malaysia
Zulkifli, Nurin Wahidah Mohd	15	2057	27	University Malaya	Malaysia
San Andres, Luis	13	2944	28	Texas A&M University System	USA
Mufti, Riaz Ahmad	12	894	16	National University of Science & Technology	Pakistan
Neville, Anne	12	7981	47	University of Leeds	England

Magazine analysis

Table III shows the analysis of the publications by journal in which they were published, allowing to observe the behavior of the 10 journals with the largest publications in this subject, analyzing the percentage of the number of publications of the total number published in this period of time, the Quartile in which the journal is located in 2020 and the h-index presented by the SCImago Journal Rank analysis page.

Table III. Analysis of the scientific production of the 10 journals with the highest number of publications

Journal	WoS	% of total	SJR2020	Quartile	H-index (SJR)	Country
SAE INTERNATIONAL JOURNAL OF FUELS AND LUBRICANTS	205	12,39%	0,65	2	47	United States
TRIBOLOGY INTERNATIONAL	101	6,11%	1,40	1	120	United Kingdom
LUBRICANTS	63	3,81%	0,59	2	24	Switzerland
PROCEEDING OF THE INSTITUTION OF MECHANICHAL ENGINEERS PART J JOURNAL OF ENGINEERING TROBOLOGY	61	3,69%	0,48	2	56	United Kingdom
TRIBOLOGY TRNASACTIONS	52	3,14%	0,64	2	65	United Kingdom
FUEL	46	2,78%	1,56	1	213	Netherlands
TRIBOLOGY LETTERS	44	2,66%	0,99	1	92	United States
INDUSTRIAL LUBRICATION AND TRIBOLOGY	40	2,41%	0,31	3	30	United Kingdom
JOURNAL OF ENGINEERING FOR GAS TURBINES AND POWER TRANSACTIONS OF THE ASME	33	1,99%	0,57	2	84	United States
WEAR	28	1,69%	1,20	1	160	Netherlands

The journals with the highest number of publications on this subject are SAE INTERNATIONAL JOURNAL OF FUELS AND LUBRICANTS (205) and TRIBOLOGY INTERNATIONAL (101). The growing development of research on this subject has had a great impact on scientific society, with most publications in journals ranked in Quartiles 1 and 2, with 3 journals in Quartile 1 and 6 journals in Quartile 2. United Kingdom is the country with the most journals participating in the top 10 in this subject, representing 40% of the journals with the most publications in this research.

Analysis of publications by country

Figure 2 shows the 10 countries with the highest production, showing that the United States is the country with the highest number of published contributions with respect to

the other countries. The United States represents 18.6% of the total publications obtained with the search equation for this topic with 307 pub-lished articles, followed by China with 218 publications, which represents 13.2% of the total publications.

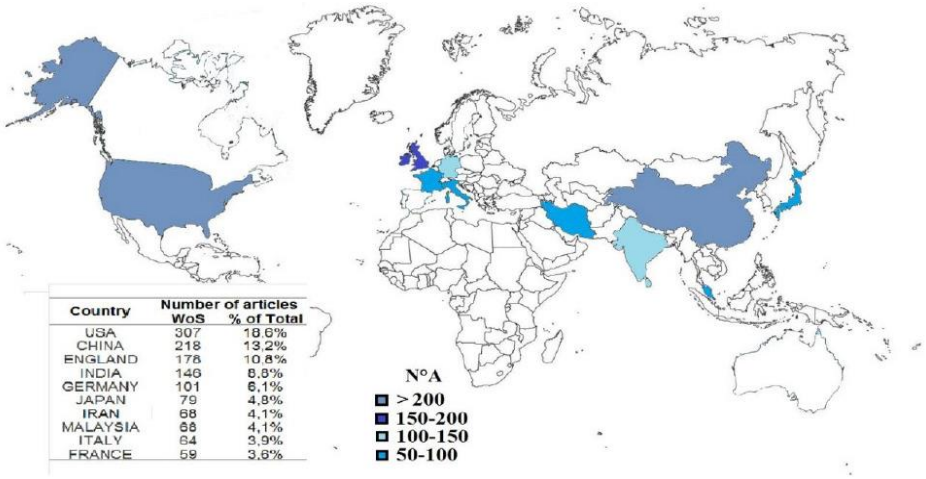

Figure 2. Graphical representation of the number of publications by country.

