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# Management of Intellectual Property as a Generator of Resources in Mexican Higher Education Institutions

*Gestión de propiedad intelectual y captación de recursos en las Instituciones Mexicanas de Educación Superior*

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**ABSTRACT**

This paper was developed to analyze the level of implementation of intellectual property management processes in Higher Education Institutions (HEI). Intellectual Property management processes in the public sector have been reduced, at least in understanding the concept, to the processes of protecting and maintaining intellectual property titles; however, it is a more extensive process than conceptualized. In this sense, Martinez et al. (2018) generated a methodology involving 19 indicators (processes) of intellectual property management implemented during the R&D&I process. These indicators were used to measure their implementation in Mexican public sector HEIs with information from the transparency portal. The research shows the importance of generating multidisciplinary groups in R&D&I processes, enhancing the financial redundancy of research investment.

Keywords: Public Sector, Intellectual Property, Research Development and Innovation, High Education Institutions.

JEL code: I23

**RESUMEN**

El presente trabajo se desarrolló con el objetivo de analizar el nivel de implementación de procesos de gestión de la propiedad intelectual en las Instituciones de Educación Superior (IES). Los procesos de gestión de la Propiedad Intelectual en el sector público se han reducido, al menos en el entendimiento del concepto, a los procesos de protección, y mantenimiento de los títulos de propiedad intelectual, sin embargo, es un proceso más extenso de lo conceptualizado. En este sentido, Martínez y Col. (2018) generaron una metodología que involucra 19 indicadores (procesos) de gestión de la propiedad intelectual implementados durante el proceso de I+D+i. Estos indicadores fueron usados para medir su implementación en las IES del sector público mexicano, con información obtenida a partir del portal de transparencia. La investigación muestra la importancia de generar grupos multidisciplinarios en los procesos de I+D+i, potenciando la redundancia financiera de la inversión en investigación.

Palabras clave: Sector Público, Propiedad Intelectual, Investigación Desarrollo e Innovación, Instituciones de Educación Superior

Código JEL: I23

## INTRODUCTION

This paper was developed to analyze the importance of the different intellectual/industrial property management processes for acquiring economic-financial resources within Higher Education Institutions (HEI) of the Mexican public sector. Intellectual property management in Mexican HEIs has yet to be internalized comprehensively, and only some of the processes are adopted within the institutions. It can be observed in a search of the institutional procedures related to this topic. However, it is of great importance to adopt a whole process of intellectual property management, which, if carried out correctly, can generate an economic benefit for the institutions that make up the Mexican public sector.

In the present research, the analysis was developed from a general concept of intellectual/industrial property management, from the gestation process of a technological development project to the point at which a possible adoption or transfer of the developed technologies may or may not occur.

The complexity of an efficient intellectual property management process means that the different indicators are interconnected, so their study and implementation represent a significant challenge. Meeting this challenge will substantially impact public policies, focusing the institutions' efforts on the processes that require more attention within the institutions —that help attract financial resources, increasing the capital for reinvestment that generates more technological development.



To achieve this resource capture through Intellectual/Industrial Property Management, the concept must be internalized not only in the regulations but also in the Research, Development, and Innovation processes related to the importance of the intangible assets owned by the institutions, their identification, and even the future vision for research.

## INTELLECTUAL/INDUSTRIAL PROPERTY

According to the World Intellectual Property Organization (WIPO) (2023), intellectual property refers to all products developed from human creativity, including literary and artistic works, original technological developments, and new processes. Intellectual property rights can be divided according to their application. Derived from this, within the classification, we can identify industrial property, whose governing body is the Mexican Institute of Intellectual Property (IMPI).

The basis of intellectual property law consists of granting exclusive economic exploitation rights for a determined period to inventors, authors, and technological developers with the potential for implementation in specific markets with an impact on society. According to WIPO (2023), several objects are covered by IP.

- Literary, artistic, and scientific works.
- Performances by performing artists and performances by performing artists.
- Phonograms and radio broadcasting.
- Inventions in all fields of human activity.
- Scientific discoveries.
- Industrial designs.
- Trademarks, trademarks, service marks, and trade names.
- Among others.

It is the set of elements such as trademarks, copyrights, patents, and trade secrets or those the company uses to exercise its activities. Since the creation of IMPI, the rules, regulations, and public policies in which this agency of the Ministry of Economy (SE) is immersed have constantly evolved. It is because organizations have focused to a greater extent on quantifying the value that can be granted to technological developments and other intangible assets, due to the great importance they have demonstrated, mainly for technological innovation, fostering more significant growth in the country (DOF, 2020).



In addition to IMPI's laws, regulations, and legislation, higher education institutions (HEI) are also subject to compliance with the laws of the humanities, science, technology, and innovation.

## INTELLECTUAL PROPERTY IN THE LAW ON HUMANITIES, SCIENCE, TECHNOLOGY, AND INNOVATION

In 2023, the then Law on Science, Technology, and Innovation was replaced by the Law on Humanities, Science, Technology, and Innovation, which provides the parameters on which the strategies for the development of Research, Development, and Innovation (R&D&I) in the priority areas identified by the government are required to be based. This law (Congreso de la Unión, 2023) has articles on intellectual property and its management within Mexican public sector institutions. The law states that:

- Article 11, Section XI: The National Council of Humanities, Science, Technology, and Innovation (Conahcyt) is an essential part of the public sector's technology transfer processes, developing general strategies to bring the technologies developed to the productive and industrial sectors so that they can be within the reach of the market, users, and society.

