Technology Transfer Offices for Better Management of The University-Industry Collaboration: Comparison of Slovenia, Italy, And Malta

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Abstract

The paper addresses a manifestation of University-Industry collaboration - the Technology Transfer Offices (TTO). The University-Industry collaboration is relevant in the age of Open innovation, and TTO serves as the meeting point of two worlds. In this context, we are interested in how three specific cases of TTO operating in three distinct innovation ecosystems understand their role and how they perceive their strengths and weaknesses. The reader of the presented research will get an insight into three innovation ecosystems, each particular in its regard, and will learn that despite the differences among countries and cultures, the questions the TTO are struggling with are less diverse. A qualitative empirical study in three countries included focus group participants and expert representatives of academic-business technology transfer actors. To sum up, the respected countries need to carefully tailor innovation policies and explore the benefits of the TTO in boosting the commercialisation of products developed at universities.

Keywords: Technology Transfer Offices; Slovenia; Italy; Malta; University-Industry collaboration; innovations; social field; cognitive frames, networks; institutions.

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1. Introduction

In times of ever-increasing interest in the university's third mission (Iakovleva et al., 2022; Leydesdorff & Etzkowitz, 2001; Nsanzumuhire & Groot, 2020), the systemic level of policymaking has made large efforts to support the establishment of framework conditions to enable the universities to initiate work in the field of the third mission.

As some research tentatively concludes, the regions can benefit from such systematic activities (Besednjak Valič et al., 2021; Kolar & Besednjak Valič, 2021) numerous efforts are being made to support the "entrepreneurial university" systematically manifested through intensified technology transfer and support for a collaborative project with industry and other stakeholders (Iakovleva et al., 2022). As the entrepreneurial university model derives from the US reality of the 19th century, characterised by a lack of state-supported research funding (Iakovleva et al., 2022), the situation in Europe is entirely different. The top-down approach in the European Union (from here onwards, EU) is noted through several initiatives, like the Commission Communication "Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation" (European Commission, 2007a), adopted in 2007. The Communication identified the need to improve knowledge transfer between public research organisations and third parties as one of the key elements of the EU's innovation strategy, as research shows the gap persists (Nsanzumuhire & Groot, 2020).

Further, the topic of a top-down approach to knowledge transfer is also addressed in the Commission's Green Paper entitled "The European Research Area: New Perspectives" (European Commission, 2007b). Following the Commission Green Paper "The European Research Area: New Perspectives" (European Commission, 2007c), the European Parliament issued a Resolution encouraging the creation of a single labour market for researchers, the development of world-class research infrastructures, the strengthening of research institutions by sharing knowledge, and the optimisation of research programs and international cooperation in science in technology (van Eecke et al., 2009). By 2020, across the European Research Area (from here onwards, ERA), the free circulation of researchers, knowledge, and technology was established. The ERA aims to create significant added value by fostering healthy scientific competition while ensuring appropriate cooperation and coordination (van Eecke et al., 2009). Apart from positive impacts, some research also notices the increase in competitiveness, creation of straw networks, and administrative burden for organisations (Besednjak Valič et al., 2021). However, the response to the European status quo seems to be in investments in networks of Technology Transfer Offices (from here onwards, TTOs) with a mission to motivate, organise and support the commercialisation of scientific and research results (Argyropoulou et al., 2018). Many European TTOs were established in the late 1990s as important intermediary actors in University-Industry collaboration.

Having said all the above, the main research question is focused on detecting the views, strengths, and shortcomings of TTOs in three unique innovation ecosystems. Further, we are interested in how innovation policies, where they operationalise the work of TTOs, can be modified to improve University-Industry collaboration and commercialisation of research results.

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We adopt a theoretical framework grounded in social fields theory to deliver the proper answers to the research question posed (Beckert, 2010; Rončević et al., 2022). This theoretical framework allows us to examine the dynamics of social forces surrounding the TTOs within the innovation ecosystems of Slovenia, Italy, and Malta. By integrating this theoretical perspective, we aim to elucidate the complex interplay between institutional structures, cultural contexts, and individual perceptions in shaping the functioning of TTOs and facilitating university-industry collaboration. By conceptualising institutions, cognitive frames and networks as social forces constructing a particular social field, we take into consideration also the role of power relations, cultural norms, and organisational structures in shaping actors' behaviours and interactions within the innovation landscape.

