SILESIAN UNIVERSITY OF TECHNOLOGY PUBLISHING HOUSE

SCIENTIFIC PAPERS OF SILESIAN UNIVERSITY OF TECHNOLOGY 2023
ORGANIZATION AND MANAGEMENT SERIES NO. 189

KNOWLEDGE TRANSFER ACTIVITIES IN UNIVERSITY

Arkadiusz SZMAL

Silesian University of Technology; arkadiusz.szmal@polsl.pl, ORCID: 0000-0001-6395-618X

Purpose: The purpose of this article is to review the literature and the activities and resources of technology transfer offices at the European level. A comparison of the literature and the practical, applied by the KTOs, approach to knowledge transfer made it possible to formulate reflections that can be used in shaping improvements.
Design/methodology/approach: The literature review on knowledge transfer was conducted using the desk research method. Searches in the databases above complemented the literature collected for the following keywords: Knowledge transfer, knowledge transfer resources and activities, forms of knowledge transfer, knowledge transfer methods, knowledge commercialization. The article uses the ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe, an industry report. The report is based on data from 519 knowledge transfer offices (KTOs) from 26 countries for fiscal year 2019.
Findings: The work indicates that there is great interest among researchers in knowledge transfer. This is related to the development of the knowledge economy. At the same time, a review of the activities and resources of technology transfer offices at the European level shows a wide variation in activities, resources and the results achieved. More accurate predictions of the motivations and decision-making approaches of academics involved in knowledge transfer and co-creation are needed.
Originality/value: The article shows the differences between the literature approach and the one used by KTO for knowledge transfer at the European level. The reflections can be used in shaping improvements in activities for increasing the commercialization of knowledge created at universities.

Keywords: Knowledge transfer, knowledge transfer resources and activities, or, forms of knowledge transfer, knowledge transfer methods, knowledge commercialization.

Category of the paper: General review.

1. Introduction

Building a competitive economy, a knowledge-based economy, requires that the process include efficient access to scientific achievements as a source of new knowledge (Kapetaniou, Lee, 2017). Knowledge transfer is a phenomenon that drives the development of innovation (Brzóska, Szmal, 2020), giving impetus to social and technological development. Knowledge transfer occurs largely through innovation systems, which consists of two main types of actors and interactions between them (Szmal, 2017). The first group includes companies that use innovations and ultimately create value. The second type of actors includes organizations that build the infrastructure necessary for innovation development. Despite, the introduction of innovation ecosystems, so-called innovation brokers, difficulties and limitations in the effective flow of knowledge are still observed.

There is a debate in the literature as to the competence (Klimkiewicz et al., 2022) scope of knowledge brokers in the innovation system, the experiences and challenges they face (Szmal, Janiszewski, 2018). Kauffeld-Monz and Fritsch (2013), studied brokers of the regional innovation system in terms of their tendency to focus on social benefits, (manifested in the desire to transfer knowledge to others) and private benefits (manifested in the desire to acquire knowledge from others). Intermediaries, functioning both within the organization and in the inter-organizational space, are tasked with the following functions: seeking relevant knowledge from external sources, translating complex knowledge so that it can be understood, and sharing accumulated knowledge using formal or informal mechanisms (Morrison, 2008, p. 820). It is crucial to properly frame the aspect of inter-organizational cooperation (Czakon, 2018) in the optics of knowledge transfer actors' activities and resources. Many researchers around the world have studied knowledge transfer offices (KTOs) as intermediaries between providers of knowledge and inventions (i.e., university researchers) and entities that can commercialize these results (i.e., companies, entrepreneurs and venture capitalists). KTO can help sustain economic and technological growth by improving university-industry relations (Chau et al., 2017; Villani et al., 2017), as well as commercializing academic research toward possible market innovations by licensing university patents and/or creating spin-offs (Brescia et al., 2016; Zhou, Tang, 2020). Because the activities undertaken by KTO face many barriers, the article undertakes a discussion of selected aspects of technology transfer offices.

The purpose of this article is to review the literature and the activities and resources of technology transfer offices at the European level. A comparison of the literature and the practical, applied by the KTOs, approach to knowledge transfer made it possible to formulate reflections that can be used in shaping improvements.

2. Research model

The literature review on knowledge transfer was conducted using the desk research method. The bibliography includes 39 items, mainly from 2002-2023, including academic articles, books, monograph chapters, industry reports and electronic sources. The following databases were used to collect scientific literature: Google Scholar, ResearchGate, ScienceDirect, EBSCO. The following combination of words using Boolean operators (AND, OR) was used in the literature search in the databases above: ('Knowledge transfer' OR knowledge commercialization) AND (resources OR 'activities'). Searches in the databases above complemented the literature collected for the following keywords: Knowledge transfer, knowledge transfer resources and activities, forms of knowledge transfer, knowledge transfer methods, knowledge commercialization.

The paper uses industry report ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe. ASTP is a pan-European association of knowledge transfer (KT) professionals whose main mission is to share best practices and enhance competence among KT professionals. The report is based on data from 519 Knowledge Transfer Offices (KTOs) across 26 countries for Financial Year (FY) 2019. This is the latest available report. The data was collected from two different sources: (1) data provided by individual Knowledge Transfer Offices who uploaded their replies directly through online survey (2) data from National Associations that conducted their own national surveys and provided ASTP with their data. Data collection started on January 2021 and closed initially on March 2021. A survey of 26 questions was used to gather information. In addition, the article uses information obtained from The Polish Association of Centers for Technology Transfer (PACTT.pl) is a voluntary association of representative units of Polish universities responsible for the protection, management and commercialization of university Intellectual Property (IP). The alliance is nationwide and currently has more than 80 members.