Production analysis by affiliation

With respect to the development of publications, it is vitally important to identify which institutions have the largest number of publications on this topic, as can be seen in Table IV, which shows that the United States Department of Energy Doe in the United States is the organization with the largest number of pub-lications on this topic. Among the countries with the most research related to organizational resilience are the United States with 4 organizations, followed by Malaysia with 2.

Table IV. Analysis of the scientific production of the 10 organizations with the highest number of publications

Organization	Number of items	Country
UNITED STATES DEPARTMENT OF ENERGY DOE	65	United States
IMPERIAL COLLEGE LONDON	39	England
FORD MOTOR COMPANY	37	United States
INDIAN INSTITUTE OF TECHNOLOGY SYSTEM IIT SYSTEM	34	India
UNIVERSITI TEKNOLOGI MALAYSIA	30	Malaysia
ARGONNE NATIONAL LABORATORY	28	United States
UNIVERSITY OF CHICAGO	28	United States
CENTER NATIONAL DE LA RECHERCHE SCIENTIFIQUE CNRS	26	France
ROYAL DUTCH SHELL	25	Germany
MALAYSIAN UNIVERSITY	25	Malaysia

PESTELanalysis. Politician Regulatory Frameworks

Petroleum policies are one of the most important points to guarantee the economic viability of an energy project. Every undertaking must establish its rules of the game taking into account these legal and juridical aspects, to determine the rights and obligations of each party involved in the operations, taxes, terms of execution, percentages of participation of the partners, among other aspects in the context of exploration and exploitation of oil and the use and commercialization of its derivatives. In Latin America, the regulatory frameworks differ substantially from the regulatory frameworks in the rest of the Americas. This difference is mainly due to the establishment of the ownership of the subsoil, since while in Latin America it corre-sponds to the State, in the United States, for example, this ownership falls specifically on individuals who have a stake in this process [41].

Brazil, Colombia, Mexico and Venezuela are the countries with the largest oil production in Latin America. Each one of them has a regulatory framework with its own characteristics that has been originated by its historical evolution and the ideological visions in which the State has participated. In each of these coun-tries, different types of regulatory models have been tested, differing not only in the type of government but also in the historical periods in which these models have been developed. Brazil and Colombia have adopted regulatory frameworks that seek to facilitate private investment and increase production. In Venezuela, due to the current crisis, state schemes are closed and production has stagnated. Finally, Mexico has had several changes in its regulatory frameworks for which their impact on production has not been clearly defined [41].

Lubricant marketing activity

Currently, there are different control bodies for the marketing of industrial lubricants used for vehicles and other hydraulic parts. At the international level, there are organizations such as the American Petroleum Institute (API), the European Automobile Manufacturers Association (ACEA), the Japanese Automotive Standards Organization (JASO) and the Society of Automotive Engineers (SAE), which are responsible for defining the physical properties and other criteria for the formulation of lubricants, so that their performance can be managed in the machines to be used [42],[43].

In many Latin American countries there are also control bodies for this activity. In Brazil, the National Agency of Petroleum, Natural Gas and Biofuels (ANP) was created in 1997 as a regulatory body to su-pervise the activities carried out by the petroleum, natural gas and biofuel industry in this country. Like-wise, this agency is in charge of establishing regulations in the non-legislative context for the aforemen-tioned sectors, focusing especially on licenses and concessions granted for the development, production and exploration of oil, natural gas and biofuel [44].

In Bolivia, through Administrative Resolution 474/2009 of May 7, 2009, the National Hydrocarbons Agency (ANH) was created to replace the former Hydrocarbons Superintendence, to regulate in the na-tional political context all activities related to the hydrocarbons chain, from exploration to the commer-cialization of fuels [45].

Mexico carries out the regulation and coordination of energy matters through the Energy Regulatory Commission (CRE). This regulatory body has the powers, attributions and other legal provisions that seek to

promote the efficient development of the industry, including the Hydrocarbons Law, the Electricity In-dustry Law, the Energy Transition Law, and the General Law on Climate Change [46].

Representing the interests of the industry, Colombia has the Colombian Petroleum Association (ACP), whose main objective is to promote public policies that enable the growth of the industrial sector in the context of fuels and lubricants [47].

