

Improving knowledge transfer and innovation services: A roadmap for Knowledge Transfer Offices



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ABSTRACT

National and regional governments have promoted the professionalisation of knowledge transfer by establishing specialised structures: Knowledge Transfer Offices (KTOs). Although previous research has examined the features and performance of KTOs extensively, there is limited evidence regarding their role and associated evolution in managing new academic, economic, social and environmental challenges that extend the scope and mission of both universities and of their KTOs. This exploratory study investigates the challenges encountered and the good practices of higher education institutions (HEIs) to improve knowledge transfer and innovation, making a threefold contribution. First, the study proposes a conceptual framework for improving KTO services based on the four intertwined dimensions of *people*, *culture*, *governance* and *collaboration*. Second, a multi-country analysis is conducted on the KTOs of nine European HEIs that participated in a project financed by the European Institute of Innovation and Technology (EIT) Higher Education Institutions (HEI) Initiative. Third, drawing on the results obtained from a questionnaire and a set of focus groups, the study constructs a proposed roadmap for implementing or improving KTOs. The findings demonstrate that KTOs should focus on up-skilling and reskilling staff (*people*) and implement effective governance and coordination mechanisms under the supervision of and in synergy with university governing bodies while continuously monitoring, adapting and improving organisational structure, processes and initiatives (*governance*). Furthermore, an entrepreneurial mind-set should be promoted among academic and non-academic staff and students (*culture*). Constructing or strengthening internal and external collaborations with the key stakeholders of the ecosystem (*collaboration*) is also crucial.

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Introduction

Universities have embraced a new Third Mission (TM) of contributing to their local communities' economic and social development (Rothaermel et al., 2007), by bridging the gap between academia and actors in the innovation ecosystem. Along with teaching and performing research, universities have also increased knowledge transfer activities. They also confront the dual challenge of demonstrating social commitment and efficient budget management and attracting financial, human and relational resources (Aragonés-Beltrán et al., 2017). To this end, national and regional governments have been promoting the professionalisation of knowledge transfer (Aragonés-Beltrán et al., 2017; Dzakiy et al., 2024; Debackere, 2012; Fernandez-Alles et al., 2019; Geuna & Muscio, 2009; Kochenkova et al., 2016). The implementation of innovation policies has paved the way to

establishing specialised structures called Knowledge Transfer Offices (KTOs) (Göktepe-Hultén, 2010; Grimaldi et al., 2011; Kochenkova et al., 2016; Sachini et al., 2024) that have traditionally acted as intermediaries between scholars and firms (Brescia et al., 2016; Cartaxo & Godinho, 2017; Hailu et al., 2024) to enhance the value of research outputs (Dzakiy et al., 2024).

The first KTOs were established in universities in the United States (Holgersson & Aabo, 2019; Siegel et al., 2004) and in Belgium's Katholieke Universiteit Leuven (Geuna & Muscio, 2009) in the 1970s. Since then, these infrastructures have appeared in many other countries such as Italy, France, Germany, Spain, Denmark, Norway, Sweden and more recently Eastern Europe (Kochenkova et al., 2016). Among other things, KTOs manage joint research projects, intellectual property rights (IPR), patent licensing, research contracts, the creation of academic spin-off companies and the provision of services to support academic entrepreneurship (de Falani Bezerra & Torkomian, 2024).

While previous research has primarily addressed KTO strategies (de Falani Bezerra & Torkomian, 2024) and performance

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measurement (Pujotomo et al., 2020), the literature has produced inconsistent results regarding the outcomes and metrics for assessing knowledge transfer processes and activities (Fernandez-Alles et al., 2019; Hamilton & Philbin, 2020). The latter may vary due to individual universities' distinctive characteristics and degree of embeddedness within innovation ecosystems. KTO human resources have rarely been investigated (de Falani Bezerra & Torkomian, 2024; Villani & Grimaldi, 2024). In particular, few studies have examined the role of KTO staff (Stankevičienė et al., 2017), KTO personnel recruitment and training (Rothaermel et al., 2007) and incentives for KTO employees (Lafuente & Berbegal-Mirabent, 2019). In addition, empirical evidence is lacking regarding KTO governance (Zhang & Zeng, 2024), the networks built by KTOs and KTOs' transformative role within specific innovation ecosystems (de Falani Bezerra & Torkomian, 2024; Pitsakis & Giachetti, 2020).

Few studies have examined the nexus between KTOs and emerging societal and environmental challenges, which increasingly extend the scope and the mission of universities and their KTOs (Borrás et al., 2024; Knudsen et al., 2019). It is crucial to understand how KTOs reshape their organisational structures and develop new capabilities to perform the tasks associated with their expanded roles (Borrás et al., 2024). Although there is enormous potential for overcoming barriers to knowledge transfer by sharing good practices for KTOs (Pronay et al., 2022), the literature has rarely investigated KTOs' managerial processes, using a comparative research approach (Aerts et al., 2022). Furthermore, a limited amount of multi-country research has been conducted since most studies have focused on single countries (Pronay et al., 2022), particularly in developed socio-economic contexts, resulting in a lack of knowledge regarding KTOs in emerging ecosystems (Goebel et al., 2024).

Advancing research on the conditions and mechanisms that can (or could) improve KTO services is especially useful for informing university governance and policy-makers to guide efforts and strategies in the field of knowledge transfer (Faccin et al., 2022). Therefore, this exploratory study examines the challenges encountered and the good practices enacted by KTOs in providing services to support knowledge transfer and innovation. A multi-country analysis has been carried out. Employing Gioia's approach (Gioia et al., 2013; Maggiani & Gioia, 2023) to ensure trustworthy research, we follow three main steps to offer new insights into KTOs (Gioia et al., 2013).

First we conceptualise four intertwined dimensions of *people, culture, governance* and *collaboration* for improving KTO services, which were considered to be particularly relevant based on the findings of a systematised literature review.

Second, we elaborate and code data obtained from a questionnaire that was administered to KTO representatives from nine of the European universities participating in the three-year project Accelerating Innovation and Entrepreneurial Excellence in Higher Education Institutions (AccEnt), which was financed by the European Institute of Innovation and Technology (EIT) Higher Education Institutions (HEI) Initiative. We then organised a set of focus groups involving 30 participants from the same consortium to validate the primary data previously collected. We also collected secondary data from the institutional documents provided by consortium partners. Because it involves both well advanced KTOs in dynamic innovation ecosystems and recently established KTOs in less developed ecosystems, the analysis covers a broad array of diverse institutional contexts and geographical areas.

Third, we articulate the research findings in a coherent form by constructing a proposed roadmap for implementing or improving KTO services for knowledge transfer and innovation.

This article offers three contributions. First, it expands the research on KTOs and on how they evolve to navigate new economic, social and environmental challenges. In particular, the study addresses the four intertwined dimensions related to KTO staff and their role (e.g. Lafuente and Berbegal-Mirabent 2019, Micozzi et al.

2021, Stankevičienė et al. 2017, Villani and Grimaldi 2024), KTO governance (e.g. Borrás et al. 2024, Debackere 2012, Fernandez-Alles et al. 2019, Zhang and Zeng 2024), the development of a knowledge transfer culture beyond KTOs (e.g. Dzakiy et al. 2024, Compagnucci and Spigarelli 2020, 2023) and KTOs' collaboration with innovation ecosystems' actors (de Falani Bezerra & Torkomian, 2024; Farjoo, 2024; Pitsakis & Giachetti, 2020). Second, this study advances KTO knowledge by adopting a multi-country approach (Pronay et al., 2022) that includes less developed socio-economic contexts (Goebel et al., 2024). Third, the study contributes to comparative research on KTO managerial processes (Aerts et al., 2022) and offers valuable insights for university managers and policy-makers (Faccin et al., 2022) by proposing a roadmap for improving KTO services and accommodating the extended scope and mission of universities and their KTOs (Borrás et al., 2024; Knudsen et al., 2019).

The paper is structured as follows. Section "Theoretical framework" reviews the related literature. Section "Context, data and methods" illustrates the context of the analysis, data and methodology adopted. Section "Results and discussion" discusses the results and presents the proposed KTO improvement roadmap. Section "Conclusion" summarises the main findings and illustrates the study's limitations and avenues for future research.

Theoretical framework

KTOs have increasingly attracted the attention of scholars, entrepreneurs and policy-makers because such offices are traditionally considered to function as bridges or intermediary organisations between academia and industry that are responsible for supporting knowledge transfer and research commercialisation (Backs et al., 2019; Rothaermel et al., 2007). KTOs have been progressively redefined as 'process catalysts, knowledge converters, and impact amplifiers' (Faccin et al., 2022, p. 2), implying that KTOs have a broader and more complex role since they can be placed 'at the nexus "inside – outside" world' (Debackere, 2012, p. 4), to manage the differing in values, interests and targets of academic and non-academic stakeholders (Dzakiy et al., 2024; Göktepe-Hultén, 2010; Hamilton & Philbin, 2020). In contrast, the literature has also portrayed KTOs as 'bureaucratic structures' (Taxt, 2024, p. 139) that usually hinder innovation and commercialisation processes.