Social fields theory posits that institutions and networks, both formal and informal, shape the behaviour of actors within The National Innovation Systems (from here onwards, NIS), influencing their interactions and decision-making processes. Additionally, cognitive frames explore how common ideas and understandings influence individuals' perceptions and responses to new technologies, thus shaping their actions within the innovation landscape. Moreover, cognitive frames elucidate how individuals' shared perceptions, beliefs, and mental frameworks influence their attitudes and behaviours towards innovation. By analysing the cognitive frames of actors involved in technology transfer, researchers can uncover underlying biases, motivations, and decision-making processes that impact the success of university-industry collaborations.

The research is focused on three distinct social settings – NIS of Slovenia, Malta, and Italy. We selected three culturally similar countries with, to some extent, nascent technology transfer ecosystems. Slovenia and Malta are particularly interesting due to their geographical size, whereas Italy is interested due to the fragmentation of their technology transfer ecosystems. Each country approaches the technology transfer, emphasising each social force of the National innovation ecosystems.

The methodology adopted in this study entails qualitative empirical research aimed at investigating the perceptions, strengths, and shortcomings of TTOs within the innovation ecosystems of Slovenia, Italy, and Malta. Through focused group discussions, the research sought input from University-Industry actors representing various entities such as universities, research institutes, spin-offs, and funding entities. The discussions provided a platform for participants to share their insights on the roles and operations of TTOs in their respective countries. Through qualitative analysis, thematic coding was applied to the transcribed records, allowing for the identification of recurring themes and patterns that shed light on the challenges and opportunities encountered by TTOs in each context.

Key findings from the study highlight the critical role of TTOs in Intellectual Property (from here onwards, IP) protection, technology commercialization, and fostering University-Industry collaborations. Despite challenges in policy regulation and bureaucratic hurdles, TTOs were recognized for their competence and quality of services. Cultural attitudes towards entrepreneurship varied, with risk aversion and fear of failure cited as barriers, particularly in Italy. Trust emerged as a critical factor for successful collaboration, with implications for partnership dynamics and innovation outcomes. Positive perceptions of collaboration in Research and Development (from here onwards, R&D) were noted, with trust-building highlighted as a gradual process influenced by external funding sources. Challenges related to time constraints, funding limitations, and differing paradigms between academia and industry were identified, underscoring the need for targeted interventions to optimize collaborative potential. These findings shed light on the complex interplay of institutional, cultural, and structural factors shaping TTO effectiveness and highlight the importance of tailored policy interventions to enhance university-industry collaboration.

The paper is structured as follows: first, we discuss the role of TTOs as intermediary services, the complex ecosystems of University-Industry collaboration and National Innovation Systems as an ecosystem of interactions and linkages. Further, we briefly present the technology transfer state-of-the-art in Slovenia, Italy, and Malta. The empirical part of the paper outlines the research methodology and delivers the results and discussions. The paper finishes with conclusion remarks.

2. Technology Transfer Offices as Intermediary Services

We approach Technology Transfer as "the process of transferring knowledge, skills, manufacturing methods, technologies, manufacturing samples, and facilities among governments and other institutions to ensure that scientific and technological progress is accessible to a broader range of users who can then further develop and exploit the technology into new processes, applications, products, materials, or services" (Messer-Yaron, 2012, p. 2). This definition refers mainly to transferring research results from Public Research Organizations (from here onwards, PROs) to the industrial sector (Messer-Yaron, 2012).

In the era of Open Innovation (Chesbrough, 2003), a structured technology transfer is a thoughtful business model and an activity particularly driven by the third mission of the university to commercialise academic knowledge and research results (Markman et al., 2008). Spill-over effects include increased entrepreneurial activity through establishing new firms, lower unemployment rates, and higher economic wealth (Hülsbeck et al., 2013). TTOs, as offices ensuring the smooth technology transfer, derive from the USA, supporting their ecosystem of seeking private funding for research activities. Similarly, the TTOs developed in the UK, whereas continental Europe does not positively respond to the TTOs as intermediary actors supporting the commercialisation of activities (Hülsbeck et al., 2013). Hulsbeck et al. (2013) underline the significance of the cultural background of continental Europe and the traditional division between Univesity and Industry as the main factors hindering the success of the business model of the TTOs (Hülsbeck et al., 2013). Apart from that, TTOs work to adopt a technology "push" or "inside-out approach", where renewed knowledge is "pushed" from the research institution to third parties (Modic & Damij, 2018). To commercialise novel technology, common means include selling IP, licensing, or forming spin-off

firms (Modic & Suklan, 2022, 2023). This technology "push" strategy creates unique problems, and many research institutions struggle to reap adequate advantages from their knowledge transfer initiatives in the short and/or long Term (Cleyn and Festel, 2016). In most countries, the TTOs operate as units within the administrative organisation of Public Research Organisations (from here onwards, PRO). As they depend on public funding and top-down financed projects, they are comprised of few or fewer employees who are to give legal and economic advice to individual inventors (Hülsbeck et al., 2013). Innovations and their commercialisation are based on networking effects between individual researchers, academic institutions, and industrial partners with the mediation of the TTOs. Some critics state that networking with other networkers has become the only purpose of existence (Krücken et al., 2007)