Strategic regionalisms

Latin American countries have a model of regionalism and development that emphasizes multidimensional regional development that seeks to identify the State and the public as important, that does not prioritize development with inclusion and that emphasizes free trade, the private sector and foreign direct investment [48]-[50]. Free Trade Agreements (FTAs) have been proposed as part of a logic to materialize the processes of expropriation of resources located outside the countries' borders and to identify the features of the process of reconfiguration of integration spaces [51].

Economic

Economic growth

The international economy has been affected by the stock market, foreign conflicts and other additional factors that have slowed the pace at which it has been recovering. In Latin America, on the other hand, this growth remains stable and it is considered that in the long term there will be full growth that will have a positive impact, especially on small companies. Figure 3 represents the GDP movement for Latin American countries, according to data provided by the Statistical Database and Publications of the Economic Commission for Latin America and the Caribbean (ECLAC) [52]. It can be observed that Brazil, Mexico, Argentina and Colombia had the highest representation in 2020.

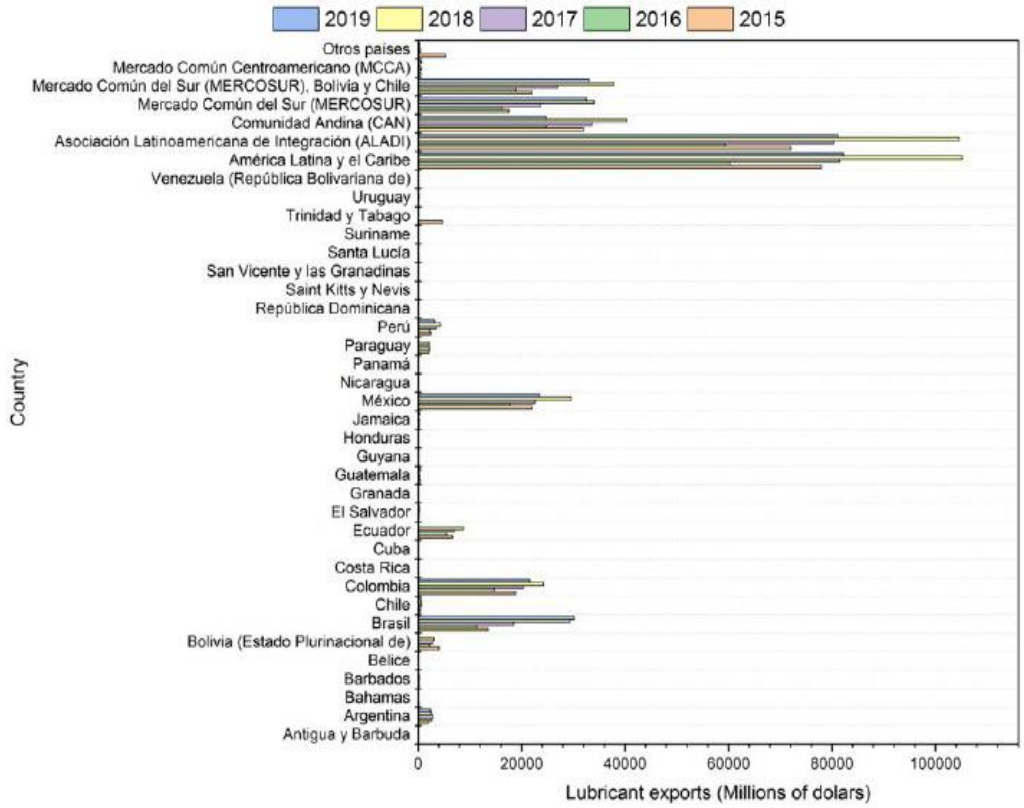

Figure 3. Lubricant exports by country.

Exchange Rates

Most lubricants are intrinsically related to the exchange rate, since they are traded by wholesalers with the prevailing currency and in some cases, in order to guarantee the value of these, future demand and supply may have the inputs in the trade due to the nature of this activity.

Export

The export of lubricants is one of the most important activities in the vehicle supply market. Based on ECLAC's Statistical Database and Publications, Figure 4 shows the behavior of the fuels and lubricants market in Latin America over the last five years.