KTOs are also known as Technology Transfer Offices, Technology Licensing Offices and Technology Commercialization Offices. Although the nomenclature is heterogeneous (even within the same country), KTO functions are often similar (de Falani Bezerra & Torkomian, 2024) and can be summarised into five activities. (i) Switchboard services for managing interactions between university and non-academic actors; (ii) network development focused on strengthening links with industry by providing entrepreneurship services; (iii) managing technology transfer, which includes invention disclosure, evaluation, patenting and licensing agreement negotiations; and (iv) managing IPR (Bolzani et al., 2020; Cunningham et al., 2020). However, these functions have recently been questioned and redesigned since KTOs are increasingly being tasked with aligning economic returns with societal and environmental impact on the geographical areas in which they operate (Borrás et al., 2024; Dos Santos & Torkomian, 2013; Knudsen et al., 2019).

Our conceptual framework for literature analysis includes the four previously introduced dimensions of *people, culture, governance* and *collaboration*. *People* refers to the development of human capital among KTO staff as promoters of knowledge transfer and innovation. *Culture* refers to the set of shared values to be promoted among all staff and students in HEIs to support the idea of systematic knowledge transfer at all levels of the university and beyond. *Governance* is related to the institutional framework and commitment to ensure cooperation within the university and with stakeholders. *Collaboration* summarises the approach to networking and

partnering with the innovation ecosystems' actors to create and transfer knowledge. Each dimension identifies a set of core features and the critical aspects that characterise KTOs. The four dimensions do not stand alone but are nurtured by strong interdependencies and mutual interactions.

After analysing relevant materials and articles, the criteria used to identify the dimensions included their recurrence and relevance to the KTO development topic. These dimensions also included neglected perspectives in KTOs studies such as human resources (de Falani Bezerra & Torkomian, 2024; Villani & Grimaldi, 2024) and the most common barriers that have been found to hinder knowledge transfer, including culture (Pohlmann et al., 2022; Pujotomo et al., 2020) and KTO organisational structure (Fernandez-Alles et al., 2019; Giuri et al., 2019; Horner et al., 2019; Pohlmann et al., 2022). We also consider forms of collaboration as a key dimension of KTOs (de Falani Bezerra & Torkomian, 2024; Pujotomo et al., 2020; Villani & Grimaldi, 2024).

The choice of labels and topics was also inspired by the economic, social and environmental dimensions of sustainable development that are reflected in the United Nations Sustainable Development Goals that include five pillars: People, Planet, Partnership, Peace and Prosperity. Indeed, the road for implementing or improving KTOs should not only be sustainable in the long run but also maximise the positive economic, technological, social and environmental impacts of KTOs (Borrás et al., 2024; Soares et al., 2020; Villani & Grimaldi, 2024). We define a roadmap to provide insights into the four dimensions and related interconnections and interdependencies. Each dimension contributes to the overall functioning and successes of KTOs and lays the foundation for our conceptual framework.

The following Sections summarise the literature we considered relevant for developing the conceptual framework, drafting the questionnaire and guiding the focus groups that are described in Section "Context, data and methods".

People

The Organisation for Economic Co-operation and Development (OECD) stated that 'well trained staff at KTOs are not only essential to the efficiency of technology transfer but can also help limit conflicts of interests with researchers' (OECD, 2003, p. 46). KTOs' functions are heterogeneous and require individuals and KTO teams to have a variety of skills to handle multiple actions (Cunningham et al., 2020). According to Shattock (2001), KTO staff should have skills in stakeholder engagement and building network capacity for brokerage, broad understanding of the innovation ecosystem in which the university operates, the ability to identify market segments and gaps for capturing business opportunities, analytical and strategic skills for identifying and leveraging research strengths, expertise in the legal domain, particularly in terms of IPR protection and experience in creating start-ups.

However, emerging societal and environmental challenges are increasingly extending and broadening the scope and mission of universities and their KTOs (Borrás et al., 2024; Knudsen et al., 2019; Taxt, 2024). Therefore, new approaches should be investigated for training KTO personnel and attracting new staff (Sachini et al., 2024) to address the new tasks related to transformation in HEIs (Borrás et al., 2024).

KTO staff may lack the required communication and negotiation skills for engaging with entrepreneurs and representatives of the financial sector (Kochenkova et al., 2016) and with other, often new, types of actors in the innovation ecosystem, including associations, local communities and social enterprises. Thus steps should be taken to develop 'a "challenge-oriented" language' (Borrás et al., 2024, p. 8) for such communication. Furthermore, the creation of academic spin-off companies and start-ups requires a broad set of competencies and

attitudes that range from legal to management domains, including drafting business plans and engaging with business angels¹ and venture capitalists² (Cunningham et al., 2020). Therefore, KTOs seek to recruit and train employees with complementary expertise to provide scholars with in-house services to turn their knowledge into business projects (Siegel et al., 2003). However, finding and recruiting expert collaborators is a major challenge (Cunningham et al., 2020).

The literature has produced contradictory results regarding the impact of KTO staff on knowledge transfer activities. Hülsbeck et al. (2013) found that merely increasing KTO human capital has little or no effect on the creation of spin-off firms in the German context. Instead, the division of labour within KTOs positively impacts the formation of start-ups. Furthermore, Siegel et al. (2004) found that KTO managers with previous business experience generally have superior market awareness, deeper understanding of technologies and their commercial potential and more proactivity when conducting negotiations. In Italy, Micozzi et al. (2021) evaluated the impact of a national policy that aimed to increase the number of KTO employees to promote technology transfer and support and protect firms' IPR. The findings revealed that the increased number of KTO collaborators had a positive effect on advancing new contacts between scholars and firms, and the number of invention disclosures and licences also rose. However, this often only occurred for universities that already had a high level of KTO employee productivity and were able to take advantage of the policy.

Therefore, the KTOs' success is not guaranteed by simply increasing the number of personnel or reinforcing staff skills and experience. It is not only a matter of 'more is better' (Perkmann et al., 2013, p. 433), university governing bodies and policy-makers should also consider the 'soft' variables of KTO personnel (Cucino et al., 2024, p. 909), particularly staff motivation and empowerment. These factors are considered in this analysis as they can improve the quality and effectiveness of KTO services and positively affect the well-being of the communities in which HEIs operate (Kochenkova et al., 2016).

Culture

Universities and firms have different values, objectives and approaches. Scholars emphasise freedom when pursuing research objectives and teaching and primarily rely on public funding (Lambert & Lambert Review of Business-University Collaboration, 2003). However, university administrative staff have additional goals related to the effectiveness of university processes and legitimate spending. In contrast, non-academic actors, particularly managers and entrepreneurs, must navigate rapid changes in turbulent environments and usually find the university's aversion to risk taking and lack of 'deal-making' mind-set frustrating (Siegel et al., 2004).

This has been portrayed as an 'identity crisis of the university' (Rothaermel et al., 2007, p. 741), indicating that cultural barriers between scholars and stakeholders of the ecosystem can potentially hinder knowledge transfer (Cunningham et al., 2014). KTO staff may also find it difficult to convince scholars to disclose their inventions and collaborate with firms (Siegel et al., 2003). Instead, entrepreneurs usually misunderstand academic targets and values, which may

¹ According to the European Commission a business angel is a private individual, often with a high net-worth, and usually with business experience, who directly invests part of their assets in new and growing private businesses. Business angels can invest individually or as part of a syndicate where one angel typically takes the lead role (see https://single-market-economy.ec.europa.eu/access-finance/policy-areas/business-angels_en#:~:text=A%20business%20angel%20is%20a,typically%20takes%20the%20lead%20role).

² According to the European Commission, venture capital funds raise a large part of their funding from institutional investors and they usually invest large amounts into firms with the potential for rapid growth. However, many investors are reluctant to invest in start-ups and innovative firms because of high risks and transaction costs. They may also believe that the expected returns will not be worth the risk (see https://single-market-economy.ec.europa.eu/access-finance/policy-areas/venture-capital_en).

negatively affect the transfer of research outcomes or even hinder licensing agreement negotiations (Sideri & Panagopoulos, 2018; Siegel et al., 2004). This means that KTOs have to consider the distinct interests of diverse actors to understand the boundaries of KTO activities and to conduct successful mediation (Dzakiy et al., 2024).

