University technology transfer: assessment of invention disclosures by technology transfer offices

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Abstract: University technology transfer offices (TTOs) encourage researchers to disclose their inventive results to assess their novelty, industrial applicability, and inventive step to protect and devise a plan to gather the necessary resources for its deployment. To describe the invention disclosure process and to gain knowledge about assessment practices to understand the invention, its market, potential for transfer, and accessibility to finance, Portuguese university TTOs were asked to provide information on their internal processes through a semi-structured survey. The most frequent practices have been identified, including, the analysis of all the technology applications, the assessment of the technology readiness level, patentability, strength of its claims, and protection costs; assessment of the extent of technology demand and potential licensees; and analysis of available sources of finance. The approach was essentially descriptive and exploratory to convey information on how to proceed to guide the initial evaluation that triggers the valorisation process.

Keywords: technology transfer; intellectual property rights; university-industry relations; assessment practices; licensing.

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1 Introduction

University technology transfer offices (TTOs) are committed to knowledge exchange between universities and businesses to create wealth for the university and for those able to use knowledge and technical solutions that can advance science, people skills, and future discoveries. This exchange about science, technology, humanities, or new ideas, is described by the UK Higher Education and Research Act, 2007 as a process or activity that contributes, or is likely to contribute, directly or indirectly, to an economic or social benefit (HERA, 2017).

This article aims to describe the invention disclosure process and to gain knowledge about practices carried out by Portuguese university TTOs to assess the value of the disclosed inventions, which have the potential to create utility to those that are directly or indirectly involved in the knowledge exchange process.

Utility can be expressed as benefits that go beyond the opportunity of making money, and it usually involves performing a technical and market assessment, protecting intellectual property rights, promoting, negotiating, and reaching a commercial deal for a technical solution that is novel, has industrial applicability and involving an inventive step that moves knowledge and technology forward (Hockaday, 2020).

In this study information has been collected regarding four dimensions:

1 the technology, aimed to understand the invention
2 the market, aimed to understand the invention market
3 the licensees, aimed to determine who may want the technology
4 financial considerations, aimed to get to know investment analyses practices.

2 Methodology

A semi-structured survey has been used to collect information among eight Portuguese University 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.

The information has been provided by the TTOs head of staff.

Five out of the eight universities appear regularly in world rankings of the top 1,000 universities (CWUR, 2021). The semi-structured survey was divided into two parts: one focused on the frequency of use of invention disclosure assessment practices, and the other one on the frequency of use of evaluation methods. This article focuses on the data from part one of the semi-structured survey. A rating scale, ranging from 1 to 5 has been used, where 1 corresponded to 'was never used' and 5 'very frequently used'. The approach was exploratory and descriptive, but also analytical in the sense that it states the issues at stake when assessing invention disclosures. The option for using a descriptive analysis was to make the data presentation very objective since the sample is relatively narrow focusing on eight Portuguese public university TTOs. Despite the narrower sample, the goal of gaining knowledge about practices carried out by Portuguese university TTOs to assess invention disclosures has been accomplished. In the future, subsequent work will be done to include data from university TTOs in other European countries.

3 Invention disclosure and assessment process

Technology transfer "refers to the process of conveying results stemming from scientific and technological research to the marketplace and wider society, along with associated skills and procedures, and it is as such, an intrinsic part of the technological innovation process" (CCTT, 2021). The technology innovation process links project outcomes to their application making them available to people and industry to derive value from their use.

Technology transfer benefits go well beyond the opportunity of making money. They can generate wealth for people and organisations that are able to use knowledge and technical solutions that can advance science, people skills, and future discoveries (Hockaday, 2020).

The main purpose of university TTOs is to transfer research and development outcomes from the university out to businesses and to encourage the researchers to

engage with the TTO in developing opportunities that are meaningful to industry and that can be commercially exploited (Fitzgerald and Cunningham, 2016).

To foster technology transfer, innovation, and the TTOs professionalisation, the Joint Research Centre (JRC) of the European Commission, created in 2018, the Competence Centre on Technology Transfer (CC TT), which provides policy-related expertise and supports TTOs in three key areas: capacity building and operational support, financing instruments and support to innovation systems and clusters[1]. This expertise is reinforced by its articulation with the European Technology Transfer Office Circle (TTO Circle).

