



International Conference on Industry Sciences and Computer Sciences Innovation

University technology transfer: Contacts and connections at the origin of licensing agreements

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Abstract

Technology diffusion and licensing agreements between universities and industry enhance the application of research results and ensures further outcomes for the university stakeholders that take part on the technology transfer process. To this end, University technology transfer offices (TTOs) work with researchers and businesses to bring new technologies into commercialization. To get to know the Portuguese University TTOs underlying interactions and factors at the origin of licensing agreements that can create wealth for people and organizations, data has been collected among TTOs head of offices using a semi-structured survey. The most frequent knowledge exchange interactions were identified, which include: meeting with researchers to discuss the innovation potential of their work; contacting companies to discuss the development of new projects; contacts with companies known by the researchers and the researchers contact with R&D people from companies is also key on reaching licensing agreements, as well as existing collaborations with industry. The conclusions have been reached using a descriptive and exploratory approach to convey information regarding interactions at the origin of licensing agreements.

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Peer-review under responsibility of the scientific committee of the International Conference on Industry Sciences and Computer Sciences Innovation

Keywords: Technology transfer; Intellectual property rights; University-Industry relations; Licensing.

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1. Introduction

University technology transfer refers to the process of exchanging knowledge, skills and technology by identifying, protecting and marketing university research outputs to be used by businesses and those that have access and can use the new advancements in technology, science and humanities. University technology transfer offices (TTOs) are committed to provide access to these outputs and to gain profit from connecting and engaging with businesses to make money out of commercialization agreements.

This article aims to identify contacts and connections at the origin of licensing agreements, to this end, information has been gathered regarding Portuguese University technology transfer offices interactions to ensure knowledge exchange, and to identify the main sources of contacts that have an impact on getting licensing agreements.

To support this study a literature review of factors underlying technology transfer agreements have been done including references to networking capabilities, researchers' engagement in post-project valorization activities, and the active involvement and collaboration between researchers from companies and universities, that together reinforce a baseline for a successful knowledge transfer.

The article structure is concise and focused on presenting the methodology, the literature review that supports this study, and on presenting the data that led to the conclusions regarding contacts and interactions at the origin of licensing agreements providing inputs to continuously foster knowledge exchange and commercialization.

2. Methodology

A semi-structured survey has been used to collect information among eight Portuguese University technology transfer offices (TTOs), namely: (1) University of Minho: TecMinho; (2) University of Porto: UPIN; (3) University of Aveiro: UATEC; (4) University of Coimbra: DITS; (5) University of Beira Interior: Innovation and development office; (6) University Nova of Lisboa: RIA – Research and Innovation Accelerator; (7) University of Évora: Technology transfer office; (8) University of Algarve: CRIA.

Five out of the eight universities appear regularly in world rankings of the top 1000 universities [1]. The semi-structured survey was divided in four parts: 1st parts: origin of licensing agreements; 2nd part: invention disclosures assessment practices; 3rd part: evaluation methods and 4th part: payments structure of licensing agreements. This article presents the data from part one of the semi-structured survey.

Two rating scales have been used:

(1) To assess the frequency of Technology transfer offices interactions for knowledge exchange, the following frequency scale was used:

Table 1: Frequency scale for intervals

	Not applicable	Infrequent	Not frequent	Frequent	Quite frequent	Very frequent
Frequency scale	0	1	2	3	4	5
Number of interactions per year	0	[1;6]	[7;12]	[13;18]	[19;24]	>24

For each value of the frequency scale, a range of interactions per year has been defined, for example, a frequent interaction corresponds to 13 up to 18 contacts per year.

(2) To assess the frequency of Technology transfer offices contacts and information that have an impact on getting licensing agreements, the following frequency scale was used, which lets margin for self-interpretation of what is a frequent action by the respondents.

Table 2: Frequency scale

	Does not happen	Not frequent	Frequent	Quite frequent	Very frequent
Frequency scale	1	2	3	4	5

The approach was exploratory and descriptive to make the data presentation very objective since the sample is relatively narrow focusing on eight Portuguese Public University TTOs. Despite the narrow sample, the goal of gaining knowledge about contacts and connections at the origin of licensing agreements has been accomplished. In the future, subsequent work will be done to include data from University TTOs in other European countries.

