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Trends in Patenting and Entrepreneurship among researchers of the Universidad Autonoma del Estado de Morelos

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— Abstract—

The purpose of this paper is to determine the trends of commercialization of knowledge from researchers of the Universidad Autonoma del Estado de Morelos (UAEM) through patenting and entrepreneurial activities. We study the segment of teachers-researchers, mostly members of the National System of Researchers (SNI) who have applied for patents aided by the internal Knowledge Transfer Office of this institution (KTO-UAEM), as well as the motivations and restrictions to develop intellectual property protection, based on the application of semi-structured in-depth interviews. The originality of this work lies in obtaining, a broad insight into the opinions of the academic community on the third mission of the University, specifically, on the patenting and commercialization of inventions. It also presents information on the development of technology transfer within the context of a public university, which already stands out in these activities at the national level, as well as its interest in transformation, towards an institution more congruent with the current environment, which seeks to transfer the generated knowledge for the benefit of society. The impact of national intellectual property policies and incentives, as well as, the little commercialization of results, have implied a reduction of the interviewees' interest in continuing to apply for patent registration. On the other hand, entrepreneurship by researchers, also mostly members of the SNI, and their students, is an outstanding activity.

Keywords:

Intellectual property; project portfolio; technology transfer; linkage; National Rresearch System

Currently, an increase in the diffusion of intellectual property (IP) has been observed, which supports the activities of Technology Transfer (TT) Raghupathi (2017). Patents are recognized as the most widely used form of IP, which encourages research, generates income, and positively impacts the economy Beltrán Morales, *et al*., (2018).

When it comes to university patent trends, the United States strongly predominates, with 18 of the 25 leaders, the first being the Massachusetts Institute of Technology, MIT. In Fisch, *et al*., (2015). The number of university publications and the technological focus in areas such as chemistry and mechanical engineering is strong determining factors of university patenting, while the size of universities and the quality of their publications are not found as significantly determining factors.

Arenas and González (2018) consider licensing and the creation of University Spin-offs as formal mechanisms for the exploitation of patents, in the first case, and for exploration, validation, and exploitation in the second. While Zúñiga (2011) recognizes that the promotion of TT through patents opens a new era of opportunities to accelerate the transformation of scientific results into innovations, especially in biotechnology, nanotechnology, and life sciences.

Although human resources are crucial both for the development and for the application of technology (Barton & Osborne, 2007), some important barriers to the commercialization of technology are short funds, the rewards that favor the science generation, avoiding applications, and the lack of linkage between researchers and companies to promote TT mechanisms, according to Siegel, *et al*., (2007) and Sarabia-Altamirano (2016). Mazurkiewicz (2018) shows an analysis of the TT barriers, as well as the beginning of this topic, the first studies of which were published in 1960 in the United States.

A key element to favor the link between researchers and companies has been the creation of Technology Transfer Offices (TTO), which have promoted public policies to stimulate not only the creation of knowledge but also its application (Lafuente & Berbegal -Mirabent, 2018). The AUTM (Association of University Technology Managers) in USA-CANADA and the TTO Network of Mexico are organizations that support the University's TT towards the industry, as well as the creation of new knowledge-based businesses.

In the case of Latin America, universities are still in a development phase for collaboration with the productive sector (Calderón, 2014). In them, the third mission is emerging. It is widely known that the first mission of universities focuses on the training of human resources, while the second is on the knowledge generation, alternately expressed as focused on teaching and research, respectively (Marhl & Paosits, 2011). The third mission is relatively recent, particularly in Latin America, and focuses on

TT (Arocena & Sutz, 2005), contributing to social, economic, and cultural development (Compagnucci & Spigarelli, 2020), or else, reflecting all the University contributions to society, Marhl, and Paosits (2011). To carry out this mission, it is essential to consider the needs and problems facing society, as well as a balance between basic and applied sciences (Caldera & Debande, 2010; Galván, 2017). At UAEM, since 2012, innovation and TT were emphasized among its priority axes from a sustainability perspective (Administration, UAEM, 2012-2018).

Mexico, since 2009, has been among the countries that have promulgated decrees or laws that stipulate that universities have the right to ownership of research results (Zúñiga, 2011), however, it is with the decree of the Congress of the Unión (2015), by which various provisions of the Law on Science and Technology and the Federal Law of Administrative Responsibilities of Public Servants are reformed, which has a legal framework that allows universities and their researchers to commercialize their discoveries, without conflict of interest, as established in article 51. However, institutional guidelines that have not yet been developed by most public universities, including the UAEM, are required.

Countries such as China and India have also implemented public policies for the commercialization of their discoveries (Krishna, 2018). Whereas, since 1980, the US Bayh-Dole Act allowed American universities to retain their intellectual property and appropriate their licensing income. The commercialization of MIT's discoveries, with the support of industry and government, has positioned Boston as the most prosperous region in the world. Parallel experiences were also identified in Silicon Valley, where Stanford University, in partnership with government and business, has made this region the most innovative in the world, creating great prosperity for California (Etzkowitz & Zhou, 2018). Both institutions are examples of modern universities, which have transformed their environment through the licensing of patents and the generation of new companies.