3. Knowledge transfer - selected problems

Knowledge transfer (KT) refers to the many ways in which knowledge from universities and public research institutions can be used by companies and other organizations to generate economic and social value and industry development (OECD, 2013). Their current role increasingly complements the traditional mission of teaching and research with interactions with industry and society (Kapetaniou, Lee, 2017). It encompasses a wide range of activities that support collaboration between universities, industry and the public sector, and includes a variety of purposes, modes and channels. Understanding the role of universities in this way

has attracted considerable attention from researchers and policymakers (Hsu et al., 2015; Trune, Goslin, 1998). While early research focused mainly on the goals of commercializing university-generated intellectual property rights (with a primary focus on patents and licensing activities), later research has emphasized additional missions, such as providing services to faculty, enhancing innovation and practical application of research results, supporting local economic development, complying with national and institutional policies, and promoting public value (Bozeman et al., 2015). Such an orientation is in line with the definition of KT activities, which by their very nature target a wide range of stakeholders with different goals and expectations (researchers, TTO managers, PRO administrators, industry, investors and decision-makers at regional, national and international levels).

Universities play a key role as independent knowledge institutions (Giuri et al., 2019). Their overarching goal is to ensure that their graduates develop the skills they need to prosper in their future work and to be open to collaboration with external stakeholders when it comes to KT (Meissner, Shmatko, 2017). Therefore, it is reasonable for universities to improve and adapt their management models to the changing landscape of the labor market and the processes of knowledge generation and diffusion. This is especially true with regard to KT activities. In fact, while universities typically serve all of KT's missions, management practices should be carefully considered, as they appear to serve different purposes (Benassi et al., 2017). In particular, several researchers and practitioners have stressed that universities should adopt a specific strategic approach to more clearly define a set of institutional goals and priorities, and then try to implement consistent actions to achieve such goals (Feldman et al., 2002; Sharer, Faley, 2008; Siegel et al., 2007). Siegel et al. (2007) argue that universities should make strategic choices about institutional goals and priorities at TCs to guide resource allocation decisions and choices about the mode of commercialization they want to emphasize.

Building on the insights of literature, Giuri at al. (2019) identify three strategic configurations of universities in the area of KT, depending on the emphasis that they devote to a specific set of KT priorities:

- Income-generation strategy - the major emphasis of the university and its TTO is on maximizing the stream of revenues that can be generated from the commercialization of ideas and inventions that are disclosed from research to industry (Axanova, 2012; Sharer, Faley, 2008). This approach is based on profit generation, whereby university KT experts collaborate with faculty to generate revenue from research, particularly from licensing agreements and research contracts. The implementation of this strategy demonstrates a strong orientation toward generating patented inventions owned by the university and using them commercially to reap financial benefits. Measures of success for this model focus primarily on revenue streams from licensing agreements or patent sales, as well as revenue derived from research contracts from industry.

- Service-to-faculty strategy - emphasizes the diffusion and practical application of knowledge outside of academia through dedicated support to faculty as a primary mission of KT activities (Sharer, Faley, 2008). In this approach, there is a focus on long-term capacity building at various levels, from the individual scientist to key actors in organizational entities. Emerging social, professional networks or technology communities generate opportunities for research collaboration and professional mobility and reveal possible applications of research results. A TTO that focuses on helping researchers to valorize their discoveries should therefore engage in scouting activities to attract top scientists with commercially focused research projects, respond quickly to faculty inquiries, offer business development assistance to research, and emphasize quick and efficient deal-making in collaboration with industry (Sharer, Faley, 2008). In this model, more emphasis is placed on the number of invention disclosures, the number of inventions that are patented, exposure to research funding, collaboration and network activity, and faculty recruitment and retention, rather than licensing revenue or start-up creation (Axanova, 2012; Batalia, 2006; Rasor, Heller, 2006).
- Local development strategy - emphasizes the attempt to contribute to the growth of the local economic systems where universities are embedded, by generating opportunities for knowledge exchange and new ventures creation (Axanova, 2012; Sharer, Faley, 2008). Universities focus on facilitating the development of technologies that form the basis for new ventures founded by researchers and/or students (start-up, spin-off), as well as the development of technologies that match the potential of local businesses. Universities and TTOs work closely to create partnerships with local public and private entities (establishing local incubators, proof-of-concept programs, accelerator programs, seed funds or industry-sponsored research labs) (Munari et al., 2016, 2018). Success is evidenced by the number of start-ups created by university lecturers or students, the creation of local jobs and the retention of graduates in these positions.