3. Transferring university technology: contributing factors

Connecting and engaging with society is referred as the 3rd mission of the University being the first two teaching and research. The terms «University technology transfer» and «knowledge transfer» became prominent after the law of the Bay-Dole Act in 1989, the act allows universities to own and commercialize inventions resulting from public research funding, and technology transfer offices have been created in Universities, either as part of the University services or as independent associations or companies. More recently the term «knowledge exchange» started to be used due to its wider scope, the term is described by the UK Higher Education and Research Act, 2017 as knowledge related to science, technology, humanity and new ideas where the exchange contributes, or is likely to contribute, directly or indirectly, to an economic or social benefit [2].

University technology transfer refers to the process of exchanging knowledge, skills and technology with companies and the wider society to create wealth for the university and to those able to use knowledge and technical solutions that can advance science, people skills and future discoveries [3]. University Technology Transfer Offices work to strengthen the University third mission fostering a wider engagement with society where knowledge and technology are exchanged in view of commercializing and gaining profit from connecting and engaging actions.

Possible technology transfer paths are licensing, selling IPR, the creation of a spin-off company, the establishment of collaboration and consortium agreements. One of the most traditional type of agreement to transfer technology to firms is the licensing agreement. A license agreement allows an existing company (the licensee) to use intellectual property rights owned by the university (the licensor) [3]. Collaboration and consortium agreements can include Cooperation Research and Development Agreements (CRADAs), Material Transfer Agreements (MTA), and Non-Disclosure Agreements (NDAs) to allow the institution to keep control over the technology while continuing to work on it while coping with third parties [4].

To transfer a technology an alignment must be found to match the characteristics and advantages of a technology with the firms' needs and interests. This is many times called a «window of opportunity» [5]. A window of opportunity is found when a firm sees a technology as being useful to replace or update existing products or that are looking to improve or diversify their product specifications and range, to gain competitive advantages and to be able to maintain or conquer market share. The timing for the technology transfer must also be aligned with the firms replacement cycle and needs, because if the replacement is made too soon, the firm may incur in high change over costs, but if a company replaces a product too late it may lose market share [5], [6], [7], and the lower the introduction costs, and the better the technology adequacy to the firm capabilities and needs, the higher is the invention value and the probability of licensing it.

A good licensee or technological partner is the one that is able to complement our resources and skills to further develop it and to scale its application, it must have access to the networks and commercialization channels that are necessary to address relevant markets, it must have a significant client base and a strong brand, it also must have a risk taking attitude, and above all it must be credible partner, that respects deadlines and meets the defined targets and that negotiates fairly so that each partner feels that a balanced agreement is reached [7].

When looking for licensees, attention must be paid to what other technical solutions and intellectual property rights are required to get a complete commercial product or if it is possible to combine the technology with existing products or systems [8]. The technology friendly use, its easy and intuitive reproduction and packaging, its robustness, adaptability to different environments, and the possibility of granting the use of the invention to conduct pilot-tests to decide on its usefulness and potential for profit are relevant factors on technology licensing decisions [9].

As a rule of thumb, smaller firms and start-ups are the ones willing to assume greater risks and more experimentation to test what might work, larger firms have more pre-established compromises and may be more difficult to approach and may not have the flexibility to adopt early-stage technologies [7]. Established enterprises tend to prefer incremental technologies that bring something new to an existing solution or that alters its design [10]. Smaller firms are more willing to adopt technologies in initial development stages, or technologies that present

disruptive characteristics allowing the development of new generation products based on different scientific domains [10], [11]. Smaller firms may also have fewer resources to invest in technology watch and may be receptive to this information, meaning that the TTOs investment in direct marketing to smaller firms may prove to be very valuable [12].

Independently of the firms' size and maturity level, technology adoption is impacted by the firms strategic orientation [13]. Firms whose growth is sustained on new products and processes continuously seek new advancements and technologies and they are potential licensees. But our technology may also serve companies whose orientation strategy is directed to follow-up pioneering companies that are willing to commit to higher risks.