Siegel et al. (2003) demonstrated that the most critical factor to facilitate a cultural shift among academics is providing a reward system for scientists. In particular, a knowledge transfer culture can be stimulated by offering career development opportunities (Kirchberger & Pohl, 2016). Notably, academic and policy discourse has tended to promote a knowledge transfer culture that is solely driven by science, technology, engineering and mathematics (STEM) disciplines. Therefore, KTOs have often focused on the formation of academic spin-off companies, patenting and licensing. However, the emergence of new social, health and environmental challenges has contributed to redesigning the overall mission of HEIs. Addressing such challenges requires a cross-disciplinary and cross-sectoral approach to knowledge transfer, including the integration of STEM with social sciences and humanities (SSH) disciplines (Compagnucci & Spigarelli 2020; 2023).

Governance

Building efficient and effective KTO governance is crucial for a number of reasons (Fernandez-Alles et al., 2019). First, KTO organisational structure and functions must be aligned with HEI objectives as part of the university's strategic mission planning process (Aragónés-Beltrán et al., 2017). Furthermore, universities have developed different institutional frameworks for research and diverse approaches to knowledge transfer; therefore, a wide variety of KTO governance is practised. Regardless of any specific organisational structure, KTO governance depends heavily on the embeddedness of the KTO within its HEI (Pronay et al., 2022), and universities may have differing degrees of success in managing knowledge transfer and innovation (Geuna & Muscio, 2009) as they are subject to social, economic and intellectual factors at the local level (Guerrero et al., 2014). While no one-size-fits-all-model of KTO governance exists (Geuna & Muscio, 2009; Guerrero et al. 2014), the set of common factors includes (i) KTO organisational structure, (ii) strategy and (iii) performance.

The type of organisational structure affects various KTO characteristics such as the flow of resources, relationships and commercialisation strategies that can subsequently influence KTOs' performance (e.g. Bercovitz et al. 2001, Markman et al. 2005). Derrick (2015) argued that all HEIs should establish an internal KTO rather than collaborating exclusively with separate knowledge transfer entities. Such a model would require KTO personnel to adapt practices to meet researchers' needs, which might ensure more effective knowledge transfer activities while satisfying scholars' publishing aspirations.

KTO strategy concerns the procedures for planning knowledge transfer activities and targets, and engaging researchers with other actors in the ecosystem such as firms, associations, incubators, accelerators, business angels and venture capitalists (Belitski et al., 2019; Bacs et al., 2019). To successfully enact HEI strategy, KTOs should clearly define a set of short- and long-term targets and initiatives (Jefferson et al., 2016), which requires the allocation of adequate financial resources. However, most KTOs still depend heavily on public funds and few HEIs have introduced additional financing systems since they are not prepared for this more 'autonomous' approach. Nevertheless, in the long-term universities and their KTOs will need to identify and pursue alternative funding sources such as potential profits derived through relationships and contracts with firms and key actors in the ecosystem (Bigliardi et al., 2015).

Measuring KTOs' performance involves multiple concerns that are particularly important from a managerial perspective (Pronay et al., 2022), which has generated diverse approaches to monitoring and

assessing KTOs (Rothaermel et al., 2007). Measuring KTO performance requires understanding the degree to which a strategic decision taken in terms of defining objectives has been fulfilled by considering the end results of the knowledge transfer process (Conti & Gaule, 2011). The metrics for KTO performance should consider tangible items such as the number of academic spin-off companies created, subsequent revenue and number of employees; patents (e.g. Algieri et al. 2013); licensing agreements (e.g. Conti and Gaule 2011); and licensing revenue (e.g. Bercovitz et al. 2001, Bray and Lee 2000). However, activity and income-based metrics are insufficient (Bengoa et al., 2021). Indeed, such metrics do not permit a meaningful comparison between geographical areas or even among HEIs in the same country. While these indicators refer to data that can be easily identified and collected, they do not include universities' features, particularly in terms of engagement within the local ecosystem, the effects on lifelong learning and general societal impact (Blasi, 2023; Perkmann et al., 2013).

Indeed, knowledge transfer mechanisms from academia to civil society can have intangible and complex impact (Blasi, 2023; Cunningham et al., 2020) that arise indirectly, which makes it difficult to attribute causality. While STEM-based knowledge transfer has more direct channels of application, SSH-based activities may have indirect effects on society at large that are more likely to only emerge in the long term (Cunningham et al., 2020). Therefore, there is the need to transition from an 'appropriation mode' of KTOs (Holgersson & Aaboen, 2019, p. 4), based on commercialising research outputs and increasing the number of patents, licences and start-ups, to a 'new utilization mode' (Holgersson & Aaboen, 2019, p. 5) that is more focused on the effectiveness of KTO contributions in addressing the current challenges of local communities.

Collaboration

Collaboration concerns KTO internal procedures for involving scholars, administrative staff and students in knowledge transfer activities and policies and the mechanisms for building and strengthening external relationships with the actors in the local innovation ecosystem (Siegel et al., 2004); for example, companies, governments, public agencies, incubators, accelerators, business angels, venture capitalists, associations, schools and non-governmental organisations and others. Therefore, KTOs must promote collaboration, while balancing the goals and interests of diverse stakeholders (e.g. Siegel et al. 2003).

Scholars are usually concerned with their academic freedom, teaching agenda and the 'publish or perish' imperative that determines career progression (Cunningham et al., 2016). Scientists and scholars are also increasingly encouraged to take part in the university entrepreneurial paradigm by collaborating with KTO staff and non-academic local stakeholders (Mangematin et al., 2014). Research has found that scholars indeed establish different types of collaboration with internal and external stakeholders, with diverse degrees of engagement. In the case of Sweden, Göktepe-Hultén (2010) found that occasional academic inventors are more likely to engage with KTO staff to facilitate the commercialisation of research outcomes and interactions with other stakeholders, whereas more experienced inventors tend to consider KTOs irrelevant or even detrimental to industry relationships since a KTO might introduce extra bureaucracy and increase transaction costs.

From the industry perspective, firms are driven to develop marketable products and services, focusing more on applied research. While secrecy and protection through patents are key tools for firms, such factors often conflict with an academic's need to publish (Fassin, 2000). However, firms will at times collaborate with HEIs to share research and development (R&D) costs and extend their networks (Cunningham & Link, 2015).

KTOs may undertake boundary spanning initiatives to establish ties between company representatives and scholars. KTO personnel should communicate firms' needs to scientists, who should define their specific capabilities and interests (Siegel et al., 2003). To foster university–industry collaboration, KTOs should extend internal cooperation to other structures within their own HEI such as project management and research grant offices and reach beyond the local innovation ecosystem (Hamilton & Philbin, 2020). Moreover, KTOs should become active members of international networks and associations to develop further connections, share good practices with peer institutions and contribute to the evolution of knowledge transfer policies (Geuna & Muscio, 2009). Overall, the involvement of professional, non-academic managers in KTOs helps HEIs to bridge the cultural gap between university and non-academic actors (e.g. Muscio 2010), promoting opportunities for collaboration.

Context, data and methods

This study investigates the challenges encountered and the good practices developed by KTOs affiliated with the consortium partners of AccEnt project, which received funding from the EIT HEI Initiative. The AccEnt project endeavoured to augment consortium members' entrepreneurial performance in close collaboration with ecosystem stakeholders. AccEnt focused on improving and extending core entrepreneurial and knowledge transfer activities at (i) student, (ii) faculty and administrative staff and (iii) ecosystem levels. The project also dedicated complementary efforts and resources to developing KTO services, testbed infrastructure, curricula and supportive materials. Partners sought to develop and share good practices for entrepreneurship, knowledge transfer and innovation by establishing a learning community within and across the consortium.

Referencing Gioia's approach (Gioia et al., 2013; Magnani & Gioia, 2023), this study employs a three-step qualitative research design that is particularly suitable for such exploratory studies as it enabled us to obtain richly descriptive reports of individuals' perceptions, attitudes, beliefs, perspectives and feelings; meanings and interpretations of events; and associated actions and behaviours within a specific context. Moreover, qualitative research for exploratory studies is the first step that can lead to more structured quantitative study (Hakim, 2000). An exploratory case study is also appropriate when the context and focus of the analysis is important for an in-depth understanding of a complex phenomenon (Stake, 1994; Yin, 2018); in this case, the design, implementation and improvement of KTOs. This research employs triangulation of primary and secondary data (Denzin & Lincoln, 2011; Gibbert et al., 2008).