The TTO Circle is a network established, in 2011, to bring together TTOs of Europe's largest public research organisations, to share best-practices, knowledge, expertise, perform joint activities, and develop common approaches toward the professionalisation of technology transfer, to create the right conditions to develop scientific and commercial innovations[2].

Further, an Alliance of Technology Transfer Professionals (ATTP), has been formed, in 2010, bringing together the Association of Science and Technology Professionals (ASTP), the Association of University Technology Managers (AUTM), among other technology transfer support organisations, and together they develop standards and recognise technology transfer professionals (RTTP)[3].

These organisations create policies and standards, provide mutual support among TTOs, and professionalise technology transfer professionals, to work closely with researchers, industries, and governments.

University TTOs must encourage researchers to disclose their inventive results to assess their novelty, i.e., to verify if the results are substantially different from anything else that is public knowledge, if it has industrial applicability and if a significant inventive step has been achieved, meaning that the invention must not be perceived as obvious by an expert in that particular field (USPTO, 2020), and to assess if it can generate profit.

This disclosure can either be done directly to the TTO or by filling out an invention disclosure form. This form usually requires information about the invention, claims, possible applications, development stage, market potential, parts that have been enrolled in the achievement of the invention, including sources of finance, publications done or planned to be disclosed, references to publications and patents with similar or convergent purposes, and the indication of firms that might be interested in licensing the technical solution (Wirz et al., 2019; Walter et al., 2018). The invention disclosure form complexity cannot be an inhibiting factor in the participation of the researchers in the technology transfer process, it must be simple and must allow the research team to document the invention. More detailed information can be obtained in subsequent meetings with the TTO (Young, 2007).

Upon receiving the invention disclosure, the assessment process starts, consisting of a combination of hard and soft factors (Hockaday, 2020). Hard-factors include the scale of addressable market, intellectual property rights assessment and scope, including patent search and patent mapping to identify the landscape of patents in a certain technology field. Soft-factors include the enthusiasm of the research team and individuals involved, experience on similar valorisation projects, and willingness to actively participate in the technology transfer process, by either committing to further developments or actively searching for licensees or creating a spin-off firm to exploit the inventive results.

Triage is used to decide which disclosures must be prioritised and receive more attention to allocate the TTOs scarce resources and time, and also to commit money to

patent protection (Hockaday, 2020; Powers and McDougall, 2005). TTOs must manage the university patent budget which will be used to file patent applications and to manage the protection process until the patent is granted or withdrawn.

University patent budget and triage raise the question of selectivity and its significance to intellectual property rights (IPR) protection. Selectivity on patent applications has a major impact on the TTOs performance (Powers and McDougall, 2005). A large patent portfolio requires greater resources and eventually, there may be a need to concentrate the commercialisation efforts on a reduced number of technologies to bet on those that have a stronger bound to market and profitability (Gardiner, 1997). Technology transfer professionals must be prepared to spend time, effort and money on assessing invention disclosures to select the ones that can generate greater profits and wealth (Dodds and Somersalo, 2007). The selection process implies carrying out a diligent assessment to ensure the researchers' commitment to continue their work with the TTO in further developments and future disclosures, since the number of invention disclosures, and the money and available funds for R&D, influence the number of licensing agreements (Chapple et al., 2005), the researchers' share of licensing revenue and other non-economic benefits of patent grant, transfer and diffusion, which also have a positive impact on the number of invention disclosures and on the amount of effort researchers commit to work on technology transfer of their R&D outcomes (Chang et al., 2015).

When there is an effective and credible collaboration between researchers and TTOs patent application figures tend to be higher (Saragossi and Potterie, 2003), and there seems to be a correlation between the development of significant patent portfolios and the number of scientific publications (Godinho et al., 2008). On the other hand, the number of patents does not reflect the impact that a university has on the economy, and the number of patents, on its own, does not describe the nature of the inventions nor their commercial value (Agrawal and Henderson, 2002), which again leads us to the importance of the TTOs' assessment practices to strategically patent those inventions that have a stronger bound to market and potential to generate wealth and profitability.