Therefore, we must pay attention to innovative and early-stage companies and also to follow-up companies and companies that apply previous or similar technical solutions. Attention must also be paid to existing solutions and patents leading to similar results and who owns them to guide the technology licensing efforts.

Attention must also be paid to the rhythm of patenting and publication and who owns them and are licensing them to identify organizations that are importing and exporting technology to determine the importance and value of different patent subclasses.

We must also be mindful that many solutions are licensed not because they embed an innovative technology, but because there is a solution or product, which may include a patent, whose functionalities have been demonstrated on the ground [7] and solutions tailor made or developed with the participation of interested companies usually set the ground for a successful technology transfer process [14].

Licensing agreements strongly rely on the size and quality of the researchers and TTOs networks, "one's worth can be approximated by the size (and quality) of one's network" [15]. TTOs acknowledge that the inventors are the most important source of licensing contacts [16], [17] and they are the primary source for firms' identification [19], [19]. Inventors can be a "one stop source of market information" [8].

The inventors' attitude towards commercialization of research, conducting additional research during patent review, and engagement and collaboration in disclosure and post-disclosure actions such as contacting companies and working with industry personnel on the underlying knowledge and skills to use the technology increase the likelihood of getting the technical solutions licensed [20].

Researchers' engagement in disclosure and pos-disclosure actions including patenting and licensing are shaped by their perceptions of the benefits of commercialization [21], [22], [23]. Senior faculty are more likely to engage in patenting and licensing actions because they have achieved greater career stability [24], [25], [26]. Researchers whose past training and experiences have motivated a positive attitude towards technology transfer are also more prone to engage in commercialization efforts [25].

Licensing benefits from the researchers networking capacity [17] and from prior relations with industry and from co-development and co-production of research [27], [28]. Industry partners are helpful in raising research questions aimed to solve actual problems [29] and research project contracts and collaborations with industry positively contribute to licensing university inventions [27].

The likelihood of reaching a licensing agreement is enhanced when researcher from the university and researchers from companies work together, also project outcomes developed with industry collaboration to address commercial needs and market opportunities have greater likelihood of being licensed [20].

Early collaboration with industry on devising research projects and getting university researchers working together with researchers and personnel from industry enhance the transfer of project outcomes.

Technology transfer offices play a relevant part in supporting university-industry relations, by making contacts, establishing connections and by instilling and creating awareness of commercialization benefits and by providing assistance in disclosure, patenting and post-disclosure actions such as making and mediating contacts to encourage researchers to keep engaged in valuing their research outcomes.

Technology transfer offices must also manage wisely the university portfolio of patents to protect and invest on inventions that can generate profit since university inventions many times require substantial additional work before being commercially viable [30] and being selective in the protection of intellectual property rights may have a major impact on the TTOs performance [31]. A large patent portfolio requires greater resources and eventually there may be a need to concentrate the commercialization efforts on a reduced number of technologies to bet on those that have stronger bound to market and profitability [32], [33]. Selectivity of inventions for patent filing positively affects

licensing allowing the allocation of limited resources to inventions that have higher technological and market significance [20].

To increase the potential for licensing multiple communication channels are used to effectively communicate the technologies value proposition, including the contact of informal networks to assess the invention technical and market potential, to identify interested companies, to raise money for further developments, to support spin-off companies' creation and to figure out the countries where the patent must be filled. These informal networks include different stakeholders either from business, state and private agencies that support businesses or from scientific organizations [34],[37].

Summing up TTOs use multiple communication channels to assess the technology value and to diffuse the technologies value proposition that consists in a clear statement that describes the technology uniqueness, applications, capabilities and next steps to be implemented [34].

Beyond the technology value proposition diffusion and the establishment of industry relations, it is important to make an integrated management of the units that support entrepreneurial activities and technology transfer processes, to enhance the relationship between the researchers and knowledge valorization professionals and to improve the definition of integrated commercialization strategies. It is also important to foster a structured relation between the university departments and research centers, and the technology transfer professionals to monitor projects from their inception until their diffusion.