In the first step of the analysis, we undertook a bibliometric analysis (Donthu et al., 2021) to identify recurring keywords and topics in the field of interest. This made it possible to define the theoretical framework for designing the questionnaire for KTO representatives and guiding our focus groups. The search for relevant studies was conducted using Scopus and Web of Science databases, searching for the following terms in articles' title, abstract, and keywords: 'knowledge transfer office', 'technology transfer office', 'innovation service' and 'university-industry collaboration'.

Second, we developed a questionnaire that was organised in four sections corresponding to our dimensions of *people, culture, governance and collaboration*. The questionnaire was drafted in English and includes 17 closed and open questions. We tested the questionnaire between May and June 2023 by soliciting feedback from AccEnt project partners. The draft questionnaire was sent to the nine partner HEIs. We received feedback from four KTO representatives and five senior scholars with backgrounds in business, economics and management and extensive experience in innovation, knowledge transfer and start-up mentoring. This step was useful for improving the questionnaire's readability, effectiveness and alignment with the literature and our research aims. In July 2023, the final version of the

Table 1
Final sample of KTOs.

Higher education institution	Country
Katholieke Universiteit Leuven (KUL)	Belgium
Thomas More University of Applied Sciences (TM)*	Belgium
Aristotle University of Thessaloniki (AUTH)	Greece
University of Macerata (UNIMC)	Italy
Maria Curie-Skłodowska University (MCSU)	Poland
Pablo de Olavide University (UPO)	Spain
Fontys University of Applied Sciences (Fontys)*	The Netherlands
Lutsk National Technical University (LNTU)	Ukraine
Odesa I.I. Mechnikov National University (OMNU)	Ukraine

Notes:
* Although TM and Fontys do not have internal KTOs, these consortium members did participate in the questionnaire and the focus groups since they respectively collaborated with the KUL KTO and with Eindhoven University of Technology (TU/e), providing services for knowledge transfer and innovation. In these cases, respondents were the academics who usually collaborated with the KUL KTO and TU/e.
Source: Authors' elaboration.

questionnaire was administered to representatives of nine KTOs affiliated to partner universities that are based in seven different EU Member States (see Table 1). Follow-up e-mails were sent to KTO representatives asking for clarification or further information, where needed. We also collected secondary data from institutional documents provided by consortium partners.

The preliminary results of the research were presented to the project partners at a consortium meeting in November 2023, during which the preliminary results were validated and further insights were collected through an organised set of focus groups. Focus groups included between four and twelve people who discussed a specific topic with the guidance of a moderator. Focus groups can generate additional information as participants may react to perspectives with which they disagree, or the group as a whole may develop an original perspective on the topic investigated (Hakim, 2000).

Four focus groups were conducted and each group was asked to analyse one of the four conceptualised dimensions in depth. Thirty people participated in the focus groups. Participants included KTO personnel, scholars and start-up representatives involved in the innovation ecosystems where AccEnt consortium partners operated. This institutional, professional and geographical heterogeneity ensured the inclusion of different perspectives on the points discussed and the exchange of insights concerning good practices for implementing or improving KTO services. The focus groups were held in English and lasted about one and a half hours. The main insights obtained from each focus group were presented in the final plenary session of the meeting, and written transcripts and recordings were also provided.

In the third step, referencing the results obtained from the questionnaire and focus groups, we developed a roadmap for sustainable improvement of HEIs' KTO services for knowledge transfer and innovation based on the four dimensions of our analysis.

Results and discussion

The following Sections summarise the qualitative and quantitative results obtained from the questionnaire and focus groups. The findings are presented according to the people, culture, governance and collaboration conceptual framework and related interdependencies.

People

The 'people' dimension refers to internal KTO staff. In this section, we sought to understand the main characteristics, challenges and the good practices related to KTO personnel and their skills. Except for two project partners, all the members had already established KTOs. Partners without an in-house KTO had entered into long-term

agreements to use the knowledge transfer services provided by other intermediary institutions in their ecosystem.

Some KTOs had over 20 or even 50 years' experience in the field of knowledge transfer, while others were established after 2013. Except for one partner, all KTOs have small teams, employing four full-time collaborators on average. KTOs often seek skills and advice from external experts on a project-by-project basis.

People and skills

Designing and implementing knowledge transfer activities requires heterogeneous skills, particularly for facilitating the combination of academic knowledge, competencies, resources and the firms' needs (Muscio, 2010) and other ecosystem actors. In addition to different levels of experience and skill development, KTOs also have diverse degrees of embeddedness within innovation ecosystems. However, the findings did reveal that most of KTOs engage in multiple functions and

'[...] seek to put together a multidisciplinary team for ensuring support services for knowledge transfer and innovation which usually fall within five fields' (focus group 1).³

KTO services can be grouped as follows:

First, KTOs manage university–industry agreements, including long-term research projects, research contracts and small consulting assignments from firms and public agencies.

Second, KTOs guide the commercialisation of research outputs by providing support for the business and IPR. To this end, KTO staff are often involved in negotiation activities and legal document drafting.

Third, KTOs support the establishment of academic spin-off companies and start-ups. This process encompasses several activities and requires a broad set of skills ranging from technical competencies such as analysing the commercial potential of innovative solutions, legal expertise concerning firm creation and knowledge for guiding nascent entrepreneurs towards funding access.

Fourth, KTOs organise activities to contribute to improving the soft skills of academic staff and students; however, KTOs do not necessarily create new entrepreneurs, instead

'KTOs may try to stimulate a more entrepreneurial mind-set among scholars and students' (focus group 1).

Fifth, KTOs are responsible for bridging the gap between scholars and non-academic stakeholders. Some KTOs also contribute information to assist policy design concerning innovation and knowledge transfer at the regional level. To do so, KTO staff must have communication, networking and negotiation skills.

When exploring the skills needed for managing the operations described above, KTO representatives emphasised the fact that the most important skills for KTO staff are IPR protection, networking capabilities and analytical, business development, negotiation and communication skills. The findings reveal that KTO staff often lack key entrepreneurial skills, indicating that this should be addressed by organising intensive continuous learning programmes engaging experts and professionals as trainers that are delivered at least two full days per month. Fig. 1 presents an overview of the most important skills required for KTO staff.

Regarding expertise in the legal domain, knowledge and previous experience in the IPR field is crucial for KTO personnel. While IPR management may vary depending on national HEI regulations, KTOs must comply with the IPR regulatory framework defined by the EU.

Along with understanding the regulatory framework, drafting licencing agreements also requires a combination of market awareness, marketing and negotiating skills. In this case, KTOs are

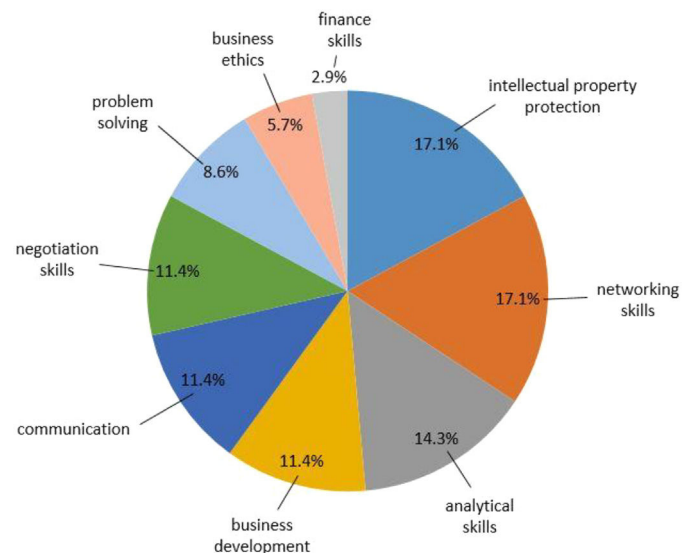


Fig. 1. Most important skills for KTO staff. Source: Authors' elaboration.

responsible for establishing a multifaceted and complex system for protecting and commercialising IPR. Furthermore, KTO staff must be aware of the problems of counterfeiting and piracy and know the legal procedures to use to avoid and/or prosecute commercial infringements that result in economic harm for scholars and their firms.

This set of IPR skills is crucial for supporting academic spin-off companies and innovative start-ups that do not have the same level of resources for managing IP portfolios as larger competitors. IPR experts also have a key role in promoting innovation and knowledge transfer between firms, which can promote job creation and competition within the local ecosystem. KTO collaborators should be offered the opportunity to improve IPR skills by attending workshops and courses and participating in events regarding cross-country topics; for example, the introduction of the Unitary Patent that aims to offer affordable patent protection in Europe with a one-off procedure for patent registration.

Networking skills are also essential as such skills enable KTO staff to maintain good relationships with colleagues and ecosystem stakeholders. Networking should leverage on

'the capacity of building and strengthening relations with various stakeholders, especially industry, by providing support services for entrepreneurship' (focus group 1).