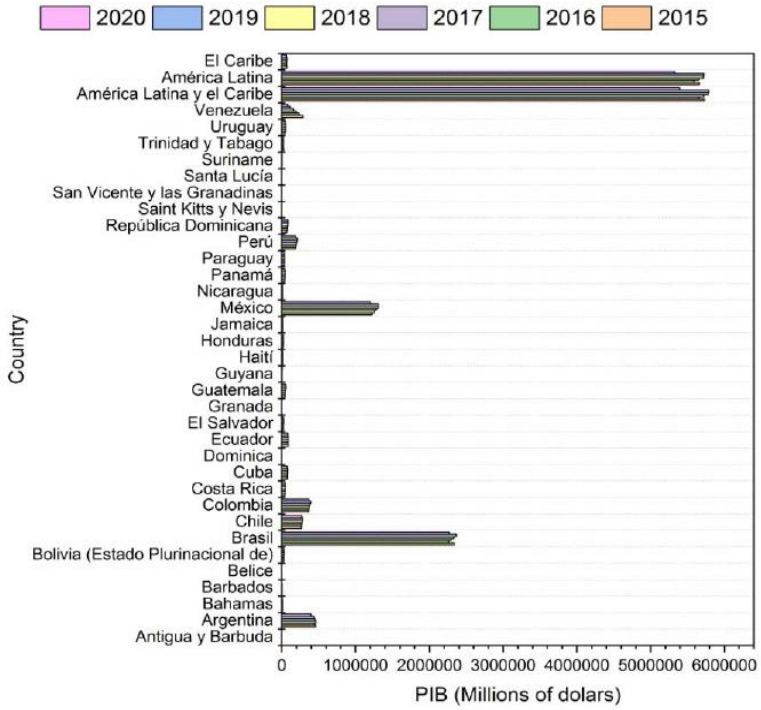

Figure 4. Behavior of fuels and lubricants market in Latin America.

Sociocultural. Economically active population

According to the International Labor Organization, the economically active population comprises all per-sons (employed and unemployed) who provide labor for the production of goods and services during a given period of time, excluding those engaged in household care and other unpaid workers [53]. Figure 5 shows the growth of the labor force for Latin American countries over the last 5 years.

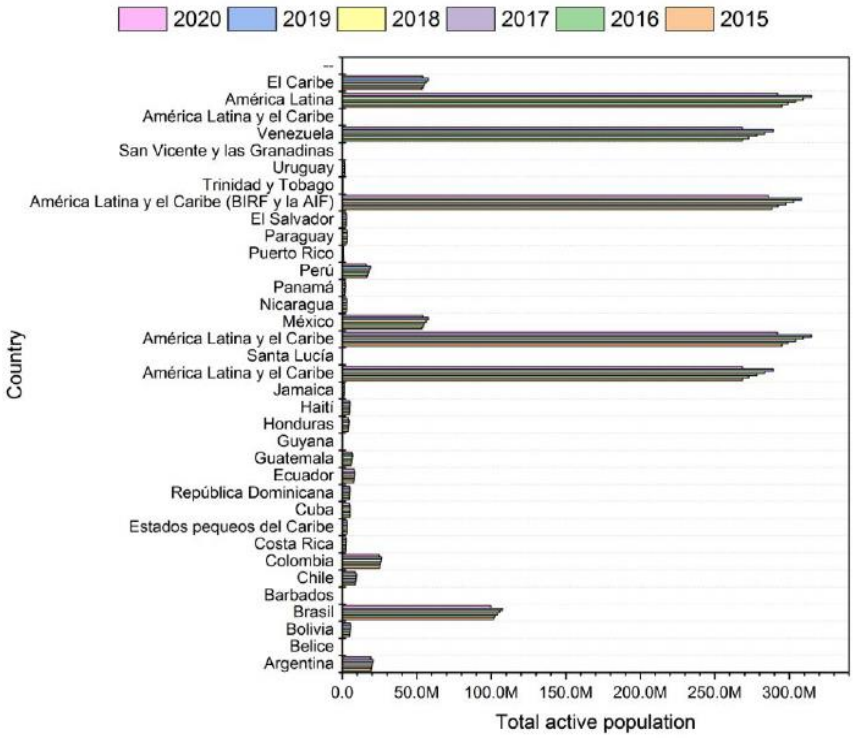

Figure 5. Growth of the labor force in Latin America.

Socioeconomic stratification

Latin America has faced a relatively important growth process in the different strata, especially in the middle-income strata. For regions where there are high levels of poverty, there has been a significant re-duction in the low-income strata between 2002 and 2017 of 15% and a considerable increase for the mid-dle-income strata of 14.2% in the same period of time. These figures have been presented as a product of the efforts that have been imparted towards poverty reduction and improvements in household income, adding also the advances in social protection systems and public transfers to lower income households and increases in labor income [54].