An effective intellectual property management strategy is essential to protect future investments and to unlock the potential of science and technology outcomes. To value those outcomes there are essentially three options: keep the technical solutions as a secret, publish the results or apply for a patent (Hockaday, 2020). Keeping an invention as a secret is not usually an option for the research team since publications are part of their academic performance evaluation, unless they are considering the creation of a spin-off company and counting on it with university support. We should also notice that, in Europe, publishing before applying for a patent means that the invention will belong to the public domain (EPO, 2021), while in the US inventors have a grace period of one year to fill a patent after public disclosure (USPTO, 2020). Keeping an invention a secret is usually a good option when it is perceived that the invention will not create a strong barrier to prevent others from reaching similar results following a different technical approach (Dolfsma, 2011; Nelsen, 1998), or when the invention field moves so fast that it is not worth filling a patent, or when it is very difficult to spot its use by other parts (Nelsen, 1998). Filling a patent application is the protection option that grants exclusive rights for the exploitation of technology and to grant future profits (Howell, 2017), by making it visible and accessible, either on technology transfer websites and databases, such as the Enterprise Europe Network[4] or by attending industry exhibitions and

technology transfer events, but most of all, by contacting potential licensees and collaboration partners.

Possible valorisation paths are licensing, selling IPR, the creation of a spin-off company, the establishment of a joint venture, and the establishment of research and cooperation agreements, e.g., CRADAs – cooperation research and development agreements, MTAs – material transfer agreements and NDAs – non-disclosure agreements, the latter allowing the institution to keep control over the technology and at the same time to access resources and knowledge from third parties, to continue or to develop new projects or R&D stages (Thalhammer-Reyero, 2008). To further advance knowledge and technology, collaboration and consortium agreements can be pursued. Collaboration agreements can be established to obtain the invention proof-of-concept or develop it into a new product or integrate it into a system, solve a particular problem, or reach the desired feature or technological advancement. Collaborations grant access to knowledge, skills, and intellectual property rights, usually under non-disclosure agreements and intellectual property rights provisions regarding co-ownership of research results. Consortium agreements bring together many parties such as companies, research labs and universities, adding complexity to intellectual property rights management, but they also provide a ground for a more successful technology transfer due to the involvement of industrial companies and partners (Hsu et al., 2015).

By considering the protection strategy and possible valorisation paths the TTOs proceed with the assessment of the invention disclosure to understand the invention, its market and potential for profit, and conduct patent searches. Searching for patents is a good practice before starting and after concluding a project. The good use of patent directories may reduce the time and costs of R&D projects (Smith, 2005). Patent databases provide valuable information about the invention field and related concepts and inventions aiming at convergent or similar outcomes. Amongst the technology and market assessment tools most used by TTOs are checklists and pre-defined evaluation models to perform a quick assessment aiming to identify potential markets, end users, potential licensees and to guide the establishment of contacts with experts in the industrial field, potential investors and companies. IPscore, available on the website of the European Patent Office[2] is one tool that aims to support a quick assessment of technologies, research projects before filling a patent application, and patents. IPscore has 32 factors grouped in four categories: legal status, technology, market conditions and finance, and the results are presented in a ranking radar graph. A projection of cash flows, despite its usefulness for some products, is not usually performed when assessing an invention disclosure. TTOs tend to use cash-flow projections when there is a manifestation of interest by an investor to have a baseline to guide the agreement negotiation or when the creation of a spin-off company is being considered (Rocha et al., 2017).

Throughout the assessment process, we must be mindful that many solutions are licensed not because they have a patent or because they have innovative technology but because there is a solution that has been demonstrated and is ready for use (Rocha et al., 2021), so all the necessary steps to reach the invention proof-of-concept and its demonstration reduces the risk perception for potential licensees, making it more valuable (Speser, 2006), which might increase the odds of being licensed. Technical solutions tailor-made to firm needs or with the firms' participation usually set the ground for a more successful technology transfer process (Harmon et al., 1997).

The assessment of invention disclosures is a crucial task to make decisions regarding, the protection of intellectual property rights, further stages of development, and the valorisation paths to reach a commercial deal (Hockaday, 2020). In this article, invention disclosures are addressed from the point of view of Portuguese university TTOs, concerning assessment practices, to figure out which ones are the most frequent in supporting the triage and selection of the most valuable R&D outcomes.