Knowledge transfer offices (KTOs) have become important agents of economic growth, innovation and technological progress (Zhou, 2020). As a result, researchers are paying increasing attention to the activities and performance of KTOs (Belitski et al., 2019). Work is emerging to better understand the motivational aspects of KTO employees - especially the antecedents of such motivation. Focusing on self-determination theory (SDT), we link the three basic needs (relatedness, competence and autonomy) that explain employees' intrinsic motivation with specific antecedents at the university and organizational levels (Pohle, Villani, Grimaldi, 2022). Academics are increasingly engaged in collaboration with companies, and the literature (De Silva et al., 2023) attempts to explain fundamental aspects of this phenomenon, i.e. to investigate the interplay between academic motivations and decision-making approaches and to unpack how resource- and engagement-based arguments could jointly offer a more accurate explanation regarding it. In addition to the creation of spin-offs (e.g. Kowal, Szmal,

2022; Clarysse et al., 2011; Huyghe et al., 2016), knowledge transfer and co-creation have become two of the key and most common activities through which academics interact with companies (De Silva et al., 2021, Klofsten et al., 2019). Knowledge transfer involves the unidirectional transfer of knowledge from academics to enterprises, with the latter independently utilizing such knowledge (Siegel et al., 2007). Knowledge co-creation involves the integration of advanced and up-to-date knowledge held by academics with market and industry know-how held by enterprises to jointly overcome specific challenges and solve problems (De Silva, Rossi, 2018). The intrinsic differences between knowledge transfer and co-creation activities (table 1) mean that the interplay of motivations and decision-making approaches of academics involved in the respective activities may differ (McMullen et al., 2020). Also present in the discussion is work relating to cross-cultural knowledge transfer (Wang et al., 2023) raising awareness of how interdisciplinary this process is.

Table 1.
The key characteristics of knowledge transfer and co-creation

	Knowledge transfer	**Knowledge co-creation**
Key objective	Transferring academic knowledge to businesses, which then use or capitalize on it	Integrating academic and business knowledge to address a specific challenge or opportunity
Role of the partners	Academics produce knowledge, and businesses receive it	Academics and businesses produce knowledge together
Nature of the knowledge	Mainly codified and embedded in artifacts or documents, although some tacit knowledge may be needed for transfer effectiveness	Tacit knowledge is crucial for the co-creation, although the co-created knowledge can become partly codified
Degree of interdependence	Low interdependence	High interdependence
Degree of complexity	Typically low	Usually high
Clarity of the outcomes	The outcomes and their beneficiaries are clearly identified prior to the interaction	Both the outcomes and their beneficiaries are dependent upon a ‘ripple out’ process that is unlikely to be predictable
Linearity of the interaction	A linear model of knowledge transfer	A non-linear, bilateral model of open innovation
Example	Licensing/selling IP; publications	Joint research; joint research labs

Source: De Silva, Al-Tabbaa, Pinto, 2023.

4. Findings - knowledge transfer resources and activities

Based on the theoretical literature review conducted to introduce knowledge transfer activities, this section characterizes the practical resources and activities carried out by knowledge transfer offices (KTOs) in European countries. The report draws on the largest dataset ever available with 519 respondent KTOs from 26 countries. The countries of operation and the number of KTOs that participated in the survey are shown in Table 2.

Table 2.
Overview of ASTP Survey response rates FY2019,2018,2017 and 2016 kraje i liczebność KTO uczestniczących w badaniu

Country	FY2019	FY2018	FY2017	FY2016
	2021 (n = 519)	2020 (n = 512)	2019 (n = 475)	2018(n=474)
United Kingdom	166	165	166	162
Italy	71	62	55	61
Spain	70	71	71	69
France	69	64	52	58
Germany	29	21	12	18
Ireland	25	25	27	24
Denmark	12	13	14	10
Poland	11	15	10	9
Czech Republic	10	10	5	8
Belgium	10	9	9	8
Netherlands	9	10	8	13
Norway	7	7	4	3
Portugal	7	1	2	1
Austria	4	4	2	3
Switzerland	3	12	13	2
Hungary*	3	6	5	4
Finland	3	2	6	5
Slovak Republic	2	1	1	1
Lithuania	1	2	3	4
Turkey	1	2	2	3
Croatia	1	2	1	0
Iceland	1	0	0	0
Luxembourg	1	1	1	1
Malta	1	1	0	1
Romania	1	0	0	0
Slovenia	1	0	0	0
Sweden	0	3	4	4
Serbia	0	1	0	1
Estonia	0	1	0	0
Greece	0	1	0	0
Russia Federation	0	0	2	0
Latvia	0	0	0	1

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

The potential of the KTOs that participated in the survey is synthesized in Figure 1.

In the 519 datasets, not all respondents provided information for all questions in the survey. Therefore, the number of responses to each question is different. The actual number of respondents is shown in the size of the sample for a specific question, denoted by "n=" in each chart.