Patent marketing is incipient in Mexico, many companies are not yet interested in using scientific knowledge. Therefore, the effort to promote innovation, transforming discoveries into valuable products is more difficult (Puerta-Sierra, *et al*., 2017).

1.1 Technology Transfer Offices

OTT's began in the United States of America in the 80s and today others have been created around the world, to transfer university knowledge more efficiently to the industry. Their role is to support scientists in commercializing their results, building strong networks with regional and international companies, reducing "language" barriers between scien-

tists and industry (Yonghong, *et al*., 2015). They act as interfaces to bring together scientists, companies, and venture capitalists (Mascarenhas, *et al*., 2018); they are catalysts for change and innovation in their region. Its performance depends on the rapid commercialization of emerging technologies.

According to Heald (2005) and Galván (2017), university patents must be extended, but many patents will never be exploited commercially, in the same way, that numerous scientific articles will never be cited. Approximately 25% of the articles published are never cited (González de Dios & Benavent, 2007). Galván (2017) estimates that only 10% of patents are licensed (sold). The TT achieved by US universities (De Vol, *et al*., 2017) shows a balance concerning the generation of science and its application. But patenting does not necessarily generate profits for inventors and organizations. MIT or Stanford University's success is very difficult to replicate, even in the US. There is no single procedure to guarantee the success of commercialization, so each institution must implement practices according to its environment. The TTO is an actor that facilitates innovation processes (Rojas, 2017) and contributes worldwide to the application and commercialization of research discoveries and the development of universities (Alvarado-Moreno, 2018; Solís, *et al*., 2020; Pérez, 2019). One of the points in its mission is to strengthen the relationship between companies and researchers, so they must identify the technological needs of socioeconomic sectors to favor TT. However, the shortage of professionals with experience in TT and the lack of financing are the main difficulties faced by Mexican TTOs (Solís, *et al*., 2020).

1.2 KTO-UAEM

As part of a national effort towards the commercialization of science, the KTO-UAEM was created in 2014; it is an independent transversal unit, with a small amount of personnel, the results of which are new companies and patent licenses; it has a specialist in patent writing and another in marketing. UAEM professor-researchers have support for the drafting of patents, including advice to respond to evaluators.

The KTO-UAEM has also been working on the creation and development of structured policies for the protection and commercialization of patents, through licenses and the creation of new companies (Velázquez, 2019). As an internal policy, patents must be presented by the KTO-UAEM, the UAEM being its owner. If commercial exploitation of patents takes place, researchers can reap part of the benefits, according to internal guidelines. The KTO-UAEM indicates the licensing scheme with the support of researchers to detect potential clients.

The registration amount of a national patent for universities in Mexico is approximately $260. The Patent Cooperation Treaty (PCT) helps international patent protection by applying this scheme; applicants can protect their invention in many countries. The KTO-UAEM has used this scheme only once, but the rights and technical translation in the selected countries exceeded budget, so almost all the patents applied for have been processed only in Mexico.

As relevant data for this research, about the critical mass in Research and Development, R&D, it is important to mention that the UAEM has 284 researchers recognized by the National System of Researchers, SNI, of which 25 have a candidate level, 167 are level I, 66 are level II, and 26 belong to level III. Of this total number, 115 are women and 169 men (40% and 60%, respectively) (Rectoría UAEM, 2017), which shows a certain gender balance and as will be seen later, also in participation. It should be noted that SNI Level III researchers are those established researchers with many international articles, many citations to their work, doctoral graduate students, and founded research groups. The critical mass of researchers at UAEM is robust, with great scientific capabilities, but little experience in TT. This is the challenge that the KTO-UAEM must face, in an environment with a greater tradition towards scientific research and teaching, with a low density of technological companies and limited resources.

1.3 University patents

According to IMPI (2016), Mexican universities have increased their production of patents, requesting the Mexican Institute of Industrial Property in 2010, 349, in 2011, 338, in 2012, 435, in 2013, 374, in 2014, 449 in 2015, 533 and, until July 2016, 240. In the period 2013 to 2018, UNAM, with 299 applications, was the university with the most patent applications, the tenth university was the Universidad Autónoma Metropolitana with 49 (IMPI, 2020). On the other hand, 41 university patents were granted in 2017, 58 in 2016, and 122 in 2019 (Ortiz, 2018).

The UAEM has evolved from the national ranking on university patents, from position 18 in 2014 to 13 in 2017, corresponding to 42 applications filed and six patents granted, which represented an important advance at the national level, positioning it among the top 15 Mexican institutions in this field. In 2018 it presented 12 applications and three patents were granted (Urquiza, 2019), from 2019 to March 2021, 17 more applications were presented, while from 2019 to March 2021, five patents were granted.