4 Data analysis

To understand universities' technology transfer practices regarding the assessment of invention disclosures and actions taken to value R&D outcomes, information regarding four dimensions was collected, each one targeting a specific question:

1 Technology: what practices are in use to understand the invention?

2 Market: what practices are in use to understand the invention market?

3 Licensees: what practices allow us to determine who may want the technology?

4 Finance: what practices of investment analyses are in use?

4.1 Technology: what practices are in use to understand the invention?

To assess the value of a technical solution, it is important to know every aspect of the invention and all the tasks that are needed to get the technology proof-of-concept. The proof-of-concept is essential to identify its applications, potential market, and profit potential. To this end, university TTOs conduct a series of actions to understand the invention. Table 1 presents the frequency of the actions for which data was collected.

Table 1 Technology: frequency of practices to understand the invention

Technology		*Average*	*Std. dev.*	*Min*	*Max*
1	Assess whether the technology is new or a modification of existing technology	4.1	1.0	3	5
2	Assess the technology readiness level (Little achieved? Reduced to practice? Commercially proven?)	4.1	1.1	2	5
3	Analysis with the research team of all product alternatives and technological applications, seeking to determine which applications or products have a stronger relation between the technology, product and market to define the protection strategy and to identify potential licensees	4.3	0.7	3	5
4	Analysis of competitive and differentiating advantages of the applications and products resulting from the technology	3.9	1.6	1	5

Table 1 Technology: frequency of practices to understand the invention (continued)

	Technology	*Average*	*Std. dev.*	*Min*	*Max*
5	Analysis of the technology characteristics to verify if it can improve development and production factors (avoid or reduce costs, promote stability and/or ease of production, increase scalability and production speed, or improve product quality)	3.8	1.0	2	5
6	Support the identification of new technology development stages and the definition of an action plan to gather the necessary resources for its implementation	3.8	1.0	2	5
7	Assess whether the use of the technology is dependent on the use of other technologies that must be licensed	3.1	1.0	2	5
8	Analysis of the risk associated with the (un)success in the applications and/or products development resulting from the technology	3.1	1.5	1	5
9	Evaluation of the extent to which the technology is complex and difficult to adopt, reproduce or introduce in industrialisation processes	3.1	1.2	1	5
10	Assessment of whether technical assistance from the research team is required to implement the technology on a licensing company, seeking to understand the extent of the intervention, and the team's availability and determination to do so	3.3	1.0	2	5
11	Assess whether the protection of intellectual property rights creates an efficient and effective barrier against current and potential technical alternatives	4.0	0.8	3	5
12	Evaluation of the possibility of the technology being redesigned through concurrent engineering (with what knowledge, at what cost, time, and technical and legal risks)	3.1	1.0	2	5
13	Identification of similar and competing R&D teams and activities	2.9	1.2	1	5
14	Assessment of whether intellectual property rights can be challenged, and if they can be easily defended, having into account the university resources to respond in case of litigation	3.0	1.4	1	5

The data that has been gathered reveals that the most frequent practices to understand the technology includes the following ones. A short remark of its importance is made for each practice.

- Analysis with the research team of all product alternatives and technological applications – to determine which applications or products have a stronger relation between the technology, product and market to define the protection strategy and to identify potential licensees – this practice is closely connected with the TEC algorithm approach (technology, entrepreneurship and commercialisation algorithm) that can be used to analyse the technology alternative applications to determine

which have a stronger link between technology, product and market (T-P-M) to relate the technology capabilities to product concepts and to the customers' actual needs to determine which constructs are most valuable for market niches (Schiltz, 2019).