Networking includes personal communication and relationship management. According to KTO representatives, networking can be pursued in person or virtually using common digital platforms such as LinkedIn or specific digital tools that have been developed by joint research projects or policy-driven initiatives. Regardless of the platforms or tools used, KTO personnel must continuously improve their networking skills by adopting a proactive approach in local and international environments.

The findings advance recent research showing that analytical skills are essential for managing KTO operations and for moving from a traditional narrow focus on technology transfer towards a better understanding of the social and environmental impact of innovations and technologies (Borrás et al., 2024). Indeed, the respondents highlighted the importance of brainstorming, research management, data analysis, problem solving and administrative organisational skills. KTOs require these skills to identify, assess and promote research strengths at individual and university levels externally. In particular, KTOs must collect information and data about the innovativeness and market potential of the solutions developed by scholars.

³ This quote, and all similar quotes below, have been taken directly from both the replies to the questionnaire and the minutes of the focus groups held with a variety of participants during the project meeting in November 2023.

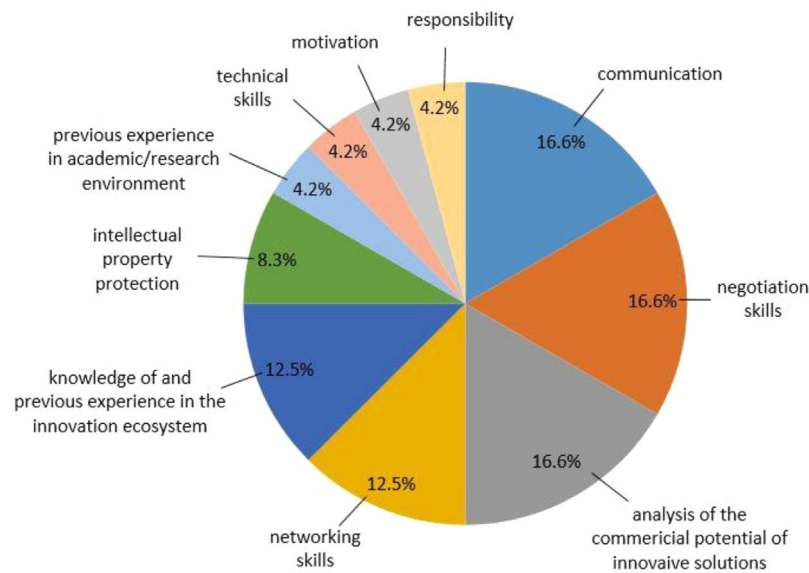


Fig. 2. Most important KTO staff skills for facilitating interactions between scholars and ecosystem stakeholders. Source: Authors' elaboration.

KTO representatives emphasised the need for staff to improve skills related to business development to support start-ups. While KTO collaborators are not expected or required to act as substitutes for scholars or nascent entrepreneurs, they should be familiar with common tools for project management. This would be useful for helping spin-offs and start-ups to define strategies and tasks, assess performance and take advantage of business opportunities by exploring new market segments.

The results also concur with recent research that has emphasised the difficulties that KTO employees encounter in external relations (Borrás et al., 2024; Pronay et al., 2022). To facilitate interactions between scholars and innovation ecosystem actors, KTO staff must rely on communication and negotiation skills and possess competencies in analysing the commercial potential of innovative solutions that are developed and in development within their HEI, in addition to acquiring new skills to support academics with business creation and IPR protection. KTO staff also need more flexible time horizons to consider longer-term processes and dedicated budgets for new tasks (Borrás et al., 2024).

Overall, KTO staff are not expected to have skills and extensive expertise to cover all administrative, legal, financial and business domains. Rather, KTO staff should mentor and guide academics by providing a helpdesk and first assessment and putting scholars in contact with external experts to manage specific issues. This is particularly important for small universities and KTOs. As shown in previous works (e.g. Dos Santos and Torkomian 2013), along with ensuring the professionalisation of KTO teams, it is even more challenging to design and enact mechanisms to retain collaborators within the KTOs in the long term to attain more consistent and sustained knowledge transfer results.

Fig. 2 presents the most important skills required for KTO staff to successfully facilitate interactions between academic and non-academic stakeholders.

People's motivation

As described in the previous section, it is essential to design and implement policies and measures to upskill or reskill KTO staff (Debackere, 2012). Furthermore, KTO managers should encourage more commitment from collaborators to encourage knowledge transfer initiatives by stressing the potential threefold impact of knowledge transfer on researchers as individuals, the university as a community and civil society. To this end, university governance

should facilitate the KTO personnel's participation in knowledge exchange programmes with peer institutions. In addition to cultivating more expertise in technical fields (e.g. IPR protection, project management, academic spin-off and start-up formation), exchange programmes should aim to build and strengthen collaboration between KTOs at regional, national and international levels. This could facilitate the design and implementation of shared actions when participating in competitive calls and engaging with knowledge transfer networks⁴.

However, it is not adequate merely to upskill or reskill KTO staff. Alignment between employees' values and KTO goals is also crucial for the success of knowledge transfer activities. Nevertheless, KTO collaborators' motivation and individual dimensions have largely been ignored (Villani & Grimaldi, 2024) in the literature and in practice. To address this challenge, role models can be adopted to influence both the motivations and the behaviour of KTO staff by facilitating the identification of KTO strengths and weaknesses, and by setting performance targets, and incentives, for both individuals and teams to improve operational efficiency. Indeed, one respondent highlighted,

'Our KTO gains valuable insights from top-performing offices, since it adapts better to changing trends, enhances collaboration, embraces new good practices and wins stakeholders' confidence' (respondent 3).

It was also noted,

'by comparing our processes with successful examples, we can identify and improve our weaknesses' (focus group 1).

Before implementing role models' approaches or corrective actions, university governing bodies and KTO managers should carefully consider their HEIs' distinctive features and links within the local innovation ecosystem (e.g. Sachini et al. 2024).

Our findings confirm previous research by demonstrating that university leadership should design and introduce incentives and code-of-conduct schemes for the academic community, encouraging and monitoring knowledge transfer activities and practices of researchers and KTO staff to motivate KTO personnel to improve

⁴ Such as the Association of European Science and Technology Transfer Professionals (ASTP), the Network for research valorization (NETVAL), and the Polish Association of Centers for Technology Transfer (PACTT).

performance (Debackere, 2012). Such schemes could potentially reduce the risk of moral hazard and agency issues. Furthermore, it is of utmost importance to obtain regular feedback from KTO managers, welcome and stimulate staff suggestions (Cucino et al., 2024) and acknowledge the KTO's autonomy (Pohle et al., 2022).

Notably, our results revealed considerable diversity of opinions across consortium members concerning the establishment of knowledge transfer incentives. Indeed, in some cases neither national legal frameworks nor university regulations are in place. Since regulations influence the design and implementation of KTO activities as well as personnel motivations, future research should collect and compare additional evidence regarding the association between incentives, motivation and staff performance on a country-specific basis. Such analyses could contribute to designing adequate incentive schemes for specific contexts.

Culture

As different interests, objectives and values are at stake among scholars and administrative staff, even within the same department or faculty, KTOs should endeavour to manage and resolve this cultural heterogeneity. In the past, it was not unusual for KTOs' institutional frameworks and policies to result in discontented scholars, internal administrative investigations or even litigation initiated by HEIs against employees (Grimaldi et al., 2011). Considering the need to establish a set of clear, transparent and balanced KTO rules at university and national levels, KTOs should also contribute to promoting a cultural shift towards an entrepreneurial mind-set within their institutions by focusing on academics and students. This dimension covers the receivers of the activities developed by KTO staff (as described in the *people* dimension).

The respondents emphasised the importance of introducing hands-on entrepreneurship workshops at undergraduate and post-graduate levels, to provide training on the main concepts and tools for knowledge transfer, innovation, entrepreneurship, project management and soft skills. Such training programmes should be collaboratively designed by scholars and KTOs. This training should be mandatory for students to at least impart the main concepts and tools for generating and developing a business idea and should also provide participants with non-monetary incentives and promote hands-on experience to encourage attendance. In this context, alumni could play an important role in stimulating an entrepreneurial mind-set by sharing real-world experiences and encouraging the formation of student networks.

Furthermore, training programmes should increase students' awareness of the importance of knowledge transfer, innovation and entrepreneurship as well as the inherent challenges and risks. This could better prepare students for starting their own businesses or entering the labour market. Implementing formal student entrepreneurship schemes, at local or even national levels, could be particularly beneficial in terms of long-term results (e.g. business development and performance) for the innovation ecosystem and for those students who are willing to enrol in university degree programmes while managing their own firms.