It should be noted that the high Mexican scientific production does not correspond to the low levels of IP registered by the universities. Tarango,

et al., (2015), report that in the period 2007-2011, on average, the highest proportion of productivity of indexed articles and patents applied for corresponding to the Universidad Autónoma de Nuevo León (272.2 to 7.2) followed by the Benemérita Universidad Autónoma de Puebla (217.8 to 3). Currently, for each patent application, more than 20 articles are published, which is a clear reflection of the public policies that have promoted the generation of high-quality science in Mexico, without achieving a balance with its application.

The AC Scientific and Technological Advisory Forum (FCCyT) has analyzed the evolution of the researchers that make up the SNI in Mexico, growing from approximately 16 thousand in 2013 to more than 25,000 in 2016, which shows that the Mexican scientific community, although small, has been consolidated (Rodríguez, 2016). In 2018 there were already 28,578 members (SNI, 2018).

Regarding the patent applications of Universities in Mexico, the national survey of Mexico's TTO Network of 2016 and 2017 indicates that TTOs manage more than 60% of these patents, 310 in 2016, and 380 in 2017. The level of licensing went from 58 in 2016 to 41 in 2017. In 2019, 75 licensing contracts were reported, considering various figures from PI Ortiz Cantú (2020). Although the figure is relatively small, it shows that this market exists, that there are Mexican companies interested in marketing it.

The AUTM publishes an annual survey on patent applications from universities in the United States and Canada, from which it is observed that, on average, each university in the United States requests 40 patents per year, managing to commercialize approximately 10% of them. For more than 30 years, TTOs in the US have worked closely with partner companies to transform scientific discoveries into business; on average, each university has released three new products per year, with licensing revenue of $450,000. In addition, they have generated around four startups per year (AUTM, 2017).

In Mexico, according to the annual survey of the TTO NETWORK, universities with certified TTOs manage to present around six per year, granting around one license per year (Ortiz, 2018). The TTO effort is very recent, however, the results are starting to be important

1.4 University entrepreneurship

The creation of university microenterprises is increasingly important (García, *et al*., 2017). They make it possible to demonstrate low-maturity technologies in the market, reducing uncertainty for investors. Universities are becoming more entrepreneurial, becoming a hotbed for the formation of new companies (Narváez Vásquez, *et al*., 2016). They configure the business model of their TTO, in addition to patent licensing, with incubation

programs and seed capital for the launch of new university companies as another transfer mechanism (Baglieri & Christopher, 2018). Patent licensing has been the most popular mechanism for the commercialization of IP in Mexico, but the creation of new companies has grown the most (Ortiz, 2018). The TTO NETWORK reported the creation of 168 university micro-enterprises in Mexico, surpassing the licensing of patents. Most of the new Technology-Based Companies, EBT, come from approximately 60 public universities. On average, each public university has generated a new company.

Regarding entrepreneurship by academics in Spain, the initiatives have arisen in an adverse environment, in particular, towards companies based on university research (Morales, 2008). Lemes Hernández (2015) mentions that such initiatives are given by opportunity and not so much by necessity and that the cases of negative experiences do not affect the antecedents of the intention; it is assumed that this is because relationships in the work environment can be competitive, and to a lesser extent, affective. Monge Agüero, *et al*., (2012) carried out a case study in Costa Rica, in which academic entrepreneurs stated that they had a high need to achieve and put into practice the acquired knowledge, as well as a high degree of satisfaction with the business experience developed.

This article will focus on trends on patents and entrepreneurship, as well as on the attitudes and motivations observed during in-depth semi-structured interviews carried out with the UAEM professor-researchers, who have collaborated in these processes.

The results found may be useful to improve the science application processes at UAEM, as well as for other Latin American institutions in similar situations, which gradually seek to give more value to knowledge.

The theoretical review was carried out using Google Scholar, with the keywords Technology Transfer, TTOs, university patenting, patents. In the temporary coverage, the last 11 years were fundamentally considered.

In this study, three research questions were established:

Q1: Is the KTO-UAEM a key factor in promoting the internal culture of patents so that researchers achieve a better balance between the generation of science and its application?

Q2: Will the portfolio of patents generated by the KTO-UAEM be attractive enough to generate resources for the university and the researchers involved?

Q3: What would be the best way to commercialize the discoveries of the UAEM, through the TT, through existing companies, or the creation of new companies by students and professors of the institution?

This work is distributed as follows: section two presents the methodology used, section three shows the results and discussion. Finally, in section four, conclusions are provided.

2. METHODOLOGY

The data collection was carried out considering primary sources, from the application of semi-structured in-depth interviews (Pomposo, 2015), with researchers who have worked in the development of patents. In-depth interviews are useful when you want detailed information about a person's thoughts and behaviors, or if you want to explore new topics in-depth (Boyce, 2006). It is a discovery-oriented method that allows the interviewer to explore the interviewees' feelings and perspectives on a topic. In the semi-structured format, the interview must be conversational (Guion, *et al*., 2021).

Regarding the determination of the confidence interval and the sample size, the Creative Research System calculator (2021) was used.