- Assessment of whether the technology is new or a modification of existing technology – to determine its level of novelty and inventive step that moves knowledge and technology forward to determine if the results are patentable or not and if we are talking about a radical or incremental invention.
- Assessment of the technology readiness level, if it is little achieved, reduced to practice, or if it is commercially proven – it is crucial to identify further stages of development (if needed) to devise an action plan to gather the necessary resources for its deployment and to map out the industrial valorisation actions to bring the technology to market.
- Assessment of whether the protection of intellectual property rights can create an efficient and effective barrier against current and potential technical alternatives – to assess the possible strength of a patent for the technology to generate profit and to stand against possible litigation actions.
- Analysis of the competitive and differentiating advantages of the applications and products resulting from the technology – to identify where its uniqueness and differentiating advantages can make the invention stand out and be ahead of possible alternatives.
- Analysis of the technology characteristics to verify if it can improve development and production factors, such as avoiding or reducing costs, increases stability and/or ease of production, if it increases scalability and production speed, or improves product quality.
- Assessment of whether technical assistance from the research team is required to implement the technology on a licensing company seeking to understand the extent of the intervention, and the team's availability and determination to do so.
- Assessment of whether the use of the technology is dependent on the use of other technologies that must be licensed.

Understanding the invention is essential to bring the technology to market and all the above-presented assessment practices are frequently used by TTOs to figure out what the technology has to offer and how can the inventive results be protected to devise a valorisation plan and make good use of the disclosed results.

4.2 Market: what practices are in use to understand the invention market?

The market study is the starting point to understand the potential invention market and analyse the relations between the technology, its applications, and its market niches, identifying consumers, concurrent applications (if any), and companies. The information collected leads to the preparation of the invention value proposition, which will be used for internal and external marketing purposes, to devise and explore a route to market, and

when successful, leads to transferring the technology to an existent organisation, or to the creation of a start-up or spin-off company (Hockaday, 2020).

To this end, university TTOs conduct a series of actions to understand the invention market. Table 2 presents the frequency of the actions for which data was collected.

Table 2 Market: frequency of practices to understand the invention market

Market		*Average*	*Std. dev.*	*Min*	*Max*
15	Assessment of the time needed to get an industrial and commercially viable application or product	3.6	1.1	2	5
16	Assessment of the extent of technology demand from companies or from target markets (market pull)	4.0	1.1	2	5
17	Analysis of the technology applications and/or products' value and usefulness to meet companies and end users' needs, trends and expectations	3.4	1.2	2	5
18	Analysis of the market size and location, expected sales forecast, and the market growth potential for the technology-derived applications	3.4	0.9	2	5
19	Performing a demand forecast for the technology-derived applications in the market niche of targeted companies	3.0	1.3	2	5
20	Identification and analysis of similar and competing product specifications, prices, and value attributed by consumers	3.0	1.3	2	5
21	Assessment of the market exclusivity degree offered by the technology in regard to competing solutions	3.0	1.1	2	5
22	Preparation of the technology value proposition	4.0	1.3	2	5
23	Preparation of information for technology marketing	3.6	1.1	2	5
24	Foreseeing the technology lifecycle taking into account the technology substitution dynamics within specific market sectors	2.6	1.3	1	5
25	Identifying:	3.3	1.5	1	5
	a what factors can instigate an organisation to adopt the technology				
	b what factors hinder the technology adoption and/or licensing.				

The data that has been gathered reveals that the most frequent practices to understand the technology market includes the following ones. A short remark of its importance is made for each practice.

- Assessment of the extent of technology demand from target markets (market pull) – if the technology is in demand it means it is desirable and worth having and, as such, it has the potential to make money and generate value and utility.

- Preparation of the technology value proposition and marketing information – the value proposition is used for marketing purposes and consists of a clear statement that describes the technology uniqueness, applications, capabilities and next steps for being used (Rocha et al., 2022).
- Assessment of the time needed to get an industrial and commercially viable application or product – the market readiness level will help to get a handle on how far from the market the invention is, and if it has been demonstrated on the ground, to identify and contact those who might want the technology (Speser, 2006).
- Analysis of the technology applications and/or products' value and usefulness to meet companies and end users' needs, trends and expectations – if it is possible to meet consumers' needs, trends and expectations, the invention expresses utility, but without market research little can be said about end users' predisposition to get the solution. Positioning the solution against other consumer factors will help to figure out if it has actual value given its features, quality, performance, accessibility, ease of use, price, aesthetics, and other differentiating factors from other available alternatives including brand loyalty that conditions the success of new solutions entering the market.
- Analysis of the market size and location, expected sales forecast, and the market growth potential for the technology-derived applications – a technology might appeal to a large market, but specific market niches that can grant profit must be identified, to decide which organisations will be the target of our technology marketing efforts.
- Identification of factors that can instigate an organisation to adopt the technology, and factors that can hinder the technology adoption and/or licensing – it is important to consider organisations that are looking to replace or update existing products or looking to improve or diversify their product specifications and range, it is also advisable to pay attention to patents and articles growth rate in a given area, and identify organisations that might be exporting and importing technology, and determine the industrial importance of different patent subclasses. Additionally, it is desirable to see an alignment between technology characteristics and the capabilities and resources of the firms. In other words, it is important to understand how the technology fits within the firms' technology and market space with whom negotiation will take place. Another important remark is related to the timing of the technology release, and ideally, the solution should be timed with the firms' product replacement or update cycles, because if a firm replaces a product too early it may incur in high changeover costs and if it replaces a product too late it may lose market share.