As for PhD candidates, KTOs should arrange training for understanding the potential impacts of research projects and putting related entrepreneurial activities into practice. Such impact should not be limited to the economic domain, but should also consider social, cultural and environmental dimensions. Furthermore, doctoral students should be offered training in IPR protection to make them aware of the risks and opportunities of applied research. KTOs should also contribute to designing and organising business idea competitions to encourage collaborations between students, PhD candidates and scholars.

KTOs should support junior and senior researchers who are willing to transform business ideas into a company to obtain funding for

scaling up and to develop and implement effective go-to-market strategies. The respondents argued that KTOs should focus more on providing support services to assess innovative solutions' technology readiness, protecting IPR, establishing academic spin-off companies and start-ups and training nascent entrepreneurial teams. Overall, consortium partners expressed the need for a change in human resources policy at national and university levels to define clear objectives, duties and incentives for knowledge transfer activities. Such changes could facilitate the emergence of a long-term entrepreneurial mind-set across university communities.

The findings also showed that a knowledge transfer-driven culture could be hampered by a lack of funding for early stage start-ups. Although KTOs usually do not themselves provide financial support, they can introduce start-ups to funding opportunities offered by business angels, venture capitalists and other stakeholders in the innovation ecosystem. Furthermore, KTOs can put researchers and incubator and accelerator managers into contact to develop business plans, participate in start-up contests and access financial support.

The process of stimulating an entrepreneurial mind-set among students and scholars has primarily focused on technological and economic dimensions, sometimes neglecting the potential contribution KTOs can make to addressing social and environmental challenges. However, most of our respondents emphasised that KTOs have now begin to promote research and solutions that are relevant to the United Nations Sustainable Development Goals.

'Our KTO tries to encourage spin-offs and start-ups to adopt more socially oriented business models, to promote responsible licensing and partnerships, and to foster knowledge exchange initiatives on sustainability issues which concern the local community' (respondent 4).

The results also indicate that KTOs should invest more resources in planning and enacting communication strategies to promote internal and external knowledge transfer culture and related activities. To this end, KTOs should coordinate appropriate actions with the university leadership and the departments/faculties/schools involved.

Table 2 summarises the main activities conducted by KTOs to stimulate an entrepreneurial mind-set among academic staff, PhD candidates and students.

Governance

Internal and external gaps in KTO organisation

Establishing and managing a KTO requires considerable organisational effort. Nevertheless, limited studies have been conducted regarding KTO governance (Zhang & Zeng, 2024). Based on the results obtained from our questionnaire and focus groups, governing KTOs and implementing their activities pose various internal and external challenges that involve the academic community and external actors in the innovation ecosystem.

The following set of challenges were identified that are related to internal gaps: i) the commitment of university leaders as individuals and governing bodies, ii) the organisational configuration of KTOs and iii) defining coordination mechanisms between university structures and KTOs.

University leaders' commitment as individuals and governing bodies, in reference to the Rectorate, Academic Senate and General Management, is crucial to embed knowledge transfer activities into HEIs' vision and mission. If university governing bodies do not acknowledge the value of knowledge transfer and innovation, it is almost impossible to establish strong and sustained cooperation with regional, national and international stakeholders. Therefore, a Deputy Rector should be in charge of TM tasks, who should have a counterpart Deputy in each school/faculty/department/academic centre to design and implement knowledge transfer initiatives, ensure the

Table 2
Actions for fostering an entrepreneurial mind-set among academic staff, PhD candidates and students.

Dimensions	Objectives	Actions
Entrepreneurial mind-set	<ul style="list-style-type: none">Inspiring people	<ul style="list-style-type: none">Seminars, start-up schools and workshops for students, PhD candidates and early stage researchers;intra and inter-university business idea competitions (for students, PhD candidates and early stage researchers);KTOs should invest more resources in communication strategies to promote internal and external knowledge transfer initiatives and related opportunities.
Nascent academic entrepreneurs	<ul style="list-style-type: none">Promoting the formation of teams, start-ups and academic spin-off companies	<ul style="list-style-type: none">Intensive team-building training and mentoring for start-ups;networking initiatives with key actors in the innovation ecosystem; (investors, entrepreneurs, potential customers and users);programmes to strengthen research project management and economic, social, cultural and environmental impact;training for researchers to design and conduct knowledge transfer strategies, including patenting, licensing and academic spin-off formation.
Scaling-up	<ul style="list-style-type: none">Supporting the growth of start-ups and spin-offs	<ul style="list-style-type: none">Universities and KTOs that operate in the same geographical area should pool resources to establish a critical mass, e.g. by building venture capitalist networks;accompanying academic spin-offs, start-ups and business projects to specialised investment forums;introducing venture capitalists to academic and student entrepreneurs;supporting the development of roadmaps with technological, organisational and financial milestones for spin-offs and start-ups.

Source: Authors' elaboration.

balance between teaching, research and knowledge transfer in each organisational structure and coordinate such initiatives at the HEI level. Our results align with those of previous analyses indicating that university governing bodies must put a lot of effort into cooperating with regional governments to formulate and enact coherent and feasible strategies for knowledge transfer (Siegel et al., 2007).

Regarding KTOs' organisation, university governing bodies should integrate or align internal front- and back-office operations. As shown by Debackere (2012), appropriate organisational mechanisms within the university can ensure coordination between the central (managerial and administrative) support function and the day-to-day operations of departments and research labs. Furthermore, institutional organisation, competencies and funding structures for KTOs should be aligned with HEIs' mission. The latter should develop an entrepreneurial identity for KTOs, providing offices with legitimacy and access to strategic resources for advancing knowledge transfer (Fernandez-Alles et al., 2019, p. 864). This implies that universities and KTOs must engage in considerable effort to effect changes and successfully achieve such alignment (Taxt, 2024). In particular,

'To ensure effective governance, specific attention should be paid to the role of SSH disciplines, avoiding overestimating a STEM-driven approach which is mainly focused on the creation of firms and patenting' (respondent 4).

Indeed, the acritical adoption of STEM-driven models and their criteria for assessing KTO performance may affect small universities and SSH-based HEIs in a negative manner.

A series of challenges posed concerns that require attention, particularly in those universities that do not have extensive expertise in the field of knowledge transfer and long term cooperation with industry. In particular, building and strengthening partnerships with external stakeholders such as industry partners, investors and government agencies can prove challenging. KTOs should arrange awareness-raising campaigns for companies and institutions to showcase the opportunities related to academic–industry collaboration.

Another effective strategy is to develop relationships with venture capitalists and business angels, which could assist in attracting start-up funding. One good practice is organising annual search and match initiatives for scholars and potential business partners.

To address the internal and external challenges described above, KTOs should formulate strategies and a set of objectives, processes and actions for knowledge transfer that are aligned with the goals of the HEI.

'This includes defining processes for knowledge creation and transfer, establishing communication channels, and training staff. Then, the KTO should ensure the successful implementation of its strategy: by engaging and supporting key stakeholders, establishing mechanisms for monitoring and evaluating the results, and for preventing or addressing issues that may arise during the implementation of the strategy' (focus group 3).

Other effective strategies are to schedule milestones and deadlines and allocate adequate human resources and funding to KTO initiatives. Table 3 presents a selection of proposed guidelines for conceptualising a KTO strategy.

Monitoring KTO performance

It is also extremely important to set up a monitoring system for KTO performance. This requires defining the concept of impact and communicating it effectively (Farjoo, 2024). Although the literature has provided various definitions, the concept of impact in the field of knowledge transfer fundamentally depends on the university's distinctive characteristics, the choice of innovations that are to be prioritised (e.g. technological innovation vs social innovation, volume of patents vs community wellness and resilience, workforce creation vs quality and extent of actions to address inequalities) and the HEI's embeddedness within the innovation ecosystem (Wolson, 2007). While the extent and outcomes of KTO operations may differ even within the same region, research channelled by KTOs can impact

Table 3
Conceptualising a KTO strategy.

Dimensions	Processes and actions
<ul style="list-style-type: none">Defining the strategic position of the university within the regional and national innovation ecosystem	<ul style="list-style-type: none">What contribution could the university make to the ecosystem?What values could the university offer/contribute to developing the ecosystem?Promoting the synergy between STEM and SSH disciplines by integrating the features of the departments/faculties/schools in the HEI.
<ul style="list-style-type: none">Identifying key dimensions for co-creation and cooperation	<ul style="list-style-type: none">What are the most pertinent technologies or lines of social/cultural/economic innovation that align with the HEI's characteristics and values?What are the most pertinent technologies or lines of social/cultural/economic innovation of the HEI that could contribute to developing the ecosystem?Studying, monitoring and assessing processes and forms of innovation, costs, markets and societal and environmental considerations.
<ul style="list-style-type: none">Defining the knowledge transfer strategy and supporting its implementation	<ul style="list-style-type: none">Engaging and supporting key stakeholders.Establishing mechanisms for monitoring and assessing actions and expected outcomes.Addressing issues and obstacles that may arise during strategy implementation.
<ul style="list-style-type: none">Setting up an incentive system to promote knowledge transfer initiatives	<ul style="list-style-type: none">Introducing incentive and code-of-conduct schemes.Reducing teaching hours to compensate for the time dedicated to research and knowledge transfer activities.Extra funding for research activities.