To carry out the interviews, the corresponding logistics were determined: appointments were established between researchers and KTO-UAEM staff, which were carried out at the researchers' workplace. Subsequently, the analysis of the results was carried out.

3. DEVELOPMENT

3.1 Patent applications registered by the KTO-UAEM

Throughout the life of the KTO-UAEM, the registration of patents per year has increased, as shown in Figure 1. Before its inception, there were isolated patent and business incubation efforts. Subsequently, applications increased systematically, reaching a rate of six to eight patents filed per year, starting in 2017. There is only one patent filed internationally, since the resources, in general, are small and insufficient to cover the amounts required for this type of application. Some fees for procedures and services are found in Patentepct (2021) and ZBM (2021).

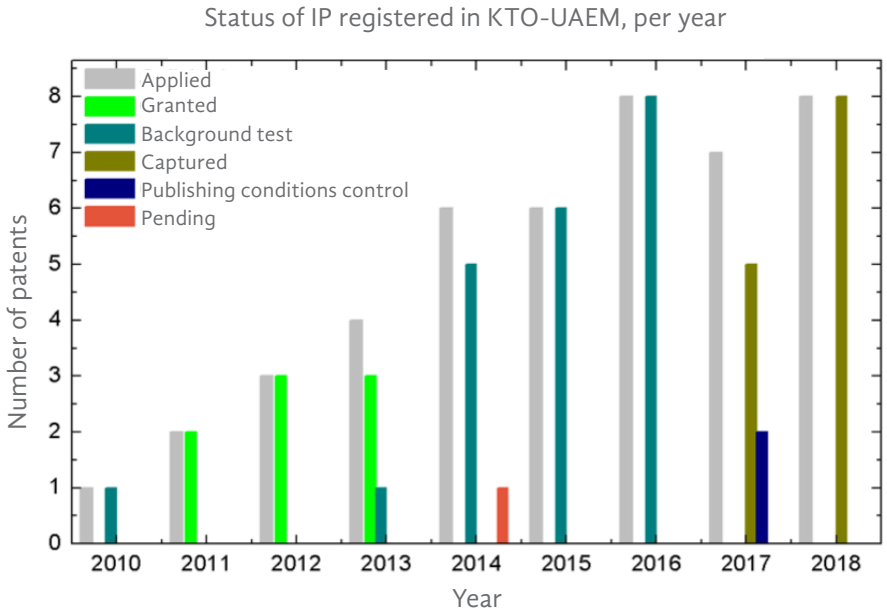

Figure 1. Status of IP registered in KTO-UAEM, per year. Source: Own elaboration

Therefore, in this case, only national patents were analyzed. The process from which a patent is filed until it is granted has required an average of four to six years, although recently this period has been shortened.

In 2018, when the surveys were carried out, 45 patents were filed, of which 6 had already been granted by the IMPI, and in 3 there was no longer interest in commercialization. Therefore, only 42 applications are considered in this work.

The patents registered by the KTO-UAEM have a greater concentration in health and materials, which contrasts at the national level, where the majority correspond to Energy, Chemistry, and Information and Communication Technologies (ICT), (Ortiz, 2018). It should be noted that researchers at the Centro de Investigación en Ingeniería y Ciencias Aplicadas (CIICAP) stand out in advanced materials, while the School of Pharmacy contributes with patents related to health. These agencies are the ones most closely linked to the private sector and have a greater patenting culture in the UAEM. The areas with granted patents are shown in Figure 2.

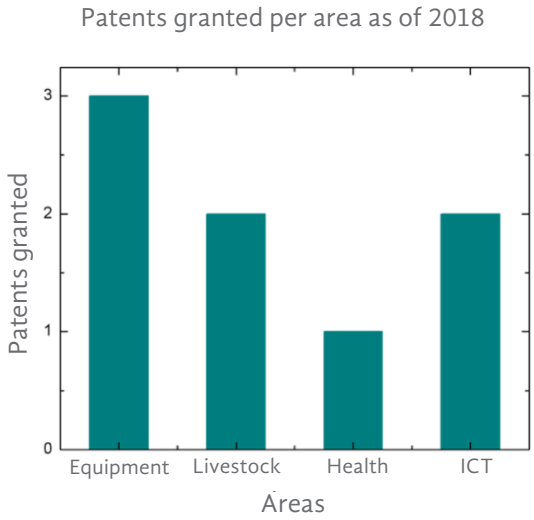

Figure 2. Patents granted per KTO-UAEM area. Source: Own elaboration

Until 2018, the sectors with the lowest number of patents were agriculture, biotechnology, and telecommunications. An analysis of the degree of maturity was carried out for all the patents filed, based on the Technological Readiness Levels (TRL) model (Mankins, 2009). The higher the level, the greater the progress towards commercialization. For its determination, in this work, a series of questions were generated based on CONACYT (2015). According to the answers provided, and to the extent that each level was satisfied, it was determined that 65% were between TRL 4 and TRL 5, with 35% and 30%, respectively. This means that most were in the laboratory-level validation stages. Very few have been tested in the market. It should also be considered that to increase the levels of readiness, the necessary investments grow exponentially.