Understanding the invention market is essential to define a marketing strategy and to establish contacts with potential licensees and other stakeholders to make the most of the disclosed inventive results.

4.3 Licensees: what practices allow us to determine who may want the technology?

To identify potential licensors, it is important not only to describe the technology and its market, but also to identify the resources and skills that are needed for the next stages of

development and application. A good licensor or technology partner must be capable to complement our resources and skills to move the technology forward. While identifying potential licensees' consideration must be made of what is needed from potential R&D and innovation partners, to figure out, how the technology will fit into their technological space that will make it, not only valuable but also transferable. To this end, university TTOs conduct a series of actions to determine who may want the technology and can add valuable inputs to it. Table 3 presents the frequency of the actions for which data was collected.

Table 3 Licensees: frequency of practices to determine who may want the technology

Licensees		*Average*	*Std. dev.*	*Min*	*Max*
26	Identification and selection of organisations interested in the technology	3.9	1.1	2	5
27	Assessment of the usefulness and need of the technology for the firms' operations and/or industrialisation processes	3.1	1.0	2	5
28	Analysis of potential licensees' strategic orientation – if they are pioneers or reactive, and if they are importers or exporters of technology	3.1	0.8	2	5
29	Assessment of industries' predisposition to adopt the technology	3.4	1.3	2	5
30	Analysis and description of the R&D and production capabilities required for the development and production of the technology and its applications and/or products	3.1	1.1	2	5
31	Analysis of how easy is to produce the technology using available equipment in the targeted industry	2.6	1.2	1	5
32	Assessment of the possibility of integrating the technology into existing systems, products and/or processes	3.3	1.0	2	5
33	Assessment of R&D, production, marketing, and sales capabilities of companies targeted by the technology	3.3	1.0	2	5
34	Analysis of the market share of companies in the segments targeted by the technology	2.6	1.1	2	5
35	Identification of the nature and extent of competition that licensee companies will face	2.8	1.2	2	5
36	Analysis of the possibility of establishing partnerships between two or more companies for the development, production, marketing, and sales of products derived from the technology to reduce time-to- market and increase market share.	2.6	1.3	1	5

The data that has been gathered reveals that the most frequent practices to identify who may want the technology, and can add valuable inputs to it, includes the following ones. A short remark of its importance is made, when relevant.

- identification and selection of organisations interested in the technology and assessment of industries' predisposition to adopt the technology
- assessment of R&D, production, marketing, and sales capabilities of companies targeted by the technology – to match the technology with the means for the next stages of development or commercialisation
- assessment of the usefulness and need of the technology for the firms' operations and/or industrialisation processes – to direct marketing efforts to those companies that may value new technology to maintain or acquire competitive advantages
- analysis of potential licensees' strategic orientation, if they are pioneers or reactive, and if they are importers or exporters of technology – to direct the technology value proposition to those companies that may be willing to license and invest in it in compliance with their innovation strategy
- analysis and description of the R&D and production capabilities required for the development and production of the technology and its applications and/or products to find an alignment between the technology characteristics and the capabilities and resources of the firms with whom it is desirable to reach a valuable deal.

Reaching out relevant potential partners that can leverage the technical solutions is essential for the technology transfer success, and knowing the requirements to advance the technology and make a profit from it, is a baseline to reach out and start conversations that may lead to negotiations and a commercial deal.

4.4 Finance: what practices of investment analysis are in use?

Valuing a technology involves making investment decisions regarding the protection of intellectual property rights, prosecution of new development stages, and structuring it up to be integrated and scalable in manufacturing or distribution processes, to reach a deal that will yield profit for the parts involved in the technology transfer process.