Social conflicts

The presence of social conflicts has always had a negative impact both socially and economically on labor processes, due to the presence of logistical delays and dead work hours that in turn affect the dynamics of the economy where the different companies are developed, including lubricant marketing companies, cre-ating instability in future logistical investments [43].

Technological. Methods to improve tribological properties

Since the main energy losses occurring in equipment are friction losses, these can be reduced by using lower viscosity oils. Currently, different methods are used to improve the tribological properties of lubricants such as chromium plating, nitrocarburizing and phosphating/ parkerizing. New technologies, such as electro-deposition (Nikasil), hypereutectic aluminum-silicon (Alusil®, Silitec®, Albond®) [55].

Improved product reliability

Currently, many of the containers in which lubricants are marketed must contain safety

devices to prevent these elements from being adulterated or their contents from being manipulated, which could cause serious problems regarding the product's guarantee and quality. Therefore, most manufacturers are leaning towards the use of automatic or electronic sealed dispensers to avoid wastage or unnecessary losses [43].

Ecological: Alternative energy sources

Most oil-producing countries are facing the threat of the emergence of other energy sources to replace these elements, and new trends are emerging in which countries are seeking to reduce their dependence on oil and eliminate polluting energy sources in order to minimize their environmental impact. As a result, countries will be driven to search for new ways to meet energy needs and substitute all petroleum products, including lubricants. In its latest annual energy forecast report, the International Energy Agency concluded that, under current environmental, financial and energy policies, oil would go from 31% of world demand to 30% in 2020 and 27% in 2040 [41].

Legal: Metrological quality control procedures

Many petroleum products and some non-petroleum materials are used as lubricants, and proper operation of equipment depends on the proper viscosity of the fluid being used. In addition, the viscosity of many petroleum fuels is important for estimating optimum storage, handling and operating conditions. Therefore, accurate viscosity determination is essential for many product specifications. For this, the ASTM D445 - 21 standard provides a test method that allows the determination of these properties in various petroleum derivatives and, among those, lubricants [56].

Exploration and production

In general, hydrocarbon exploration and extraction activities are carried out through contracts or assign-ments, and concessions are prohibited by constitutional mandate. Private parties may only participate in the development of these activities by entering into service contracts with the assignees, the consideration for which must be paid in cash. [41]

Hydrocarbon extraction activities and tariffs

In the context of hydrocarbon extraction activities, a greater strengthening of coordination among all en-tities involved in the process is required to achieve the development of a regulatory regime which risks resulting in duplication of efforts, regulatory contradictions and legal gaps such as the absence of defined responsibilities and accountabilities. Therefore, the extension of existing regulations applicable to onshore exploration and exploitation is necessary. However, although some regulations can be extrapolated, they may not be entirely applicable or convenient in a different setting such as offshore activities [57].

Constitutional principles

Countries in Latin America handle these activities in the oil context differently, both historically and con-stitutionally. However, the main producing countries (Mexico, Venezuela, Brazil and Colombia) have in common that the president and ministers are in charge of exercising executive power and there are oil reg-ulatory agencies. It should be noted that no significant national private oil sector has emerged in Latin America and the State has been in charge of creating companies to operate these activities [41].

Conclusions

Finally a growth is observed in the political, economic, social, technological, ecological and legal envi-ronments in the context of the use of lubricants, the purpose of this study was to carry out a systematic review and analysis of the research development related to this concept and focused on the areas of interest mentioned.

The bibliometric results show that, in the last decade, the volume of publications obtained has had an in-crease of 70%, with the year 2020 being the year with the highest number of publications on the subject. Additionally, an analysis from the point of view of publications by authors, publications by journals, pub-lications by countries and production by affiliation, shows that Latin America does not have sufficient participation to enter the ranking of 10 among the categories mentioned.

On the other hand, based on the pestel analysis carried out, it can be highlighted that political and economic factors have a great influence on the commercialization of lubricants, due to import regulations and the logistic activity of several companies involved in this process. Countries such as Brazil, Colombia, Mexico and Venezuela, which have the largest oil production in Latin America, have tried and adopted different types of regulatory models that have facilitated the development of private investment and increased production, with the exception of Venezuela, which due to the current political and economic crisis has closed state schemes and stagnant production.

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