There was only one patent on TRL 9 (Figure 3). This has implied a high technical-financial uncertainty, limiting the attention of potential investors.

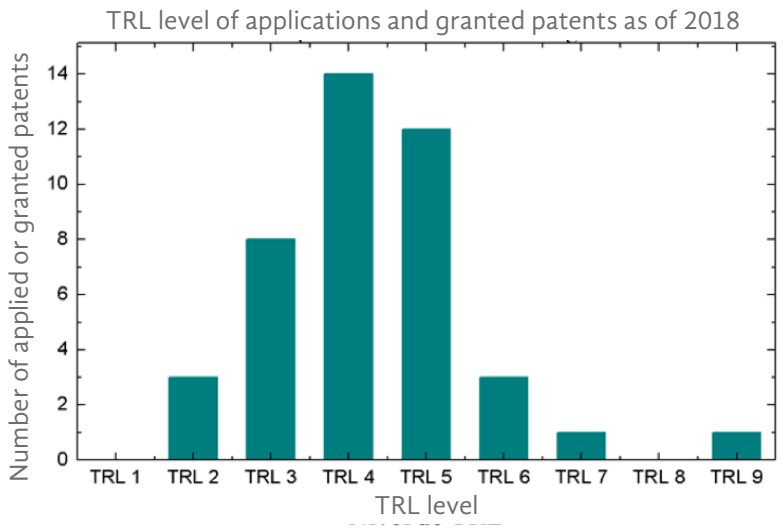

Figure 3. TRL level of applications and granted patents, KTO-UAEM. Source: Own elaboration

It should be noted that Morelos is a state in the south-central region of Mexico, traditionally dedicated to the manufacturing industry, services, commerce, and agriculture, according to the KTO-UAEM Board of Directors (2018), Figure 4. High-tech manufacturing is emerging. According to the type of patents that have been developed (Figure 2), many of them do not have local licensing possibilities. However, at the national level, there are companies in business sectors in which they have patents (SIEM, 2021), for which they may be of interest.

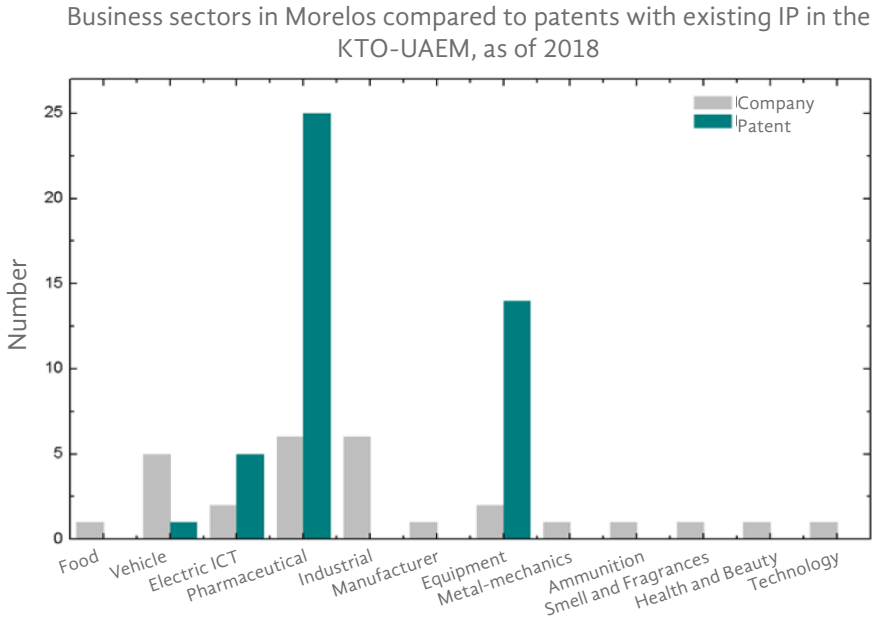

Figure 4. Business sectors in Morelos compared to patents with existing IP in the KTO-UAEM, as of 2018. Source: Own elaboration

As of March 2021, the status of IP in the KTO-UAEM is presented in Figure 5. These are 54 patents applied for, 17 granted, six in capture, 20 in control of conditions for publication, and one pending for one, according to information from the KTO-UAEM.