To carry out and make these investment decisions, University TTOs conduct a series of actions to assess the potential for profit and how to gain the needed resources for a successful technology valorisation. Table 4 presents the frequency of those actions for which data was collected.

Table 4 Finance: frequency of practices to assess profit potential and needed resources

	Financial considerations	*Average*	*Std. dev.*	*Min*	*Max*
37	Analysis of the technology potential to generate profit for a specific company	3.4	0.9	2	5
38	Analysis of how much is necessary to invest in the technology to obtain an industrial and commercially viable application or product	3.4	0.9	2	5
39	Identification of available public funding sources to continue the technology development	4.1	1.0	3	5
40	Evaluation, before applying for a patent, of the likelihood of getting financial support from companies for further developments and commercialisation	2.8	1.2	1	5

Table 4 Finance: frequency of practices to assess profit potential and needed resources (continued)

Financial considerations		*Average*	*Std. dev.*	*Min*	*Max*
41	Analysis of the possibility of licensing the technology to an organisation that assumes the costs of later developments	4.0	0.8	3	5
42	Assessment of the investment risk considering the technology readiness level	2.8	1.5	1	5
43	Assessment of the markets economy performance, that will be targeted by the technology	2.9	1.0	2	5
44	Assessment of how much a licensee will have to invest to have an application or product ready for market	2.6	1.1	2	5
45	Prospecting the expected profit or savings by a potential licensee	2.8	1.2	2	5
46	Performing a discounted cash-flow projection to determine the net present value, pay-back period, and return on investment	2.5	1.1	2	5
47	Assessment of the technology development costs incurred by the University	3.8	1.0	2	5
48	Assessment of the patent application and management costs before its submission	3.9	1.1	2	5
49	Prospecting the University profit from a knowledge and technology transfer agreement	3.4	1.1	2	5
50	Analysis of the possibility of the university acquiring an equity share in a company wanting to license the technology (including a start-up or academic spin-off)	1.9	0.8	1	3

The data that has been gathered reveals that the most frequent practices to assess the profit potential and how to gain the needed financial resources include the following ones:

- identification of available public funding sources to continue the technology development
- analysis of the possibility of licensing the technology to an organisation that assumes the costs of later developments
- assessment of the patent application and management costs before its submission
- analysis of the technology potential to generate profit for a specific company
- analysis of how much is necessary to invest in the technology to obtain an industrial and commercially viable application or product
- prospecting the university profit from a valorisation agreement.

The above actions to address financial considerations will support decision-investments, under budget constraints, to move the technology into further development stages, devise

an intellectual property rights strategy, and ramp up its valorisation, to reach a balanced deal that makes sense either for the licensee and the licensor.

5 Conclusions

To understand university technology transfer practices regarding the assessment of invention disclosures and actions taken to value R&D outcomes, information regarding four dimensions was collected, each one targeting a specific question:

1 Technology: what practices are in use to understand the invention?

2 Market: what practices are in use to understand the invention market?

3 Licensees: what practices allow us to determine who may want the technology?

4 Finance: what practices of investment analyses are in use?

From the analysis of the frequency of use of assessment practices we can conclude that overall the ten most frequent practices are:

1 analysis of all product alternatives and applications, seeking to determine which ones have a stronger relation between the technology, the product and the market to define the protection strategy and to identify potential licensees

2 assessment of whether the technology is new or a modification of an existing technology

3 assessment of the technology readiness level

4 assessment of whether the protection of IPR creates an effective barrier against current and potential technical alternatives

5 assessment of the extent of technology demand from companies or from target markets

6 preparation of the technology value proposition

7 identification and selection of organisations interested in the technology

8 identification of available public funding sources to continue technology development

9 analysis of the possibility of licensing the technology to an organisation that assumes the costs of later developments

10 assessment of the patent application and management costs before its submission.

The analysis of these practices provides a baseline to be more effective when assessing invention disclosures, to gain value from results stemming from scientific and technological research that must be transferred to the marketplace and the wider society, and to create wealth for people and organisations that are able to use knowledge and technical solutions that can advance science, people skills, and future discoveries.

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