The technology diffusion enhances the application of research results and ensures further resources for the development of new projects and we must be mindful that to effectively value a technology there are essentially four options: (1) The inventor creates a spin-off company to value technology outcomes; (2) The invention is integrated in a larger product or system and solves a specific problem of a firm – in this case we already have at least one potential licensee for the invention; (3) The research team develops a technical solution to solve or advance a specific issue of a company with whom they are already working – in this case, the licensee will be the firm; (4) The inventor delegates the technology commercialization responsibility on an external entity – this last option is the one that is less likely to succeed. The inventor must be actively engaged in the technology transfer process, he also has to try to sell or license the invention with the support of the TTO.

The inventors engagement on technology licensing processes is essential, and this is well acknowledged by TTOs, that recognize that behind their success and growth are the relations with the researchers and the early collaboration with industry in devising projects and on getting a straight collaboration with industry researchers and personnel to advance project outcomes that are commercially viable [20]. TTOs must also act as a “value shop” managing a network of actors and technologies, to support the researchers during the knowledge valorization processes [35], [36].

4. Data analysis

To understand University technology transfer practices that lead to licensing agreements, information has been gathered regarding their interactions to ensure knowledge exchange, and to identify the main sources of contacts that have an impact on getting licensing agreements. This information is presented in the following two sections:

- a) Technology transfer offices interactions for knowledge exchange
- b) Technology transfer offices contacts and information that have an impact on getting licensing agreements

4.1. Technology transfer offices interactions for knowledge exchange

Technology transfer offices work with researchers, industry and state agencies and other economical players to figure out possible routes to market and to find companies and investors willing to take the challenge of integrating and commercializing new developments and technology. Table 3 presents the TTOs main interactions to achieve knowledge exchange between different stakeholders.

Table 3. technology transfer offices interaction for knowledge exchange

TTO interactions for knowledge exchange	Average	Std.Dev	Mode	Median	Min	Max
Meet with a researcher or research team to discuss the innovation potential of their work and the possibility of working with industry	4.5	0.5	4	4.5	4	5
Receive a contact from a company looking for support to develop an idea or to solve a specific problem	4.3	1.2	5	5.0	2	5
Contact companies to discuss the possibility of developing projects in cooperation with the University	4.1	1.2	5	5.0	2	5
Meeting with researchers to define research lines and projects with potential for innovation and of interest for a particular industry or company	4.0	1.3	5	4.5	2	5
Receive a contact from a company that wants to know what works are in progress in a particular research area at the University	3.5	1.8	5	4.0	1	5
Receive a contact from a company interested in developing a project in co-promotion to benefit from public funding programs	3.5	1.3	5	3.0	2	5
Identify and approach companies that can develop applications for a new technology developed by the University	3.4	1.4	3	3.5	1	5
Meet with a researcher or other academic member interested in creating a spin-off company	3.1	1.4	3	3.0	1	5
Receive a contact from a company interested in getting technology from the University	3.0	1.8	5	2.5	1	5
Presenting a technology to a potential licensee	2.6	1.7	1	2.5	1	5
Be contacted by a technology transfer professional from another University to get support licensing it	1.5	1.1	1	1.0	1	4
Contact a technology transfer professional from another University to get support on licensing it	1.3	0.5	1	1.0	1	2

	Not applicable	Infrequent	Not frequent	Frequent	Quite frequent	Very frequent
Frequency scale	0	1	2	3	4	5
Number of interactions per year	0	[1;6]	[7;12]	[13;18]	[19;24]	>24

The data that has been gathered lets us know that the most frequent interaction for knowledge transfer include the following in descendent order:

- a) Meet with a researcher or research team to discuss the innovation potential of their work and the possibility of working with industry – transversally to the Portuguese university TTOs meet with researchers on average more than 24 times per year.
- b) Receive a contact from a company looking for support to develop an idea or to solve a specific problem – the average is 4,3 meaning that this is a quite frequent contact that is established between 19 up to 24 times per year, which is a positive indicator regarding the role of that the TTOs play in mediating these contacts within the university. Notice should also be paid to the mode that is five, meaning that some TTOs are being contacted more than 24 times per year by companies looking for support to develop an idea or to solve a specific problem.
- c) Contact companies to discuss the possibility of developing projects in cooperation with the University – TTOs on average contact companies to discuss project development between 19 up to 24 times per year, the mode is also five meaning that some TTOs establish these contacts more than 24 times per year.
- d) Meeting with researchers to define research lines and projects with potential for innovation and of interest for a particular industry or company – the results in this indicator are also very favorable for the majority of the TTOs, they are meeting with the researchers to define research lines and projects between 19 up to 24 times per year, and the mode is also five meaning that some TTOs establish these contacts more than 24 times per year.
- e) (1) Receive a contact from a company that wants to know what works are in progress in a particular research area at the University and (2) receiving contacts from companies interested in developing a project in co-

promotion to benefit from public funding programs – are two kinds of contacts that the TTOs receive between 19 up to 24 times per year, and the mode is also five meaning that some TTOs receive these contacts more than 24 times per year.

- f) (1) Identify and approach companies that can develop applications for a new technology; (2) Meeting with a researcher or other academic member interested in creating a spin-off company; (3) Receiving a contact from a company interested in getting technology from the University; and (4) Presenting a technology to a potential licensee – each of these four interactions are frequent on average, meaning that between 13 up to 18 interactions are taking place per year. Although presenting the technology to a potential licensee has a mode of 1 meaning that some TTOs are making 1 up to 6 presentations to potential licensee, which might be an interaction requiring improvement by Portuguese TTOs.
- g) (1) Being contacted by a technology transfer professional from another University to get support licensing it and (2) Contact a technology transfer professional from another University to get support on licensing it – these two interactions are least frequent among the Portuguese TTOs, which might denote some lack of interaction between University technology transfer offices.

These interactions have implications on knowledge exchange and the data suggests that the Portuguese TTOs under analysis have some positive indicators regarding their interactions with the researchers and industry, denoting their relevance in early collaborations with industry to support the development of research projects and in pos-project valorization to support technical solutions demonstration, pilot testing in companies and on the establishment of licensing agreements, although, making presentations with the intent of licensing technology is an indicator that seems to denote a need for improvement, the same applies to the interaction between the University TTOs.

4.2. Technology transfer offices contacts and information that have an impact on getting licensing agreements

Technology transfer offices will be working with researchers and networks of contacts to convey scientific and technological results to industry to make them available to people and organizations that can gain advantages from their application and that can generate wealth and money for the parts engaged on the technology transfer process. To this end, TTOs invest time and effort on making contacts and on the analysis of market information. Table 4 presents the frequency of contacts and information that have an impact on getting licensing agreements by Portuguese TTOs.

The data that has been gathered lets us know that the most frequent contacts and information that have an impact on getting technology transfer agreements are, in descendent order:

- a) (1) Contact with Portuguese companies, this is the most frequent contact leading to the establishment of valorization agreements; closely followed by (2) establishing contacts with companies known by the researchers.
- b) Contact with companies from other countries, also play a relevant role in technology transfer.
- c) (1) Contact with large companies; (2) the researchers contact with R&D people from companies; and (3) existing collaboration agreements, are also frequent, (4) contact with small businesses, almost pair wises with the frequency of contacts with large companies.
- d) (1) Contact of companies that became aware of the technology in articles published on websites or specialized journals, is reported as being a frequent information at the origin of transfer agreements, the same frequency is reported regarding (2) the contact with companies based in the region where the university is located; (3) contact with university graduates working in business sectors targeted by the technology and (4) previous licensing agreements, are also frequent although not as frequent as the previous two.
- e) (1) Agreements resulting from public presentations of research results either by the inventors or the TTOs are reported as not frequent.
- f) (1) Contact from companies that got information from patent directories; (2) Participation in international technology transfer fairs; and (3) contact of companies that got information about the technology from the TTOs website are also not frequent.