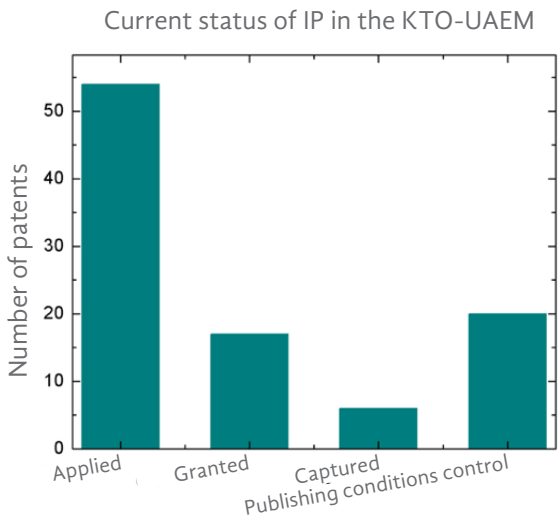

Figure 5. Current status of IP in the KTO-UAEM, until March 2021. Source: Own elaboration

3.2 Sample selection

With Espacenet (2018), the patents requested by the KTO-UAEM (Table 1) were searched, using the identification number of the patent. This Table shows a total of 80 registered women and 65 men, some of them are students, and there is repetition in terms of the researchers who lead the groups of applicants.

Table 1

UAEM patents and inventors, registered in Espacenet until 2017

Number	ID number	Men	Women
1	MX201014422	7	6
2	MX201110190	4	4
3	MX201113522	1	1
4	MX20125321	1	1
5	MX20125322	1	1
6	MX201214978	2	1
7	MX20132342	1	2
8	MX20135576	3	1
9	MX20135768	5	0
10	MX201315275	2	2
11	MX20143901	1	2
12	MX20145001	2	1
13	MX20146541	3	1
14	MX201412768	6	7
15	MX201412783	2	0
16	MX201414291	4	0
17	MX20158244	1	2
18	MX201510197	1	2
19	MX201510653	3	1
20	MX201514094	1	2
21	MX201514095	1	2
22	MX201515327	1	3
23	MX20161343	2	3
24	MX20163003	6	0
25	MX20166999	1	2
26	MX201610606	2	1
27	MX201614103	4	0
28	MX201616320	3	3
29	MX201617266	2	3
30	MX2017730	0	2
31	MX20173328	2	2
32	MX20177947	0	3
33	MX20177956	1	1
34	MX201715882	1	1
35	MX201716429	1	1
36	MX201716354	2	1

Source: Espacenet (2018)

From the above information, 25 representative researchers were identified, some of whom have generated more than one patent.

For the interviews, the confidence interval was determined with Creative Research Systems software. Taking into account the population (25), the confidence level (95%), and the sample size (19), the calculation showed a confidence interval of 11.24%. It was not possible to reduce this interval since one of the barriers to overcome was to make appointments with the researchers and meet with them, of which the results obtained from the 19 interviewees are presented. It should be noted that reduced samples have been analyzed in other works, such as in the case study presented by Aguero, *et al*., (2011).

Figure 6 shows the percentages of interviewed and non-interviewed. The interviews were planned to last approximately 30 minutes, but in some cases, more sessions were needed.

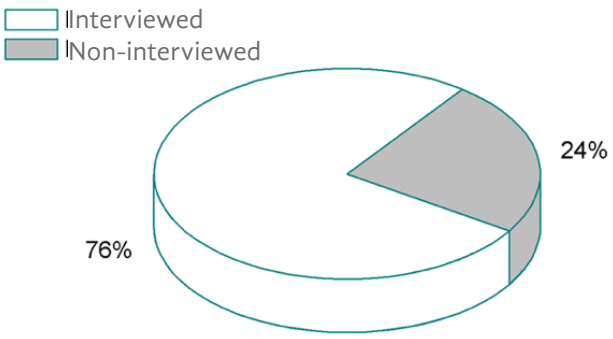

Figure 6. Percentage of interviews conducted. Source: Own elaboration

4. RESULTS AND DISCUSSION

4.1 Results of semi-structured in-depth interviews

Regarding gender, from the information shown in Table 1, without considering students and avoiding repetitions, it is found that, of all the female UAEM professor-researchers, only 2.95% (13) of the total number of full-time researchers (439, as of 2017), have participated in the groups that have applied for patents, while, men, have been 4.77%, (21). Together, they constitute 7.72% of the total PTC. Therefore, 92.28% of UAEM researchers are dedicated to traditional activities, research, and human resources training.

Of the 25 leading researchers identified, some of them have applied for more than one patent. Although the development of patents requires more time and financial resources, there is no impact on the productivity of the

leading inventors since, as can be seen in Figure 7, most of them are part of the National System of Researchers, SNI (2018).

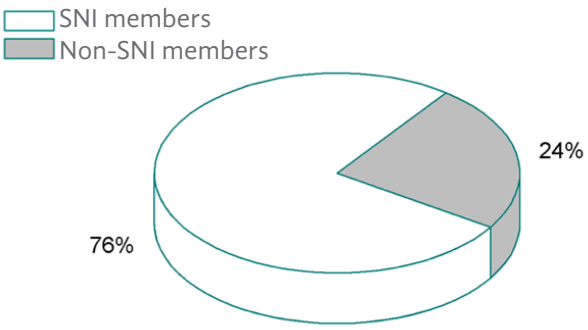

Figure 7. Percentage of researchers, leaders of patent application teams, in the SNI. Source: Own elaboration

The surveys were applied to 19 of the 25 team leaders who have applied for patents, who agreed to be part of the group under analysis, so they will constitute our 100%.