- Article 11, Section XXIII: Likewise, the Conahcyt must generate strategies for protecting intellectual property in such a way that it favors the national public interest. Furthermore, Article 33, Section IX mentions that IP rights shall respond to the national public interest and the welfare of the people of Mexico.

- Article 38: Copyright and Intellectual Property rights derived from research financed by Conahcyt must generate returns for this organization:
    - Paragraph 2: Conahcyt will be the holder of the IP rights derived from the projects financed by this entity, without prejudice to the moral rights. However, it also comments that in technological development projects where the institutions contribute concurrently, the rights may be shared according to the contribution provided by each of the different actors.

- Articles 49 and 50: As part of the integrated intellectual property management process, Conahcyt must promote the establishment of science and technology-based companies with public participation, as well as technology transfer for the integral development of the country.

- Article 72, paragraph VIII: Conahcyt centers must implement science and technology to improve or generate new products, services, and productive processes.



- Article 74: The National System of Public Research Centers attached to Conahcyt must generate the necessary strategies to recognize the IP rights corresponding to the Technological Developments and Innovations carried out by the researchers that are part of the same institutions.

Intellectual property is part of public sector institutions' intellectual and technological capabilities. It can be generated in an inter-institutional manner, increasing the capacity of the products of research and technological development. In addition to this, the institutions have already installed technological capabilities and the intellectual capital represented by each of the researchers that compose them. One of the ways to take advantage of technological and intellectual capabilities is through inter-institutional collaboration. In this regard, the General Law of Humanities Science, Technology, and Innovation (Congreso de la Unión, 2023) establishes that:

- Article 8: The government shall encourage the government to meet, associate, and collaborate nationally and internationally.
- Article 9, Section III: It is public policy to develop and consolidate national capacities ... as well as to maintain and continuously improve the infrastructure and equipment

necessary for R&D&I, in addition to the pertinent collaboration mechanisms for efficient use.

- Article 26, Section VIII, and Article 27: It is public policy for state and local governments to promote collaboration, cooperation, and metropolitan and regional articulation for the best design of projects in the humanities, science, technology, and innovation.
- Article 33 Section II: The activities and projects supported by the state must foster the articulation of national and regional capacities through the collaboration of academics and community members with knowledge, experience, and professional solvency.

These public policies should be inserted into the Research, Development, and Innovation processes, even if they still need to be implemented.

## INTELLECTUAL PROPERTY IN R&D&I

Intellectual/industrial property is a fundamental part of the intangible assets of the institutions dedicated to R&D&I. However, its development has not been fully achieved within public institutions due to a group of barriers such as the lack of culture in the researchers of the institutions, the level of bureaucracy of the institutions themselves, and the lack of rules, regulations, legislation, and public policies focused on the management of intellectual property (Garrido, 2023).



In Science, Technology, and Innovation, the importance of securing intellectual/industrial property through the corresponding titles has the potential to contribute to prosperity and social and economic competition in Mexico, as long as there are the necessary strategies to bring technological developments to the market (Garrido, 2023), including those of the public sector, and thus be within the reach of society, avoiding that they remain as empty research, or generation of sterile technology.

It is necessary to implement public policies such as those already mentioned. However, it has been observed that there needs to be more congruence between these and their implementation. They leave, to a certain extent, the Public Research Centers and Higher Education Institutions unprotected (Rodriguez & Morgan, 2020), which are the institutions that have the most qualified personnel for technological development at the national level and which should be considered as one of the primary "concurrent" resources for the projects. Intellectual/industrial property is fundamental for the development of organizations, taking better advantage of their technological and intellectual capabilities.

An example of this is NASA, which, according to GreyB (2022), 2021 obtained profits of 1.5 billion dollars from patents that are currently active, or the Massachusetts Institute of Technology (MIT), an institution that in 2022 obtained, according to data from the same institution, 87.4 million dollars from the licensing of its technological developments.

As in the large institutions in the United States, a policy that promotes the management of industrial property in the Mexican public sector is of great importance, as well as a great need, to increase the competitiveness of the institutions in charge of technological development, generate resources for the same institution, and potentiate the generation of new projects that generate new technologies, with intellectual/industrial property titles, and in this way become a virtuous circle. However, reducing spending in this area in the public sector is one of the most significant barriers to technological development in our country.

Lederman and Maloney (2003) mention at least four main reasons for the inhibition of spending on technological development, where the low appropriation of the same forms an essential part, reducing the redundancy of the investment due to the use of information, developments, and technology by third parties of the information that has been made available to the public domain, through publications in journals, without the need for the authorization of the developers; This, however, could be modified through a change in internal policies related to the management of intellectual property, encouraging the distribution of scientific and technological knowledge through an intellectual property management system, to obtain not only moral recognition but also a recovery of the investment made in the R+D+i processes of the Mexican public sector.



The work in inter and multidisciplinary schemes for obtaining intellectual property titles, and therefore the exclusive right of exploitation (via products and services or technology transfer), is necessary as part of the care and safeguarding of the technological heritage, intellectual capital, and investment that all development represents (Gómez, 2016).

Achieving this represents an arduous task since an intellectual property management scheme must start from the moment of the gestation of a research project (both basic and applied), carrying out a constant process of identification of technologies susceptible to protection, from the products to the processes that have been developed or improved during the research. In addition, it also involves commercial processes, such as technology foresight and market studies, and transfer, commercialization, and/or exploitation processes by the institutions involved in the development, including those of the public sector.