Signing an agreement crystallizes the value of a technology and understanding what interactions can lead to a licensing agreement may prove useful to redirect our valorization efforts.

The data that has been gathered regarding contacts and information that have an impact on getting licensing agreements by Portuguese TTOs suggests that the contacts established with companies known by the researchers play

a relevant role in technology transfer and that contacts with both national and international companies are valuable. The researchers contact with R&D people from companies is also key on reaching licensing agreements, as well as existing collaborations with industry. The inventors’ engagement and the established collaborations with industry does seems to be at the success of technology transfer as suggested by Wu, Welch & Huang, 2015 [30].

Table 4. technology transfer offices contacts and information that have an impact on getting technology transfer agreements

Contacts and information at the origin of licensing agreements	Average	Std.Dev	Mode	Median	Min	Max
Contact with Portuguese companies	4.1	1.1	4&5*	4	2	5
Contact of companies known by the researchers	3.7	1.4	4	4	1	5
Contact with companies from other countries	3.6	1.0	4	4	2	5
Contact with large companies	3.3	0.8	3	3	3	5
Researchers' contact with R&D people from companies	3.3	1.3	3	3	1	5
Existing collaboration agreements with companies	3.3	1.1	4	4	1	4
Contact with small businesses	3.2	1.2	4	4	1	4
Contact of companies that became aware of the technology in articles published on websites or specialized journals	3.1	1.1	3	3	2	5
Contact with companies based in the region where the university is located	3.1	1.6	2&5*	3	1	5
Contact with university graduates working in business sectors targeted by the technology	2.8	1.2	2	2.5	2	5
Previous licensing agreements	2.7	1.5	1&3*	3	1	5
Agreements resulting from public presentations by inventors of their research results	2.4	1.1	3	3	1	4
Agreements resulting from public presentations of research results by the Technology Transfer Office	2.1	1.1	2	2	1	4
Contact from companies that got information from patent directories	2.0	0.8	2	2	1	3
Participation in international technology transfer fairs	2.0	0.6	2	2	1	3
Contact of companies that got information about the technology from the University Technology Transfer Office website	1.9	0.7	2	2	1	3

*there is more than one mode

	Does not happen	Not frequent	Frequent	Quite frequent	Very frequent
Frequency scale	1	2	3	4	5

4. Conclusion

To understand practices leading to licensing agreements, information has been gathered regarding Portuguese University technology transfer offices interactions to ensure knowledge exchange, and to identify the main sources of contacts that have an impact on getting licensing agreements.

From the analysis of knowledge exchange interactions we can conclude that the following six are the most frequent ones, meaning that more than nineteen interactions are established per year on each one: (1) Meeting with a researcher or research team to discuss the innovation potential of their work and the possibility of working with industry; (2) Receiving a contact from a company looking for support to develop an idea or to solve a specific problem; (3) Contact companies to discuss the possibility of developing projects in cooperation with the University; (4) Meeting with researchers to define research lines and projects with potential for innovation and of interest for a particular industry or company; (5) Receiving a contact from a company that wants to know what works are in progress in a particular research area at the University and (6) Receiving contacts from companies interested in developing a project in co-promotion to benefit from public funding programs.

The data suggests that the Portuguese TTOs under analysis have a frequent interaction with researchers and industry to support the development of research projects and in pos-project valorization. The data also denotes that there is not a frequent interaction between University technology transfer offices.

From the analysis of contacts and information that have an impact on getting licensing agreements we can conclude that companies known by the researchers play a relevant role in technology transfer and that contacts with both national and international companies are valuable. The researchers contact with R&D people from companies is also key on reaching licensing agreements, as well as existing collaborations with industry.

These results and the literature review on contributing factors to exchange knowledge and technology provide a baseline to understand underlining interactions and factors at the origin of licensing agreements that can create wealth for people and organizations willing to take the challenge of integrating and commercializing new developments and technology.

Acknowledgement

This work was funded by national funds, through the FCT – Fundação para a Ciência e Tecnologia and FCT/MCTES in the scope of the project UIDB/05549/2020.

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