Of these, 13 were male researchers, and six were female researchers, 68% and 32% respectively.

The inventors' age ranges between 40 and 60 years.

Regarding motivation, 95% showed high motivation for their inventions, being proud of them.

Almost 84% of the researchers were interested, happy, and hopeful, in creating an KTO-UAEM patent portfolio with a commercial focus, to make the discoveries more attractive in the search for potential clients. The researchers who participated in the preparation of the patents felt alone once the patent was applied for because there was no follow-up for its eventual commercialization. Developing a properly designed patent portfolio is a big step for them. The KTO-UAEM does not have funds to promote the incubation of university companies but has recently made a more marketable portfolio.

Almost 16% of researchers saw themselves as entrepreneurs, based on their patents, while 84% preferred to find who licensed them.

In contrast, 16% of researchers consider that the best way to commercialize their discoveries would be by creating new companies, with their students, raising seed capital from families and friends.

Regarding attitude, approximately 95% of the interviewed researchers were friendly and open to dialogue, only 5% were indifferent and apathetic. This fact demonstrated the great interest of the UAEM researchers in transferring their knowledge, although there was some discontent or apathy (5%) towards this process.

Regarding the intention to patent again: only 36% of the researchers interviewed consider the intention to patent, some of whom give continuity to previous patents (Figure 8).

The KTO-UAEM has promoted TT, but, in general, traditional missions of human resources and research training have been prioritized internally.

In addition, the commercialization of results has been scarce, so it is estimated that this fact has negatively affected the culture of patenting.

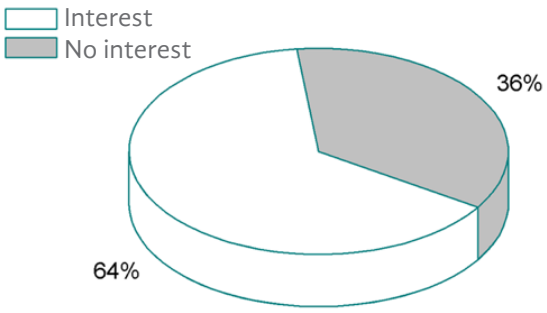

Figure 8. Researchers' interest in patenting again. Source: Own elaboration

On the other hand, the following barriers of communication with the researchers were detected when conducting the interviews:

- Time to respond to invitations.
- Difficulty making appointments. Their rescheduling negatively affected the quality of the surveys.
- During the interviews, more time was spent explaining the KTO commercialization processes, as well as disseminating the benefits of creating a more attractive patent portfolio for the private sector.

4.2 Discussion

The KTO-UAEM has promoted the culture of patenting among the scientific community as contemplated in the first research question (Q1). The results show that there are already indicators on the third mission of the university.

Although only 7.7% of all researchers have participated, as patent applicants.

The emphasis of the KTO-UAEM was orthodox. As a first stage, it established administrative procedures to promote the culture of patents within the University, and simultaneously to identify potential clients to "sell" licenses. Some courses were also offered for university entrepreneurs, where two Boot Camp workshops were organized. With these actions, it has been possible that 16% of the researchers considered that they could be entrepreneurs of their patents since after these activities they founded their

companies. With three spin-offs, the UAEM is above the national average, since as mentioned above, the average is one. Of the 42 UAEM patent applications, only three have been transferred to new microenterprises

It was also identified that the majority of UAEM researchers have patented without detecting the needs of the industry, at least corresponding to the state of Morelos (Figure 5).

Regarding the research question on the impact of the patent portfolio to commercialize the knowledge of the UAEM, it can be argued that more time is needed for its evaluation. However, as a positive effect, it was found that the researchers considered it a good procedure, partially affirming the second research question (Q2). International universities have developed similar catalogs with success.

Like the results of this article, other authors have discovered that patents are a limited channel for the TT process (Costa Póvoa & Siqueira-Rapini, 2010), a limitation that was associated with the need for further research to convert to the patent on a process or final product. They found that the best TT process is to carry out joint projects between universities and companies, to develop technology and train staff in parallel, to achieve a better assimilation scheme.

The UAEM has begun with the certification of its administrative processes, training its staff, and creating the internal patent center, recognized by the IMPI. Some courses and workshops on entrepreneurship have been given. Despite these limitations, three new micro-companies were created: SALUTIS, which markets compounds that strengthen the human immune system, INNTECVER with mini antennas for broadcast TV, and ACYIPRAOVEMI for mushroom concentrates as nutritional supplements. Which were founded with the effort and investments of researchers and students. The lead researchers were two men and a woman. Two of the three leading entrepreneurs of these spin-offs are members of the SNI (2018). Figure 9 shows their impact on technological development.