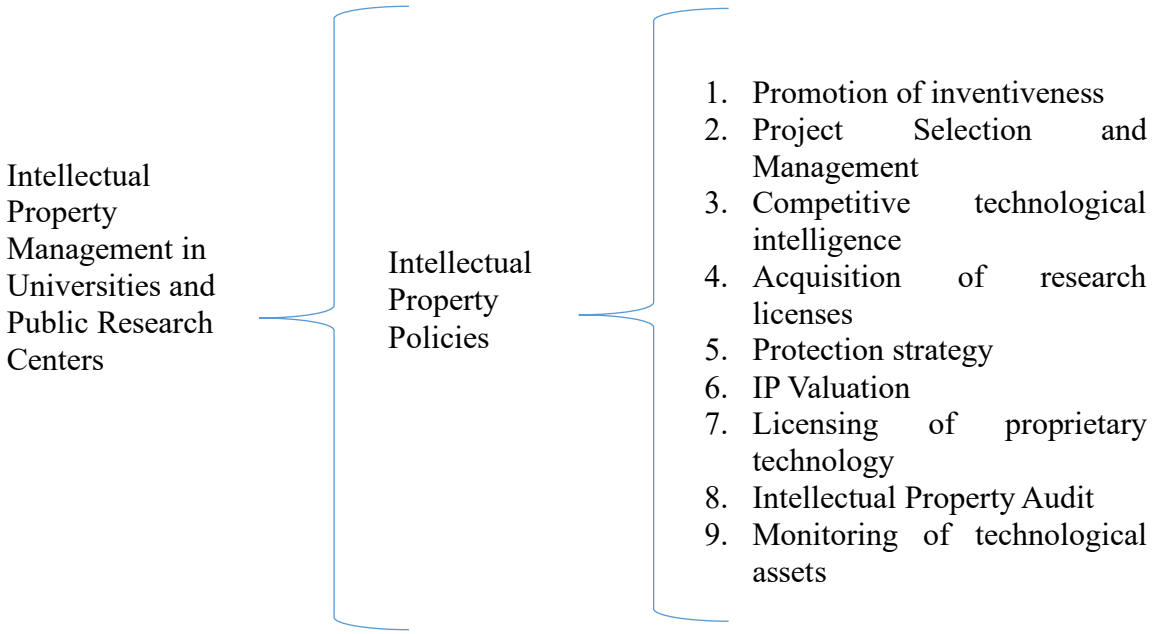
## INTELLECTUAL PROPERTY MANAGEMENT IN THE PUBLIC SECTOR

Intellectual Property Management (IPM) is one of the main processes for technologies developed by public institutions, including HEIs, to reach society and thus directly benefit the sectors in which they are inserted (Salazar & Henríquez, 2010). Likewise, Salazar and Henríquez (2010) mention that this process would achieve the redundancy of the financial resources invested in R&D&I processes, thus achieving an increase in the levels of research and technological development.

According to Masó (2015), one of the most effective tools for academic institutions in the public sector to truly achieve scientific and technological progress, by the practical and ethical commitments they have inherent to society, is the management of technology through the identification, protection, administration, and transfer of technological developments susceptible to be protected. Solleiro (2003) mentions that nine elements make up the management of intellectual property (Figure 1).

Figure 1. Elements of Industrial Property Management






Source: Luna and Solleiro (2007) based on Solleiro (2003).

These elements are immersed in all research and development processes within public sector institutions. However, not all processes are given the same importance in the country due to

the socio-technical system in which these types of institutions are immersed, in such a way that innovation in the institutions is inhibited.

The concept of innovation is comprehensive. This concept has tried to be described as "what did not exist and now exists," "creativity and inventiveness," "research and discovery," and "design and technological development" (Echeverría et al., 2010, p. 0). However, they require the characteristics Schumpeter (1934) described as effectiveness, transcendence, and permanence (Echeverría et al., 2010).

According to Echeverría et al. (2010), the process of innovation per se consists of transforming reality and generating new combinations of what already exists, related to creativity, inventiveness, and the materialization of inventions into products, following the fundamental laws of conservation of matter and energy. This concept is closely related to the emergence of emergent properties inserted within Wilber's holoarchical theory, where everything is part of something and simultaneously is a whole within an integral vision of things (Medina, 2018).

Intellectual property management, as part of a generalized process in R&D&I, can be analyzed within this theory, where management is not only the obtaining of property titles but is part of a more complex process, which goes from the conceptualization of an idea to the arrival of knowledge to society through a product or service.