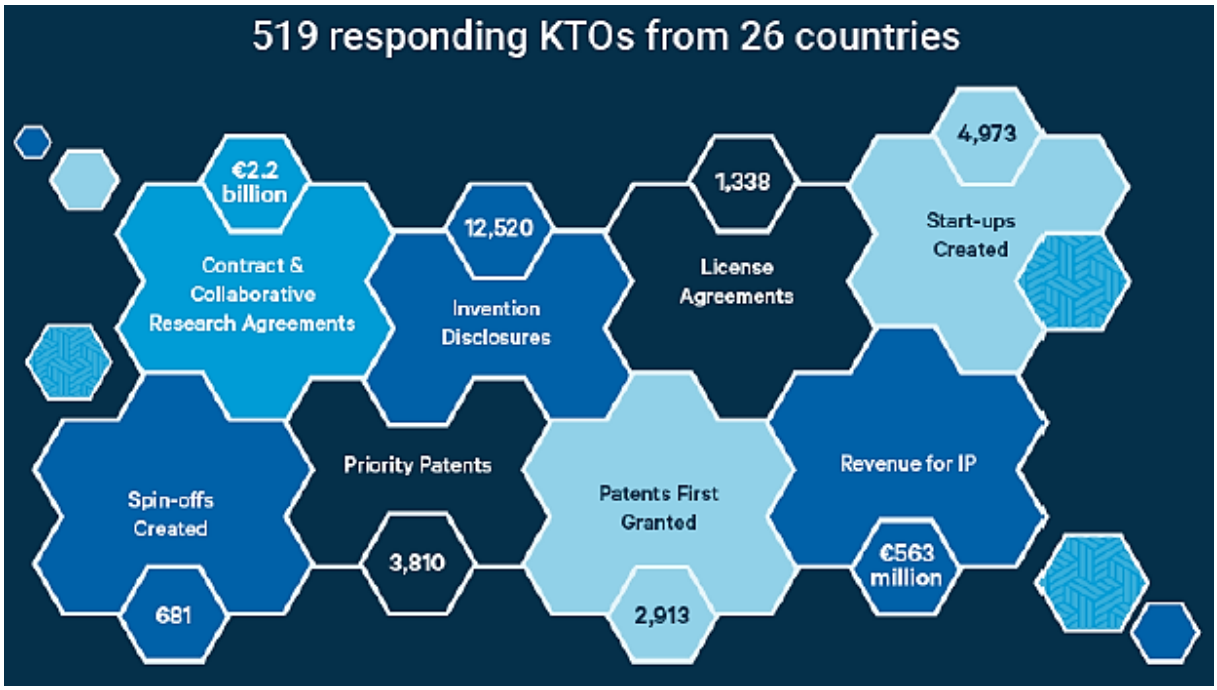

Figure 1. Overview of Survey Main Outputs and Findings.

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

Figure 2 presents the distribution of the operating time of the KTOs in the sample. It is worth noting that the vast majority of KTOs have already gained considerable experience by conducting knowledge transfer for more than 10 years.

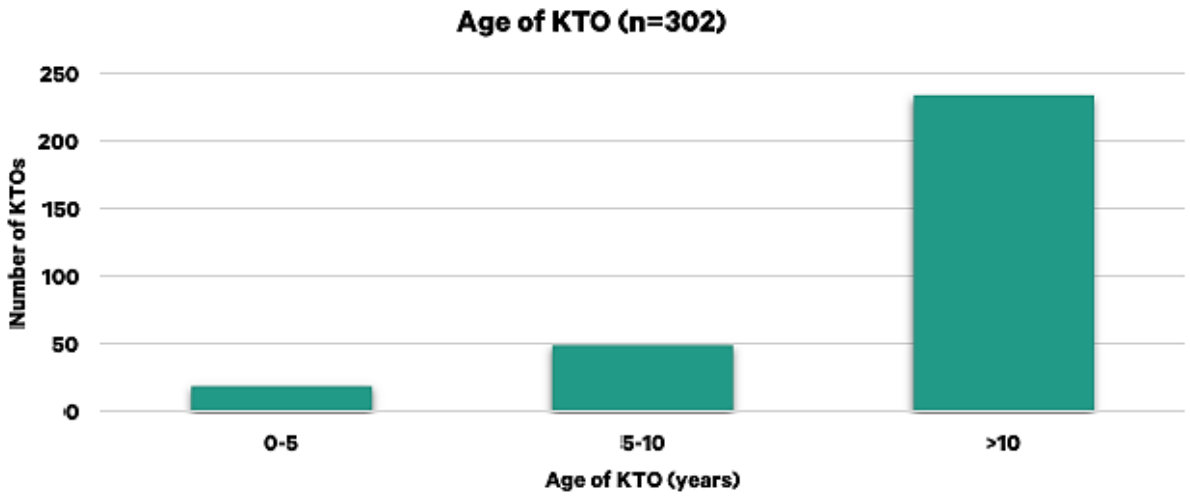

Figure 2. Distribution of KTO's age in number of years.

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

An important dimension characterizing the capacity for viable KTO operations is the employment status of the required specialists. This aspect is shown in figure 3.

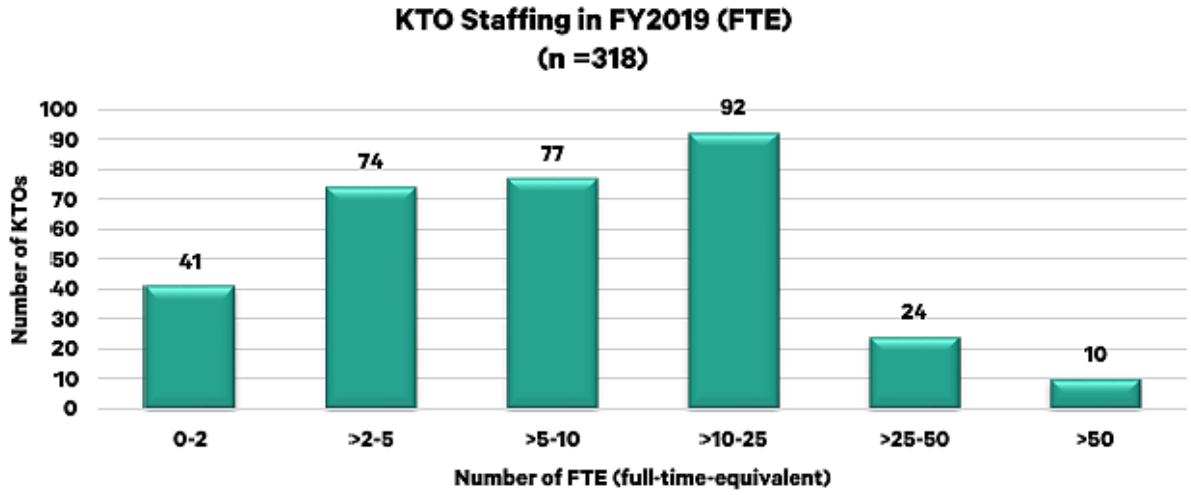

Figure 3. Distribution of KTO staffing levels in FTEs.