Source: Authors' elaboration.

economic, cultural, social and environmental dimensions. These dimensions are interlinked; for example, licensing agreements and academic spin-off companies can generate additional revenue for HEIs and employment opportunities, particularly for early stage researchers and graduates. In addition, direct economic and technological spillovers may occur at the local level by stimulating additional R&D investment and job creation (Siegel et al., 2007).

When the dissemination and the use of research outputs is enabled by the implementation of effective KTO support services, this can have economic impact by promoting the development of new products and services, influencing business strategies and generating job opportunities. Research can also be used by firms to develop innovative technologies and methods to reduce the environmental footprint of activities. Universities, incubators and accelerators can all have an important role in transferring such research to the business field.

Concerning the social, environmental and cultural dimensions, one respondent said,

'[...] KTOs can contribute to inspiring social entrepreneurship and solutions to societal challenges. Also, research channelled by the KTO can drive sustainability-focused innovations. Indeed, scientists can study environmental issues, develop new technologies to save resources and reduce the footprint of cities, industries and consumers. Moreover, KTOs can promote a culture of innovation and knowledge sharing' (respondent 8).

Knowledge transfer of scientific research could also provide insights that can assist the design of policies and regulations for entrepreneurship and innovation, e.g. research specialisations and subsidies for applied research, upgrading ties within the ecosystem and subsequent performance. Furthermore, KTOs can pass on knowledge to encourage regional governments to base strategies on the real needs of specific geographical areas. The findings confirm that KTOs should be legitimated by their university governing bodies to engage in activities that go beyond the mere commercialisation of research outcomes. Indeed, the absence of changes in their institutional official mandate can generate tensions within KTOs regarding how to interpret the expectations surrounding their expanded role (Borrás et al., 2024). Therefore, KTOs should be mandated to interact

with local government institutions and participate in regional infrastructure, e.g. science parks and incubators.

Table 4 presents the key dimensions, challenges and suggested actions for defining a KTO monitoring system.

The results show that challenges in the field of KTO monitoring include a lack of exchange of experience and information about scientific and technological achievements and lack of communication between KTOs and academic staff. In addition, the risk of duplicating monitoring activities remains, which can result in multiple surveys

Table 4
Designing a KTO monitoring system.

Dimensions	Challenges and actions
<ul style="list-style-type: none">Data collection and tracking	<ul style="list-style-type: none">Obtaining accurate and comprehensive data on the current status of already established knowledge transfer activities. This can be challenging because of decentralised processes.A starting set of KTO performance indicators includes, but should not be limited to, the size and (financial) volume of the collaborative research portfolio; the portfolio of discoveries, patents and licences; and the spin-off portfolio.
<ul style="list-style-type: none">Metrics	<ul style="list-style-type: none">Defining appropriate metrics for monitoring the heterogeneous outputs of knowledge transfer;balancing quantitative metrics such as revenue with qualitative indicators, including societal impact and the degree of the HEI's and KTO's engagement with external ecosystem stakeholders.
<ul style="list-style-type: none">Evaluating impact	<ul style="list-style-type: none">Assessing the impact of knowledge transfer activities can be challenging due to the time lag between efforts and outcomes (tangible and intangible). For example, it may take years for technologies to reach the market, generate revenue or have any societal impact, necessitating long-term evaluation.

Source: Authors' elaboration.

and reports with heterogeneous outcomes even within the same department/faculty/school.

KTOs' structure, implementation and management should be based on clear regulations at university and country levels. However, scholars, university managers and policy-makers must collaborate to address the challenge of conceptualising a system of indicators based on a certain degree of flexibility for considering the features and activities of the various types of HEIs and KTOs (Molas-Gallart et al., 2002). To ensure a practical solution for this issue, it is of the utmost importance to define

'appropriate performance metrics to monitor the knowledge transfer activities and balancing quantitative metrics, such as revenue generation, with qualitative indicators, like societal impact and innovation ecosystem engagement' (focus group 3).

Collaboration

The capacity to construct and strengthen ties with diverse private and public ecosystem stakeholders is crucial for ensuring the effective impact of university activities in the geographical areas where they operate. Our findings add to recent research asserting that KTOs should understand the interests and mutual benefits of HEI stakeholders to develop an innovation path that is aligned with the existing ecosystem (Farjoo, 2024). To this end, a two-step process should be managed by KTOs under the supervision of the university governing bodies. This process first involves

'understanding and aligning the diverse interests and the objectives at stake of stakeholders' (respondent 3).

Second, KTOs must

'navigate bureaucratic and administrative hurdles when designing and implementing collaboration agreements' (respondent 3).

Diverse motivations and visions indicate the need to identify a set of common goals and shared interests among HEIs, firms and other non-academic stakeholders. Different opinions may emerge due to

heterogeneous perspectives on innovation, approaches to business development and use of available resources. It is not only a matter of whether a university is able to reach out to the external community, but also whether the external community (in the opposite direction) is willing and able to establish a dialogue with academics. For example, a reciprocal perception often arises that the business sector is too distant from university programmes, initiatives and innovation processes. Although mutual lack of confidence may prevail, collaboration can be promoted by leveraging digital tools to overcome misconceptions and cultural barriers to allow co-creation and knowledge transfer to take place.

KTOs are also important for developing effective initiatives to improve cooperation, outreach and engagement with the non-academic community. To do so, KTOs should support (i) information flow, cultivating awareness of what is happening in academic and non-academic communities and (ii) networking, establishing relationships with others and building bridges between communities.

The specific tools used to promote cooperation should be aligned with HEI objectives. For example, arranging networking events and organising sessions to connect investors and promising ventures is recommended to create meaningful interactions when the targets are potential investors for spin-off companies and start-ups. Networking events could include conferences, sectoral investment forums, demo days, start-up competitions and virtual events based on digital platforms. Presenting stories of successful firms and innovations that have already received funding could also attract and encourage future investors. Such networking could be promoted by external partners specialised in supporting start-ups and transforming academic research into marketable products and services. One respondent emphasised that

'the KTO can further strengthen its activities by cooperating with KTOs of other countries. This facilitates the exchange of good practices and joint solutions to global challenges' (focus group 4).

In addition to collaborating with other KTOs, it is also imperative to cooperate with regional and national clusters with industrial or thematic specialisations, e.g. sustainability or digital innovation. Such actors could help KTOs to engage potential investors. Alumni

Table 5
Challenges and actions for KTOs to enhance collaboration and co-creation.

Challenges	Actions
<ul style="list-style-type: none">• Reaching and engaging potential investors and licensees for academic spin-offs and start-ups at European and international levels	<ul style="list-style-type: none">• Building, promoting and revising brokerage digital platforms to showcase both scientists' profiles and the ideas/technologies/applications/services developed to facilitate knowledge transfer from academia to industry and society at large;• collaboration with international enterprise networks to make patents available on their platforms and establish partnerships between nations;• technologies and licensing opportunities could be advertised by channelling contents and potential applications through websites, social media, videos, brochures, conferences and exhibitions;• communication should leverage competitive advantages and economic benefits as well as the social and environmental sustainability of innovations.
<ul style="list-style-type: none">• Addressing potential conflicts between inventors or institutions involved in research• Dealing with the dyad of disseminating research findings vs commercial appropriation of knowledge	<ul style="list-style-type: none">• A code-of-conduct should address issues such as research security and integrity, conflicts of interest and commitment;• ensuring proper IPR assignment;• identifying suitable commercialisation pathways for IP and potential licensees or partners;• negotiating fair and beneficial licensing agreements that respect the interests of all parties involved;• promoting awareness of the importance of protecting, using and disseminating research outcomes.
<ul style="list-style-type: none">• Costs for patenting and lack of funds	<ul style="list-style-type: none">• Clear rules must define how costs and processes are shared between scientists, research groups, KTOs, HEIs and non-academic stakeholders collaborating in knowledge transfer activities.

Source: Authors' elaboration.

networks could also be involved in these initiatives. Indeed, alumni can serve as ambassadors by inviting investors, experts and mentors to support knowledge transfer and academic entrepreneurs. Table 5 presents a selection of challenges and actions for building or strengthening ties between KTOs and ecosystem stakeholders.