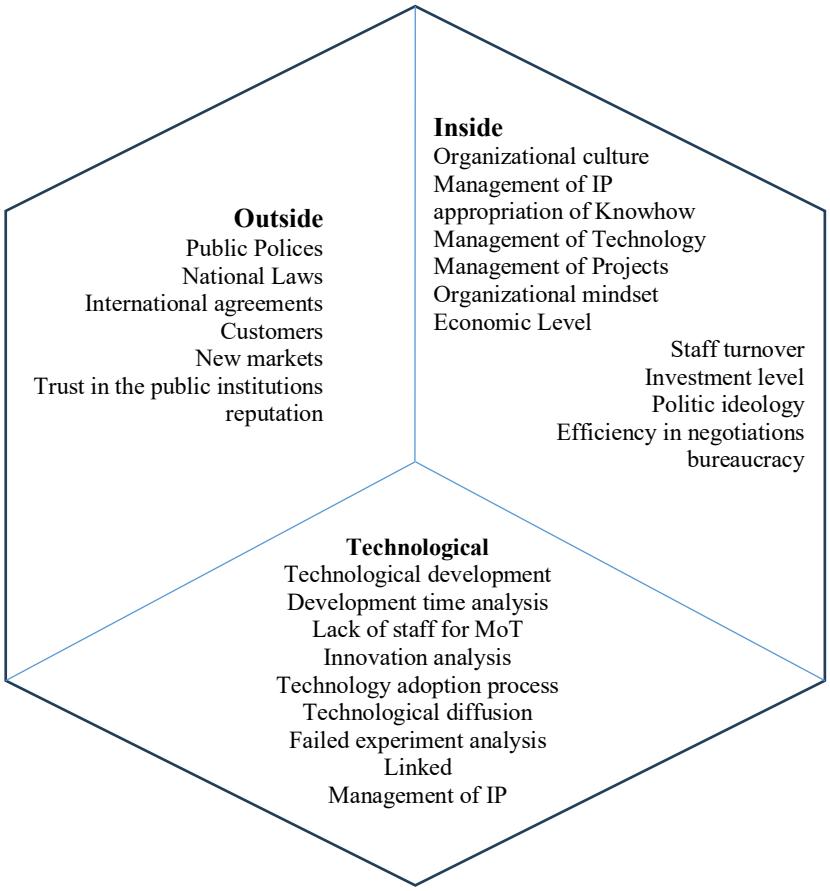


Similarly, institutions should be considered as a subsystem of a more extensive system (socio-technical system), in which internal, external, and technological factors are mainly involved (Figure 2), making the innovation process of Mexican public sector institutions more complex.

These elements should be considered within the processes of Industrial Property Management developed in the public sector, where, through public policies, the internal factors that inhibit the exploitation of technologies developed in this sector, such as Higher Education Institutions, can be influenced. Such is the case of bureaucracy, which, according to Garrido (2023), is one of the main factors inhibiting innovation within Mexican public sector institutions.

Several models have been developed related to the management of intellectual property that involve, more directly, the processes of the different institutional areas, achieving the intermediation between them.

Figure 2. Elements of the socio-technical System of Innovation in the Public Sector




Source: Own elaboration (Lepratte, 2012; Moore, 2005; Levén, Holmström & Mathiassen, 2014; Bommert, 2010; Díaz et al., 2018; Vega, 2015; Colunga, Molina & Armenteros, 2016; Bernier, Hafsi & Dechamps, 2015; Rodríguez & Cerda, 2017).

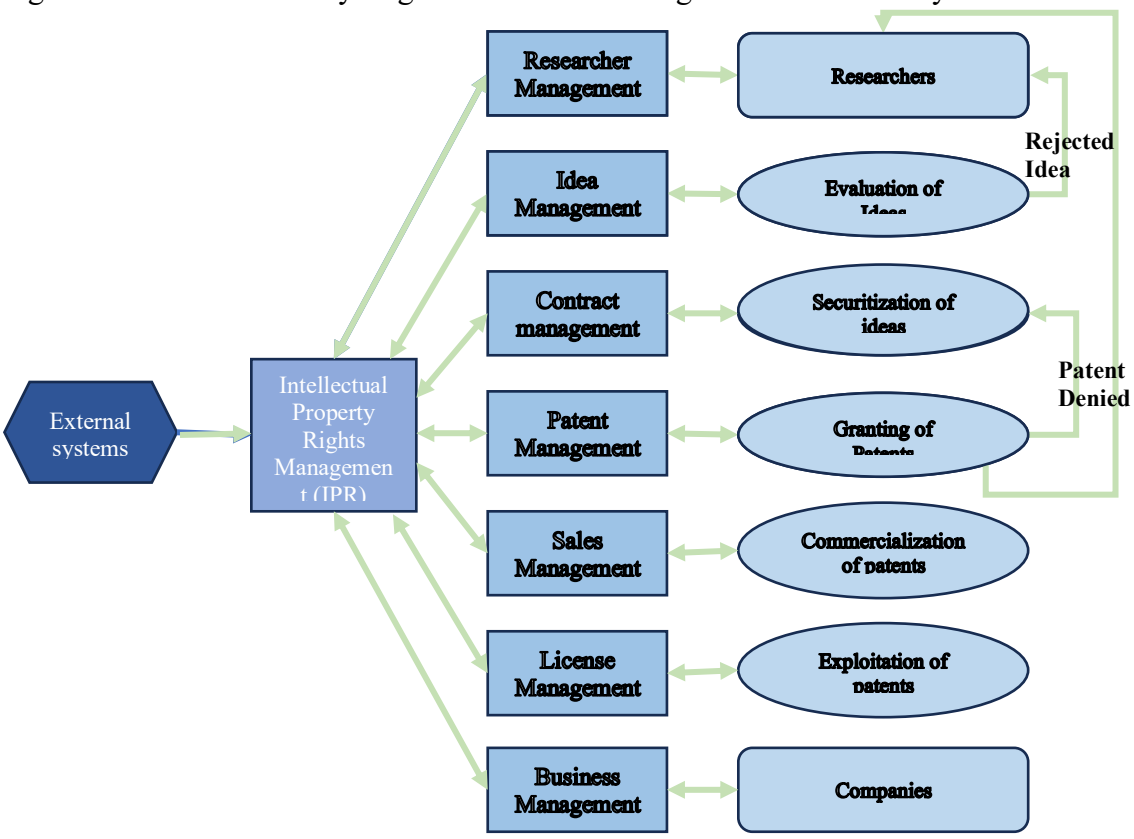
Table 1. Processes and sub-processes of Patent Management in Universities

| University Patent Management | |
|---|---|
| Physical Subprocesses | Administrative Subprocesses |
| Evaluation of ideas/projects and search for funding | Researcher management |
| Formalization of projects | Idea/project management |
| Granting of patents | Contract management |
| Commercialization of patents | Patent management |
| Exploitation of patents | Sales Management |
| | License management |
| | Business Management |

Source: Lopez et al. (2009).