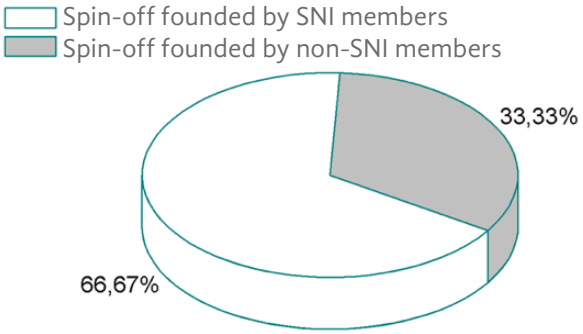

Figure 9. Percentage of spin-off founding leaders members of the SNI. Source: Own elaboration

In Morelos, with a low density of EBTs, the commercialization of knowledge was more effective through the new university spin-offs, answering question three (Q3). However, the university must define clear guidelines on the incubation process, which could be carried out within university laboratories. However, the university must define clear guidelines on the incubation process, which could be carried out within university laboratories. A modern university implies teaching and scientific production, but also the application of knowledge, Sánchez-Barrioluengo, and Benneworth (2019). New university companies, due to their origin, would be much more interested in acquiring and commercializing new knowledge.

It should be noted that the three university spin-offs created in the UAEM, compared to the national magnitude, where the National Autonomous University of Mexico, UNAM, is the Leader University, with 11 registered spin-offs (Torres, 2017), is a significant fact. In Maldonado-Sada, *et al*., (2019) it is recognized that academic spin-offs are a recent issue in Mexico, so there are few reported cases. In García Colina, *et al*., (2017), in the impact analysis of university spin-offs, only 10 were considered, from different states of the country.

In the study presented here, a clear division of attitude is observed within the chosen sample. While 37% of scientists want to re-patent, 63% consider this approach inappropriate. Almost 84% of scientists perceive problems between the third mission, focused on TT, with the traditional teaching and research missions.

Patenting, transferring, and entrepreneurship activities are not adequately rewarded. Therefore, 84% of the respondents perceive TT activities as an additional burden on their activities, with no short-term benefits. On the other hand, TT's mission has caused tension due to the lack of clear policies. There are conflicts and problems between "traditional" academic researchers and the small nucleus of "innovators", similar to that mentioned in Philpott, *et al*., (2011). This has generated isolation and rejection. This attitude may also be related to funding, coming from various funds, basically focused on research.

TT could create enormous value for the economy of developed countries through licensing, but also with new university companies (Etzkowitz & Ranga, 2010). Furthermore, innovation and entrepreneurship skills are essential for the complete training of students. Therefore, the current lack of funds for the commercialization of knowledge is perceived as detrimental to long-term economic development (Soetanto & Van Geenhuizen, 2015).

5. CONCLUSIONS

Despite having the KTO-UAEM, there is still low participation of scientists in patent matters, since only 7.7% of them have registered their inventions. However, as of 2018, a portfolio with 42 patent applications was integrated, which positioned the UAEM as the most important in the state of Morelos, in terms of patents (UAEM, 2018). Of the 25 leading researchers identified, 74% belonged to the SNI, which allows us to observe their impact on technological development.

The KTO-UAEM successfully focused on the patenting process, but the scarcity of mechanisms to achieve escalation and, therefore, commercialization, caused 63% of those interviewed not to consider patenting again. Fortunately, the creation of spin-offs is not significantly affected.

It is observed that productivity, in terms of patents of male and female researchers, is relatively comparable, according to the respective population in the UAEM.

It is notorious that the commercialization of patents is a great challenge in Morelos, due to the low density of technology companies and their commercial reach. Only three of them have been transferred to UAEM spin-offs, but unfortunately, they have not yet yielded the expected economic results. One-third of the entrepreneurs were members of the SNI.

It was identified that the KTO-UAEM has little diffusion within the University campus since not all researchers and students know its services in-depth, so it is necessary to intensify these tasks. It is recommended that the internal policies be published shortly, as well as the permanent search for sources of financing to mature the technologies in the early stages of maturity.

Surveys show that 95% of professors are motivated by the creation of the UAEM patent portfolio, so it is possible to support activities aimed at its commercialization.

Innovation and entrepreneurship skills are essential for the complete training of students. Therefore, the current lack of funds for the commercialization of knowledge is perceived as detrimental to long-term economic development, in congruence with what was detected by Soetanto and Van Geenhuizen (2015). It is concluded that to promote the commercialization of knowledge, a better balance between basic research and the application of science is required.

It was found that UAEM researchers have created patents without detecting real needs in the industry or without having previously carried out a market analysis to determine the viable niche for their creations and inventions, which makes their commercialization difficult. But it should be clarified that science can generate new markets, not explicit ones, that traditional market methods cannot perceive.

Due to the small size of the sample, the knowledge obtained is limited, however, a certain similarity can be observed in some of the elements analyzed, with other reported works, as well as other new ones, related to perception.

Unfortunately, these results cannot be extrapolated, however, they allowed us to obtain primary information to analyze trends in patenting and entrepreneurship at UAEM. As future work, it is expected to follow its evolution.

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