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

Among the responding KTOs (n=318), the average number of FTEs ranges from 3 to 25. We can also note that 13% of KTOs are very small, with 2 or fewer FTEs, while 11% are very large, with more than 25 FTEs. 23% of KTOs employ 2 to 5 FTEs, 24% of KTOs employ 5 to 10 FTEs, and 29% employ 10 to 25 FTEs. Only a few KTOs are larger - 7.5% employ 25 to 50 FTEs, and another 3% are even larger.

In order to gain more insight into the activities of the KTO, respondents were asked to provide data on the proportion of all FTEs in the KTO who are involved in one of the following activities:

- Research support, including handling of MTAs, CDAs, Collaborative Research Agreements etc. Commercialisation activities, including IP protection and commercialisation, licensing, and consultancy agreements.
- Supporting entrepreneurship activities at PRO(s) including training, business planning and incubation.
- Business development including industry liaison.
- Other activities.

The breakdown of the KTO's involvement in each activity is presented in figure 4. The overall percentage of FTEs allocated to research support is the highest of the five different activity areas listed in the questionnaire, at 30.7%, and the percentage of FTEs allocated to commercialization activities is second (24.5%). A comparison of data from the various ECAs shows that, overall, a similar percentage of FTEs are allocated to business development and entrepreneurship support (about 10% each).

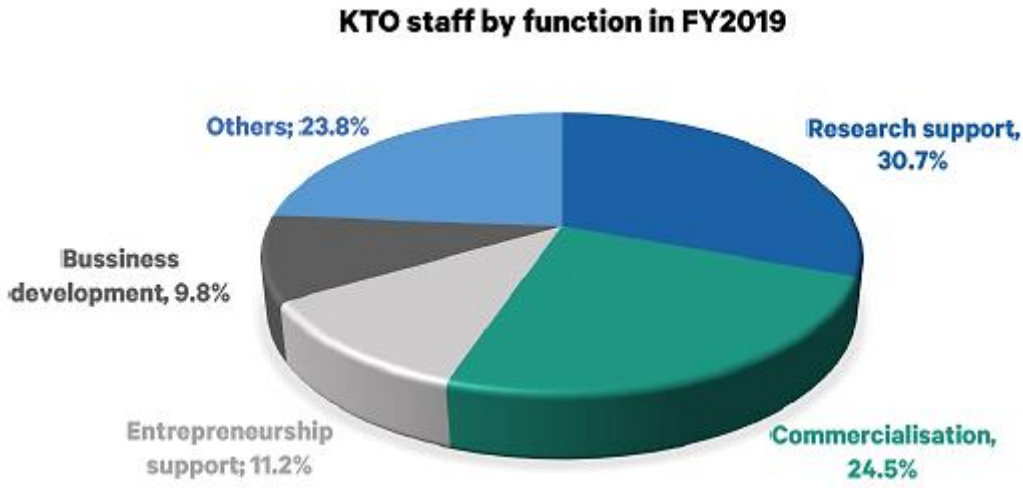

Figure 4. Distribution of KTO staff across major KTO functions.

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

An important aspect of KTO activity is the fact for how many Public Research Organisation(s) (PRO(s)) work. Most KTOs serve a single PRO (94%) and some KTOs report data for multiple PROs, with 3% serving 2 different research institutions, and 2% serving between 4-7 PROs. Only a minority of 1% operates on behalf of 10 or more research institutions. This small group of KTOs operates in Germany and Norway only. To complete the picture of KTO activity, it is worth noting how large research budgets are allocated by supported PROs. This relationship is shown in figure 5.