López et al. (2009) developed a Model of Processes by Regulation for University Patent Management (Figure 3) based on information obtained from universities in Chile, Colombia, and Spain. In this model, he presents the main subprocesses of intellectual property management identified in this research, dividing them into physical and administrative subprocesses (Table 1).

Figure 3. Process Model by Regulation for the Management of University Patents




Source: Lopez et al. (2009).

Using the above model as part of their theoretical framework, Martinez et al. (2018) developed a methodology for the management of Intellectual Property, in which they included the 19 indicators with the most significant influence on the measurement process, where they identified an insufficiency of implementation in the use of specialized patent information, prospective studies, valuation of intangible assets and in the granting of permissions for the use of third parties through licenses.

Well-managed Intellectual Property Management contributes to the mission of public sector institutions, making information related to the results of applied research processes available to the public domain through Intellectual Property titles, facilitating access to new products, services, and technologies through transfer, adaptation, and adoption to the target sectors

(Salazar & Henríquez, 2010). In this way, technological developments impact society, facilitating access to the public through the massification that the private sector can achieve.

Intellectual Property Management requires highly specialized knowledge to carry out the necessary technical analysis successfully, in addition to being an expert in background and prior art research, and finally implementing the appropriate methodologies for the evaluation of technical, commercial feasibility and productivity (Gómez, 2016), including a high-level analysis of financial, marketing and production process issues.

In Mexico, investment in intellectual, technical, and technological capabilities has increased significantly in the public sector; however, this effort has not had a financial impact on the institutions due to the low implementation of intellectual property management processes within this sector (Luna & Solleiro, 2007).

Several fundamentals encourage the management of intellectual property. According to Gómez (2016), they correspond to technological development and can be summarized to:

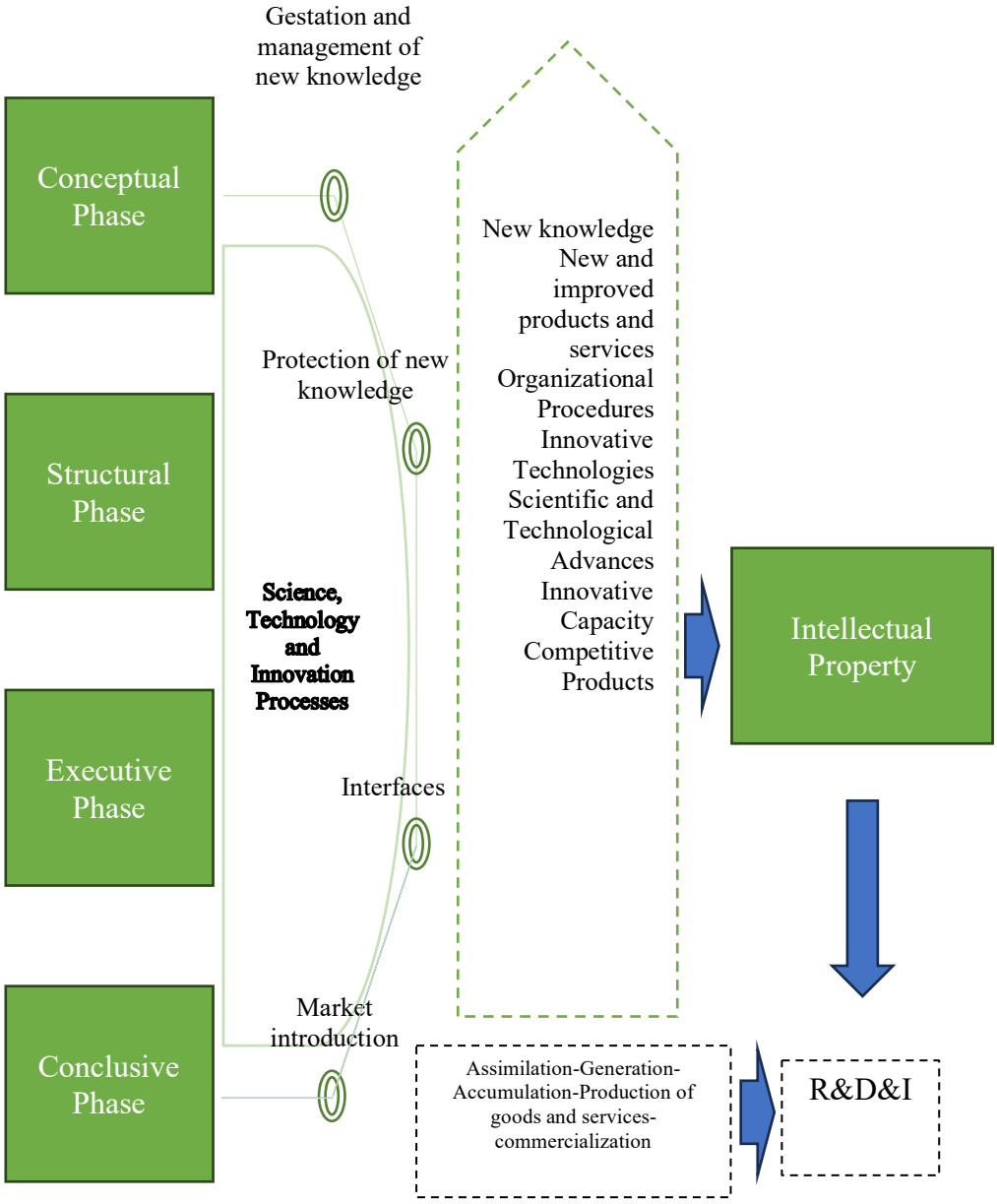
- Technology is a creative process that encourages companies to improve products, production processes, marketing, and services.
- It is a catalyst for economic, scientific, and social development.
- Supports the management of support or incentives to improve technological development.
- It is a negotiating factor in the framework of the treaties signed by Mexico.
- Understanding intellectual property assets improves and streamlines intellectual property trading practices and procedures.