A roadmap for KTO improvement and interdependencies between dimensions

To address internal and external obstacles to the adoption of a new paradigm of knowledge transfer, KTOs' role should be redesigned by considering their mission, functions, social responsibilities and the channels through which diverse impacts can be affected on the local communities and innovation ecosystems in which they operate.

We present a roadmap based on the four dimensions of our theoretical framework. Given the need to continuously monitor, improve and adapt the KTO structure and processes, offices should design services for knowledge transfer and innovation by implementing specific actions concerning *people*, *culture*, *governance* and *collaboration* to ensure synergy between the four dimensions. Fig. 3a presents a synthesis of the findings obtained from our qualitative analysis.

Regarding the people dimension, KTOs should enhance staff skills and expertise by hiring personnel with diverse backgrounds and professional experience, developing in-house training programmes for upskilling and reskilling and encouraging KTO staff to build and strengthen collaboration with non-academic partners who could contribute to further improving innovation services. Along with selecting and training staff, KTOs should stimulate the transition towards a new culture of knowledge transfer and innovation by promoting an entrepreneurial mind-set among KTO personnel, scholars and students. It is also essential to introduce monetary and non-monetary incentives to motivate KTO collaborators to improve performance at individual and team levels.

In addition, it is crucial to ensure effective governance and streamline KTO operations. To this end, universities' governing bodies should strengthen their commitment and leadership roles and recognise KTOs' roles and responsibilities by defining a clear organisational structure and articulating coordination mechanisms between the KTO and other university bodies, offices and infrastructures. This would subsequently enhance synergies at the university

level, better allocate human and financial resources and avoid overlapping activities between offices and departments/schools/faculties.

Along with internal collaboration, KTOs are tasked with creating and strengthening strategic partnerships with key stakeholders of the local innovation ecosystem to exchange and acquire knowledge and resources to improve services for knowledge transfer and innovation. To this end, KTOs must understand the needs of key stakeholders, leveraging appropriate communication strategies and channels to disseminate the value of knowledge generated at the academic level. KTOs should also exploit the opportunities offered by participating in international networks, particularly those that concentrate on exchanging, adapting and implementing good practices for knowledge transfer. Non-academic intermediaries could be of assistance for starting collaborations and developing formal partnerships. Once ties have been established, scholars and students can be connected to specific projects or entrepreneurial initiatives to promote co-creation.

As shown in Fig. 3b, interdependencies and synergies between the four dimensions are important. The people dimension seems to be the most important, considering the role of KTO staff as ambassadors, promoters and mentors of knowledge transfer and co-creation mechanisms. People can nurture the culture dimension, support the development of an entrepreneurial attitude across the academic community (*p1*). Governance is also crucial as a prerequisite to ensure commitment, resources and sound/sustainable organisation of KTOs, which influences each of the three other dimensions (*g1*, *g2*, *g3*). Despite changes in university governance and vision for the role of KTOs, having a strong internal culture can ensure HEIs' long-term commitment to knowledge transfer within the innovation ecosystem (*c2*). When the foundations of culture are strongly rooted, the role of a KTO cannot be questioned.

Collaboration is at the heart of KTOs as networking encourages innovation and co-creation processes and prepares the foundation for sustainable partnerships that could reinforce teaching and research activities and HEIs' internal culture of entrepreneurship. A clear governance commitment (*g1*), a well prepared and motivated staff (*p2*) and an established culture of knowledge transfer and entrepreneurship (*c1*) can collectively guarantee the trust and reliability of the local community and foster better collaboration capacities for universities. Furthermore, close collaboration can improve people's skills (*co2*) and internal culture (*co1*) through mutual learning and HEIs' improved absorptive capacity.

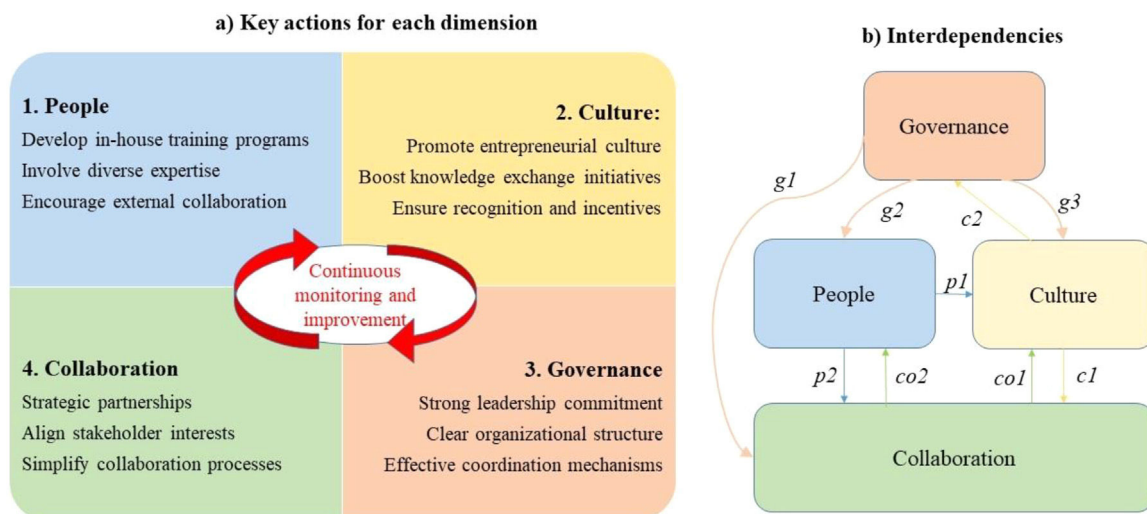


Fig. 3a and 3b. A roadmap for KTO implementation and improvement. Notes: *p* = people; *c* = culture; *g* = governance; *co* = collaboration. Source: Authors' elaboration.

Conclusion

This study explored the challenges encountered and the good practices enacted by KTOs in improving services for knowledge transfer and innovation. After conceptualising a theoretical framework for KTOs based on four intertwined dimensions of *people, culture, governance* and *collaboration* we designed, tested and administered an online questionnaire to the representatives of nine KTOs in HEIs participating in the European AccEnt project. The results were then validated and enriched with the information obtained from a set of focus groups involving 30 participants, encompassing scholars, KTO personnel and start-up representatives. The roadmap we constructed could drive university managers to implement or improve KTOs in the long run in addition to informing policy-makers designing knowledge transfer policies.

HEIs have adopted different approaches to knowledge transfer and innovation, enacting diverse strategies and practices based on their distinctive characteristics and vocations. Institutions that are more focused on STEM disciplines usually have a technical approach for setting up and managing KTOs and tend to develop initiatives that are primarily driven by technology transfer between academia and the business community. Start-up creation and patenting are crucial concerns for such KTOs. In contrast, SSH-driven universities struggle to promote technological cultures of innovation. Consequently, they could neglect the contribution they could make to knowledge transfer and innovation. However, some of these HEIs have progressively developed a wider concept of knowledge transfer by addressing the economic effects of their activities as well as the social, cultural and environmental impacts on their communities. This approach should not be considered as an alternative to KTOs' technical focus. However, it could inspire HEIs to evaluate their expected contribution to social progress. Indeed, the commitment of universities to exert a growing impact on civil society is not the result of a generous choice on their part, but an expression of the growing imperative of social responsibility. HEIs and their KTOs are intended to function as engines of development and true guardians of legality, culture and democracy. Therefore, they should contribute to addressing inequalities by accepting the importance of communities' heterogeneity and uniqueness to address discrimination and promote equal opportunities and solidarity by fostering more inclusive social contexts. Such targets could also be achieved through technology transfer, which becomes a tool and not the unique aim (or end) of universities and their KTOs.

As for the limitations of this study, our analysis was based on a sample of nine European universities and their KTOs from different geographical areas that reflect heterogeneous institutional frameworks. Furthermore, each HEI/KTO has distinctive features and degrees of embeddedness within innovation ecosystems and diverse experience in designing and enacting support services for knowledge transfer and innovation. Therefore, caution must be taken in generalising the results to other contexts.

Future research should investigate the generalisability and effectiveness of the proposed roadmap. In particular, by analysing a broader sample to cluster KTOs according to the specific features of HEIs and ecosystems. To this end, the use of software may offer further qualitative insights into the interdependencies between the dimensions. Moreover, to further validate the approach, it would be beneficial to develop a longer term analysis by establishing a set of indicators for each of the roadmap dimensions. While only four key dimensions were selected in this study for examining KTOs, future studies could identify and categorise further innovation resources for examination.

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Declaration of competing interest

None

CRediT authorship contribution statement

Lorenzo Compagnucci: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Francesca Spigarelli:** Writing – review & editing, Supervision, Project administration, Conceptualization.

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