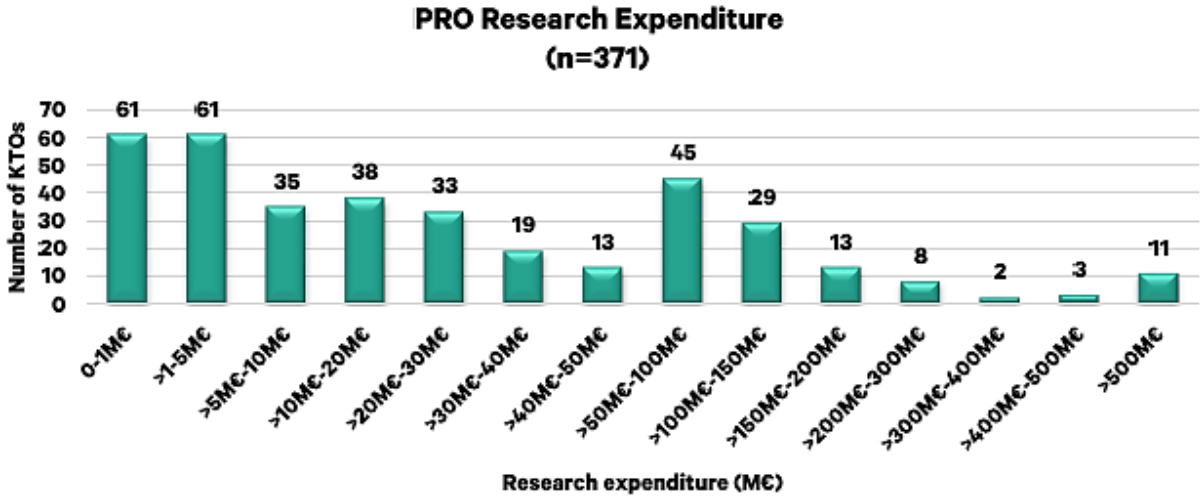

Figure 5. Distribution of PRO research expenditure.

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

The main activity of the KTOs has always been Intellectual Property (IP) management because it creates a base for commercialization of research results. The output of the IP management activity are quantitative indicators. Table 3 shows the total reported number of invention disclosures, priority patent applications and patents first granted to KTOs in FY2019.

Table 3.
Total number of KTO's Intellectual Property Activities

KTO's IP Activities	No. of responding KTOs (n)	Total
No. of invention disclosures	484	12,520
No. of priority patent applications	316	3,810
No. of patents first granted	272	2,913
No. of active patent families	307	38,056
No. of licensed or optioned Patent families	148	3,367

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

177,784 conducted agreements with industry were reported by European KTOs in FY2019. A breakdown of these number across different industry agreement types are given in Table 4.

Table 4.
Overview the number of contract research, collaborative research and consultancy agreements

New industry agreements	No. of responding KTOs (n)	Total
Contract Research Agreements	352	35,363
Collaborative Research Agreements	186	10,286
Consultancy Agreements	334	131,133

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

In terms of contract value shown in Table 5.

Table 5.
Income generated from research, collaborative and consultancy agreements

Income from Industry agreements	No. of responding KTOs (n)	Total (€)
Contract Research Agreements	332	1,384,447,767
Collaborative Research Agreements	145	825,292,501
Consultancy Agreements	303	506,807,932

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

From the data collected in table 6, it is clear that, among Licenses, Options and Assignments, License agreements are by far the most common modus for commercialisation of technology/IP rights developed within academic centres across Europe.

Among the licence agreements, patent licences are the most common (47%) followed by software licences (20%) and materials licences (21%). By "other licences" (12%), we consider licences of IP from copyright, design, trademark, trade secret, plant breeder rights, and datasets.

Table 6.
Overview of licenses, options and assignments signed

Commercial contract	Number of responding KTOs (n)	Total number of agreements signed
Licenses	199	1.338
Options	165	155
Assignments	170	312
License agreements	**Number of responding KTOs (n)**	**Total number of agreements signed**
Patent licenses	199	626
Software licenses	131	272
Material licenses	154	286
Other licenses	107	154

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

In FY2019, 432 respondents reported a total of €563 million in commercial revenues from intellectual property. This is one of the most frequently reported indicators, with more than 83% of KTOs responding. In addition, there was a steady increase in the total amount of IP revenue: €458 million (by 404 KTOs in fiscal 2017) to €522 million by 431 KTOs in fiscal 2018 to €563 million by 432 KTOs in fiscal 2019. Table 7.

Table 7.
Total gross revenues from the commercialisation of IP

IP Revenues	Number of responding KTOs (n)	Total (€)
Gross revenues from IP	432	563,183,505
Including Gross revenues from patent licenses	186	91,833,424
Including Cashed-in equity	291	76,832,280

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

Analyzing the distribution of gross intellectual property revenues by KTO, 32% of KTOs (138/432) have no intellectual property commercialization revenues, and another 28% report revenues of €50,000 or less. Fifty-five KTOs (or about 13% of respondents) report revenues in fiscal year 2019 exceeding €1 million.

An equally important aspect of KTOs is the support provided in the process of creating new businesses. The main goal of many KTOs is to create new businesses, often supported or driven by government economic development policies. Its goal is to stimulate such activity in order to increase employment and expand the local industrial base. To contribute to the aforementioned economic development policies, governments focus on new companies regardless of where the business ideas come from, as long as they attract investment and create new jobs. The study distinguishes between (1) companies that have a formal agreement with the KTO or PRO to use intellectual property developed at the PRO to develop new products or services (spin-offs) and (2) companies that do not rely on such intellectual property or formal use agreements (start-ups), but were founded by PRO students or employees. This distinction is important because spin-offs refer to the results of research conducted by PROs, while start-ups do not, and therefore the former are more likely to be managed and supported by the KTO table 8. For the purpose of the aforementioned economic development policy, governments make such distinctions less often, given that new companies attract investment and create new jobs wherever business ideas may arise.

Table 8.
Overview of the number of spin-offs and start-ups created

	Number of responding KTOs (n)	Total number of companies created
Spin-offs created	468	681
Operating spin-offs	387	4,533
Staff in operating spin-offs (FTE)	199	37,178
Start-ups created	358	4,973

Source: ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.

The details show that almost 50% of the KTOs have not created any spin-offs nevertheless, the total number of spin-offs rose from 569 in FY2018 to 681 in FY2019 by reporting KTOs.