Much of the research talks about the institutionalization of intellectual property, where it is included in their regulations and procedures. However, the appropriation of technology is not an essential source of income for institutions since researchers focus R&D&I processes on developing products with academic value rather than searching for technology transfer to the private sector and, therefore, to society (Garrido, 2023).

Martinez et al. (2018) divide their methodology into 4 phases: conceptual, structural, executive, and conclusive, interrelating the management of Science, Technology, and Innovation projects with Intellectual Property rights (Figure 4), in which the 19 indicators that they identified as primary for the measurement of Intellectual Property Management are integrated (Table 2).

Figure 4. Relationship between R&D&I projects and intellectual property




Source: Martinez et al. (2018).

Table 2. Relationship between the phases of Intellectual Property Management and its processes.

| Conceptual Phase | Structural Phase | Executive Phase | Conclusive Phase |
|---|---|---|---|
| Prospective Studies | Contractual provisions in TT and investment projects | | Valuation of intangible assets |
| Degree of Technological Up-to-Date | | Budget for IP protection | Sale of the product |
| Search for technological background | | | Licensing of third parties |
| Research of competitive opportunities | Prospective studies | Strategic alliances and cooperative productions | |
| Investigation of the applicable legal framework | Market research | Use of specialized patent information | Maintenance and upkeep |
| Use of specialized patent information | Evaluation of forms of protection | | Assimilation and Technology Transfer |
| Infringement of third party rights | Preparation of confidentiality agreements | Human capital training | |
| | Aesthetic image design | | |

Source: Own elaboration based on Martínez et al. (2018).

Although these indicators were analyzed about their implementation of an Intellectual Property Management process within the R&D&I projects developed in a public institution, they should also be analyzed about the economic benefit of implementing each process for institutions of this type. However, the validation of the indicators by the authors provides a window of opportunity for the analysis of public institutions and their relationship with the generation of financial resources through an efficient intellectual property management process.

## METHODOLOGY

The project was developed through a quantitative methodology. The present research was conducted in a sample of 10 Mexican public sector Higher Education Institutions (Table 3) randomly selected through Microsoft® Excel® software.

Table 3. Sample of Higher Education Institutions

| Institution |
|---|
| Universidad Veracruzana |
| Autonomous University of Baja California |
| University of Chihuahua |
| Autonomous University of Nuevo Leon |
| University of Colima |
| Benemérita Universidad Autónoma del Estado de Puebla (Autonomous University of the State of Puebla) |
| University of Guadalajara |
| Autonomous University of Tamaulipas |
| Autonomous University of Chapingo |
| Autonomous University of Querétaro |

Source: Own elaboration

The information for the analysis was obtained through the public universities' transparency portal comprising the sample (Table 3), seeking to ensure information related to the total number of projects and property titles active in each institution. This information was entered into Minitab® statistical software for processing.



For the research, the indicators identified by Martinez et al. (2018) (Table 4) were analyzed and validated for the 256 research projects active in the year of the research at the University of Pinar del Río. In addition, information was requested on generating own resources by project development, technology transfer, royalties, and commercialization of products or services.

Table 4. Indicators of the Martinez et al. (2018) methodology

| Indicator |
|---|
| Use of specialized patent information |
| Degree of Technological Up-to-Date |
| Background Search |
| Maintenance and preservation of IP rights |
| Market research |
| Confidentiality agreements |
| Research of competitive opportunities |
| Aesthetic image design |
| Applicable legal framework |
| Infringement of third-party rights |
| Prospective studies |
| Budget for processing and maintenance of IP rights |

| |
|---|
| Valuation of Intangible Assets |
| Technology assimilation and transfer |
| Contractual provisions of IP rights |
| Permission for use by third parties |
| Evaluation of other forms of protection |
| Strategic alliances and cooperative productions |
| Training of human capital |

Source: Martinez et al (2018).

The study was carried out in 2 phases. Phase 1: Analysis of the implementation of Intellectual Property Management processes in Higher Education Institutions. The implementation analysis was carried out by obtaining descriptive statistics from the information provided by the institutions using Minitab® software.

Phase 2. Relation of Intellectual Property Management indicators and the obtaining of resources. This phase was developed to analyze the relationship between obtaining one's resources and the different figures for obtaining economic resources related to intellectual property management through a Spearman correlation analysis. Similarly, a correlation analysis of the different indicators proposed by Martínez et al. (2018) was performed with the income obtained through the project development, technology transfer, royalties, and commercialization of products or services to analyze which indicators, from the information provided in the transparency portal, have a more significant relationship.



## RESULTS

Analysis of the implementation of Intellectual Property Management processes in Higher Education Institutions.

The analysis of the Technological Management indicators showed a high culture in the implementation of essential processes for research. However, it showed a significant lag in the implementation of processes related to the commercialization of intellectual property rights and the development and evolution of the market (Table 5).

The indicator that has a lower implementation, according to the data obtained through the Transparency Portal, is the analysis of the possible violation of third-party rights (Market evolution), which is implemented in 7% of the projects and can trigger future legal and economic problems for the institutions, leaving them unprotected from the beginning of the R&D&I processes.

Table 5. Implementation of IP Management Processes in Higher Education Institutions

| Variable | N | Media |
|---|---|---|
| Use of specialized patent information | 10 | 0.819 |
| Degree of Technological Up-to-Date | 10 | 0.330 |
| Background Search | 10 | 0.700 |
| Maintenance and preservation of IP rights | 10 | 0.900 |
| Market research | 10 | 0.294 |
| Confidentiality agreements | 10 | 0.600 |
| Research of competitive opportunities | 10 | 0.220 |
| Aesthetic image design | 10 | 0.274 |
| Applicable legal framework | 10 | 0.620 |
| Infringement of third party rights | 10 | 0.0700 |
| Prospective studies | 10 | 0.280 |
| Budget for processing and maintenance of IP rights | 10 | 0.650 |
| Valuation of Intangible Assets | 10 | 0.300 |
| Technology assimilation and transfer | 10 | 0.290 |
| Contractual provisions of IP rights | 10 | 0.376 |
| Permission for use by third parties | 10 | 0.400 |
| Evaluation of other forms of protection | 10 | 0.580 |
| Strategic alliances and cooperative productions | 10 | 0.400 |
| Training of human capital | 10 | 0.680 |

Source: Own elaboration with the data



The implementation of indicators presented in Table 4 also shows us the reduced importance given in the institutions to the investigation of competitive opportunities (.220), design of the aesthetic image (0.2740), generation of prospective studies (0.2800), assimilation and transfer of technologies (0.2900), generation of market studies (0.2940), valuation of intangible assets (0.3000), analysis of the degree of technological actuality (0.3300), review of contractual provisions related to IP rights (0.3760), licensing or permission of use to third parties (0.4000) and development or generation of strategic alliances and cooperative productions (0.4000).

However, there is a high implementation of the processes necessary to maintain and conserve intellectual property rights, which may result in a high investment. However, due to the need for more implementation of processes related to the market, there is a low redundancy of this to the HEIs.

*Relationship between Intellectual Property Management indicators and resource acquisition*

In the Spearman correlation analysis of the obtaining of resources (Table 6), it is observed that there is a negative correlation between the obtaining of own resources and the obtaining

of resources related to the management of intellectual property (technology transfer, royalties, and commercialization of products and services), evidence of the need to increase the attention on the processes of Intellectual Property Management to consider this as an essential source of income.

Table 6. Spearman's correlation of own resource revenues and IP management

| Indicator 1 | Indicator 2 | Correlation |
|---|---|---|
| Revenues from project development | Own resources | 0.321 |
| Income from technology transfer | Own resources | -0.401 |
| Royalty income | Own resources | -0.401 |
| Revenues from commercialization of products or services | Own resources | -0.214 |

Source: Own elaboration

*Relationship between Intellectual Property management Indicators and Resource Procurement*

Spearman's correlation analysis between the indicators and the obtaining of resources through technology transfer (Table 7) shows a positive correlation (although low) mainly with the market processes of technological developments, such as the application of technology foresight methodologies and the analysis of competitive opportunities (technological development initiation process), market studies (intermediate process) and the valuation of intangible assets, the design of the aesthetic image and the maintenance and conservation of IP rights (final process).



Table 7. Correlation analysis of technology transfer with Intellectual Property Management

| Indicator | Source of Income | Correlation |
|---|---|---|
| Use of specialized patent information | Technology Transfer | -0.316 |
| Degree of Technological Up-to-Date | Technology Transfer | 0.217 |
| Background Search | Technology Transfer | -0.074 |
| Maintenance and preservation of IP rights | Technology Transfer | 0.216 |
| Market research | Technology Transfer | 0.217 |
| Confidentiality agreements | Technology Transfer | 0.071 |
| Research of competitive opportunities | Technology Transfer | 0.297 |
| Aesthetic image design | Technology Transfer | 0.217 |
| Applicable legal framework | Technology Transfer | -0.291 |
| Infringement of third-party rights | Technology Transfer | -0.216 |
| Prospective studies | Technology Transfer | 0.297 |
| Budget for processing and maintenance of IP rights | Technology Transfer | 0.009 |
| Valuation of Intangible Assets | Technology Transfer | 0.297 |
| Contractual provisions of IP rights | Technology Transfer | 0.145 |

| | | |
|---|---|---|
| Permission for use by third parties | Technology Transfer | 0.221 |
| Evaluation of other forms of protection | Technology Transfer | 0.082 |
| Strategic alliances and cooperative productions | Technology Transfer | -0.33 |
| Training of human capital | Technology Transfer | -0.074 |

Source: Own elaboration

About the generation of resources through the figure of royalties (Table 8), some processes are directly related to the market, repeating in this sense the analysis of technological foresight, market studies research of competitive opportunities, and the design of the aesthetic image. This analysis also shows an increase in the relationship of all indicators concerning technology transfer, which could indicate that not all technology transfer processes are considered intellectual property and, therefore, generate a constant income for the institutions.