5. Conclusions

Universities are key agents of economic and social progress. Their current role increasingly complements the traditional mission of teaching and research with interactions with industry and society. The role of universities conceived in this way has attracted considerable attention from scholars and policymakers. KT is a complex and rapidly evolving phenomenon based on the interactions of several stakeholders. Universities can pursue a variety of goals through KT activities, such as providing services to faculty, enhancing innovation and practical application of research results, generating additional revenue streams, supporting local economic development, adhering to national and institutional policies, and promoting public value.

More accurate predictions of the motivations and decision-making approaches of academics involved in knowledge transfer and co-creation activities are needed. Resource-based and commitment-based arguments offer different predictions of the interplay between motivations and decision-making approaches adopted, the cognitive proximity between academics and business researchers reflecting whether the partners are from the same/different disciplines. Capturing these situational considerations that indicate how commitment- and resource-based arguments together offer a more comprehensive explanation of the interaction. We discuss the implications for how universities can offer tailored training, rewards and support structures based on the interaction between motivational and decision-making approaches. Motivations indicate intentions, decision approaches describe behavioral patterns; therefore, studying the interaction between these two key dimensions can provide an in-depth understanding of the psychology of academics engaging in business. Understanding this interplay is particularly important for better formulating the incentives and support structures that can yield effective interactions between academics and companies and the associated generation of business and social value.

Acknowledgements

The paper was funding 13/040/BK_23/0114 Silesian University of Technology.

References

1. ASTP 2021 Survey Report on Knowledge Transfer Activities in Europe.
2. Axanova, L. (2012). US academic technology transfer models: traditional, experimental and hypothetical. *Nouvelles-Journal of the Licensing Executives Society, 47(2),* 125.
3. Barjak, F., Es-Sadki, N., Arundel, A. (2015). The effectiveness of policies for formal knowledge transfer from European universities and public research institutes to firms. *Research Evaluation*, *24*(1), 4-18.
4. Batalia, M. (2006). Avant-garde technology transfer at a midsize, private university. *Technology Transfer Practice Manual, 2*.
5. Belitski, M., Aginskaja, A., Marozau, R. (2019). Commercializing university research in transition economies: Technology transfer offices or direct industrial funding? *Research policy*, *48*(3), 601-615.
6. Bozeman, B., Rimes, H., Youtie, J. (2015). The evolving state-of-the-art in technology transfer research: Revisiting the contingent effectiveness model. *Research Policy*, *44*(1), 34-49.
7. Brescia, F., Colombo, G., Landoni, P. (2014). Organizational structures of Knowledge Transfer Offices: an analysis of the world's top-ranked universities. *The Journal of Technology Transfer, 41,* 1-20. 10.*1007/s10961-014-9384-5.*
8. *Brzóska, J., Szmal, A. (2020). Innovations as the source of creating the value in business models, In: Sustainable economic development and advancing education excellence in the era of global pandemic.* International Business Information Management Association (IBIMA), Granada, Spain. Soliman, K.S. (Ed.), pp. 13592-13602, p-ISBN: 978-0-9998551-5-7.
9. Chau, V., Gilman, M., Serbanica, C. (2017). Aligning university–industry interactions: The role of boundary spanning in intellectual capital transfer. *Technological Forecasting and Social Change, Vol. 123,* pp. 199-209, ISSN 0040-1625, https://doi.org/10.1016/j.techfore.2016.03.013.
10. Clarysse, B., Tartari, V., Salter, A. (2011). The impact of entrepreneurial capacity, experience and organizational support on academic entrepreneurship. *Research policy*, *40*(8), 1084-1093.
11. Czakon, W. (2018) Network coopetition. In: A.-S. Fernandez, P. Chiambaretto, F. Le Roy, W. Czakon (eds.), *The Routledge Companion to Coopetition Strategies* (pp. 47-57). Abingdon: Routledge.
12. De Silva, M., Al-Tabbaa, O., Pinto, J. (2023). Academics engaging in knowledge transfer and co-creation: Push causation and pull effectuation? *Research Policy*, *52*(2), 104668.