Table 8. Correlation analysis of royalty income with Intellectual Property Management.

| **Indicator** | **Source of Income** | **Correlation** |
|---|---|---|
| Use of specialized patent information | Royalties | -0.214 |
| Degree of Technological Up-to-Date | Royalties | 0.336 |
| Background Search | Royalties | 0.065 |
| Maintenance and preservation of IP rights | Royalties | 0.283 |
| Market research | Royalties | 0.468 |
| Confidentiality agreements | Royalties | 0.25 |
| Research of competitive opportunities | Royalties | 0.567 |
| Aesthetic image design | Royalties | 0.336 |
| Applicable legal framework | Royalties | -0.102 |
| Infringement of third party rights | Royalties | 0.283 |
| Prospective studies | Royalties | 0.567 |
| Budget for processing and maintenance of IP rights | Royalties | 0.179 |
| Valuation of Intangible Assets | Royalties | 0.567 |
| Technology assimilation and transfer | Royalties | -0.236 |
| Contractual provisions of IP rights | Royalties | 0.359 |
| Permission for use by third parties | Royalties | 0.452 |
| Evaluation of other forms of protection | Royalties | 0.287 |
| Strategic alliances and cooperative productions | Royalties | 0 |
| Training of human capital | Royalties | 0.065 |

Source: Own elaboration

Likewise, the above may indicate the functioning of technological development in HEIs, where technological developments of this type are commissioned, as mentioned by Rodriguez and Morgan (2021), and probably need to be considered within the indicator of the analysis of contractual provisions of Intellectual Property.

Regarding income from the commercialization of products and services (Table 9.), Spearman's correlation analysis showed that most of the indicators show a negative correlation, probably because the purpose of Mexican public institutions is not commercialization, being the granting of permission for use to third parties (.227) the best form of commercialization by the institutions; however, focusing efforts on intellectual property management processes, mainly about services, could increase the level of income from this item.

Table 9. Correlation analysis of revenues from commercializing Products and Services with Intellectual Property Management

| Indicator | Source of Income | Correlation |
|---|---|---|
| Use of specialized patent information | Marketing of products and services | -0.737 |
| Degree of Technological Up-to-Date | Marketing of products and services | 0.212 |
| Background Search | Marketing of products and services | -0.34 |
| Maintenance and preservation of IP rights | Marketing of products and services | -0.581 |
| Market research | Marketing of products and services | -0.18 |
| Confidentiality agreements | Marketing of products and services | 0.274 |
| Research of competitive opportunities | Marketing of products and services | -0.145 |
| Aesthetic image design | Marketing of products and services | -0.045 |
| Applicable legal framework | Marketing of products and services | -0.625 |
| Infringement of third party rights | Marketing of products and services | -0.498 |
| Prospective studies | Marketing of products and services | -0.145 |
| Budget for processing and maintenance of IP rights | Marketing of products and services | -0.564 |
| Valuation of Intangible Assets | Marketing of products and services | -0.145 |
| Technology assimilation and transfer | Marketing of products and services | -0.657 |
| Contractual provisions of IP rights | Marketing of products and services | 0.112 |
| Permission for use by third parties | Marketing of products and services | 0.227 |
| Evaluation of other forms of protection | Marketing of products and services | -0.365 |
| Strategic alliances and cooperative productions | Marketing of products and services | -0.317 |
| Training of human capital | Marketing of products and services | -0.34 |

Source: Own elaboration

In addition, the negative correlation indicates a need to increase efforts in intellectual property management processes focused on commercializing services.

## CONCLUSIONS

Higher Education Institutions are a source of technology in technological and intellectual capabilities. However, in the Mexican public sector, public policies, regulations, legislation, incentive mechanisms for researchers, and even the culture and vision of these institutions have left them lagging in the technological development markets.

Although all knowledge is valuable, R+D+i should be projected to generate products or services that benefit society, focused on problems, needs, and future advances. The lack of investment or focus on technology foresight processes in Mexican public sector Higher Education Institutions generates a sterile field of knowledge, with knowledge that, for the most part, will not be applied, representing more of a cost than an investment. Implementing a constant process of technological foresight, which focuses on the efforts of R+D+i, will favor the redundancy of the resources invested in R+D+i, awakening the interest of the market and the public sector and representing a real benefit to society.



Similarly, market studies are an essential part of the intellectual property management process. Higher Education Institutions should include personnel specialized in marketing in the technological development projects to support the approval decisions of R&D&I projects in such a way that they seek to have a tangible impact on society to subsequently focus efforts on the design of the image of the products.

In addition, the institutions must implement processes for a specialized valuation of intangible assets to increase their bargaining power during the review of IP contractual provisions and ensure that the investment generated in technological developments redounds through the figures of income from technology transfer and royalties.

Finally, it is essential that, in Higher Education Institutions, R&D&I projects are developed in a multidisciplinary way, involving personnel from different areas at different levels, and in this way, cover a general process of intellectual property management, where lawyers, administrators, financiers, engineers, and others, generate large-scale projects to impact the market, thus generating their resources that support the generation of new research, in a fertile ecosystem for progress and technological evolution that is part of today's society.

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