13. De Silva, M., Gokhberg, L., Meissner, D., Russo, M. (2021). Addressing societal challenges through the simultaneous generation of social and business values: A conceptual framework for science-based co-creation. *Technovation*, *104*, 102268.
14. Feldman, M., Feller, I., Bercovitz, J., Burton, R. (2002). Equity and the technology transfer strategies of American research universities. *Management Science, 48*(1), 105-121.
15. Giuri, P., Munari, F., Scandura, A., Toschi, L. (2019). The strategic orientation of universities in knowledge transfer activities. *Technological Forecasting and Social Change*, *138*, 261-278.
16. Hsu, D.W., Shen, Y.C., Yuan, B.J., Chou, C.J. (2015). Toward successful commercialization of university technology: Performance drivers of university technology transfer in Taiwan. *Technological Forecasting and Social Change*, *92*, 25-39.
17. Huyghe, A., Knockaert, M., Obschonka, M. (2016). Unraveling the "passion orchestra" in academia. *Journal of Business Venturing, 31*(3), 344-364.
18. Kapetaniou, C., Lee, S.H. (2017). A framework for assessing the performance of universities: The case of Cyprus. *Technological Forecasting and Social Change*, *123*, 169-180.
19. Kauffeld-Monz, M., Fritsch, M. (2013) Who are knowledge brokers in regional systems of innovation? A multi-actor network analysis. *Regional Studies, 47(5),* p669-685.
20. Klimkiewicz, K., Szmal, A., Staszkiewicz, M., Kowalik, W., Kowal, D. (2022), Analysis and development of competencies of faculty innovation brokers. Evaluation and measurement methods. In: J. Duda, T. Bernat (eds.), *Science, business and universities. Cooperation, knowledge transfer and entrepreneurship* (pp. 111-127). Routledge Studies in International Business and the World Economy. Routledge, ISBN 9781032192345, DOI: 10.4324/9781003258278-10.
21. Klofsten, M., Fayolle, A., Guerrero, M., Mian, S., Urbano, D., Wright, M. (2019). The entrepreneurial university as driver for economic growth and social change-Key strategic challenges. *Technological Forecasting and Social Change*, *141*, 149-158.
22. Kowal, D., Szmal, A. (2022). Functioning challenges of spin-off companies in innovation ecosystem of Polish universities. In: J. Duda, T. Bernat (eds.), *Science, business and universities. Cooperation, knowledge transfer and entrepreneurship* (pp. 195-209). Routledge Studies in International Business and the World Economy. Routledge, ISBN 9781032192345, DOI: 10.4324/9781003258278-15.
23. McMullen, J.S., Brownell, K.M., Adams, J. (2021). What makes an entrepreneurship study entrepreneurial? Toward a unified theory of entrepreneurial agency. *Entrepreneurship theory and practice*, *45*(5), 1197-1238.
24. Morrison, A. (2008). Gatekeepers of Knowledge within industrial districts: who they are, how they interact. *Regional Studies, 42(6),* pp. 817-855.

25. Munari, F., Sobrero, M., Toschi, L. (2017). Financing technology transfer: assessment of university-oriented proof-of-concept programmes. *Technology Analysis & Strategic Management*, *29*(2), 233-246.
26. Munari, F., Sobrero, M., Toschi, L. (2018). The university as a venture capitalist? Gap funding instruments for technology transfer. *Technological Forecasting and Social Change, 127,* 70-84.
27. Pohle, A., Villani, E., Grimaldi, R. (2022). Personnel motivation in knowledge transfer offices: The role of university-level and organizational-level antecedents. *Technological Forecasting and Social Change, Vol. 181,* 121765, ISSN 0040-1625, https://doi.org/10.1016/j.techfore.2022.121765.
28. Rasor, R., Heller, P. (2006). Administration of large and small technology transfer offices. *AUTM Technology Transfer Practice Manual, 2(Part 1).*
29. Sharer, M., Faley, T.L. (2008). *The strategic management of the technology transfer function—Aligning goals with strategies, objectives, and tactics.* les Nouvelles.
30. Siegel, D.S., Veugelers, R., Wright, M. (2007). Technology transfer offices and commercialization of university intellectual property: performance and policy implications. *Oxford review of economic policy*, *23*(4), 640-660.
31. Szmal, A. (2021). The concept of a pro-innovation fund in the innovation ecosystem of the Silesia Region. In: K.S. Soliman (ed.), *Innovation management and information technology impact on global economy in the era of pandemic* (pp. 11893-11899). Proceedings of the 37th International Business Information Management Association Conference (IBIMA), 30-31 May 2021, Cordoba, Spain. International Business Information Management Association, ISBN 978-0-9998551-6-4
32. Szmal, A. (2017). *Innovation ecosystem in the Silesian region - configuration of the key actors.* Conference proceedings. Book 1, Modern science (5), Business and management. STEF92 Technology, Sofia, pp. 525-532.
33. Szmal, A., Janiszewski, A. (2021), Role of knowledge brokers as facilitators of organizational development in era of Industry 4.0. In: R. Kusa, I. Skalna (eds.), *Organizational development: Contemporary challenges* (pp. 39-52). Akademia Gorniczo-Hutnicza im. Stanislawa Staszica w Krakowie, ISBN 978-83-66727-18-2
34. Szmal, A., Janiszewski, A. (2018). *Activities of knowledge intermediaries in regional innovation system - experiences, perspectives and challenges*. Conference proceedings. Modern science (5) Iss. 1.5, Business and management. STEF92 Technology, Sofia, pp. 11-18.
35. Trune, D.R., Goslin, L.N. (1998). University technology transfer programs: A profit/loss analysis. *Technological forecasting and social change, 57(3),* 197-204.
36. Villani, E., Rasmussen, E., Grimaldi, R. (2017). How intermediary *organizations facilitate university–industry technology transfer: A proximity approach. Technological*

Forecasting and Social Change, Vol. 114, pp. 86-102, ISSN 0040-1625, https://doi.org/10.1016/j.techfore.2016.06.004.

37. Wang, Q., Clegg, J., Gajewska-De Mattos, H., Buckley, P.J. (2023). It's personal: The emotional dimension of psychic distance perception in intercultural knowledge transfer. *International Business Review, Vol. 32, Iss. 5,* 102167, ISSN 0969-5931, https://doi.org/10.1016/j.ibusrev.2023.102167.
38. Zhou, R., Tang, P. (2020). The role of university Knowledge Transfer Offices: Not just commercialize research outputs! *Technovation, 90*, 102100.
39. Zhou, R., Tang, P. (2020) The role of university Knowledge Transfer Offices: Not just commercialize research outputs! *Technovation, Vol. 90-91,* 102100, ISSN 0166-4972, https://doi.org/10.1016/j.technovation.2019.102100.