National Innovations Systems and University-Industry Collaboration

When addressing the National Innovation System (from here onwards, NIS), we understand it as a network of institutions, organisations, and people engaged in a country's innovation processes (López-Rubio et al., 2022 Kolomytseva & Pavlovska, 2020). The NIS is more than simply a collection of separate institutions; it is an ecosystem of interactions and linkages between them. It includes various actors, such as universities, research institutes, businesses, government agencies, and other organisations. Freeman (Freeman, 1987) established the notion of NIS in 1987, defining it as a network of institutions that interact, import, change, and disseminate new technology. According to Freeman, the NIS consists of formal and informal institutions and functions on a national scale. .

In recent years, the idea of NIS has expanded to include a larger spectrum of social and institutional elements influencing innovation. Scholars such as Beckert (Beckert, 2010) and Rončević et al. (Rončević et al., 2022), for example, have conceptualised NIS as a social field, underlining the significance of cognitive, social, and institutional factors for innovation. The methodological approach SOFIA (Rončević et al., 2022) was tested on several occasions (Besednjak Valič, 2022; Klopčič et al., 2022). Institutions are the formal laws and structures that affect the behaviour of NIS agents, whereas networks are the informal contacts and partnerships between actors. Cognitive frames are shared ideas and understandings that impact how actors perceive and respond to new technology. The relevance of cognitive and institutional elements in shaping the NIS is also emphasised (Modic & Rončević, 2018; Rončević et al., 2022).

Both subsystems (academic and industrial) communicate via intermediate organisations. Regional development agencies, technology and/or scientific parks, and TTOs are examples of fields(Kolomytseva and Pavlovska, 2020). These last can help academics and industry by providing money, infrastructure, and business development services. For instance, regional development agencies may aid in the transfer of knowledge and technology from academia to industry by encouraging collaboration between academics and industry fields (Kolomytseva & Pavlovska, 2020). Technology and science parks can help speed the commercialisation of university research and create new goods and services by offering access to cutting-edge facilities, equipment, and experience (Arranz et al., 2020). However, to be able to deliver fully integrated service, specific competencies are in place, particularly for territorial actors engaged in the future development of NIS.

3. Technology Transfer in Slovenia, Italy, and Malta

The current state of technology transfer in Slovenia

The Higher Education Act (Republic of Slovenia, 1993) and the Research and Development Activities Act (Republic of Slovenia, 2022) are the two major statutes for the dynamic growth of science and research at universities and research institutes, and both must better represent the demands of knowledge and technology transfer.

Slovenia aims to involve and engage "customers" (i.e. consumers of government services) in the creation process to provide more efficient and effective contact points for the information and communications materials provided by the government. Innovation (including research and science organisations – Slovenia Research and Innovation Agency (from here onwards, ARIS), public institution SPIRIT,..) mutually reinforce and signpost each other, where necessary, to ensure that the journey of relevant stakeholders in the innovation ecosystem to access key information (funding, policies, responsible people, and contact information) is as simple as possible (Ministry of Economic Development and Technology RS, 2022).

The Ministry of Higher Education, Science, and Innovation (from here onwards, MHESI) made €6 million available between 2017 and 2022 to assist the work of TTOs (European Commission, 2017). This was accomplished through the Knowledge and Technology Transfer (from here onwards, KTT) initiative, with eight partners spending 80% of the funds on human resources (Stres & Pal, 2020). This contributed to forming a network of TTOs throughout Slovenia, which should be conserved but enhanced in terms of effect. In 2024, 2 KTT initiatives were awarded an additional 4,3 million EUR (Republic of Slovenia, 2024). The main tasks of KTT remain in networking, strengthening links and cooperation between public research organisations and the industry. Additionally, the KTT strengthens the commercialisation of already developed scientific solutions, encouraging demand (*KTT*, 2023). Despite this initiative, in 2024, the Slovenian TTO ecosystem is in a nascent phase, supported by the Slovenian Innovation Hub (from here onwards, SIH). SIH is another top-down initiative to ease the transfer of innovation and technology from universities and research institutions to the commercial sector to produce new goods, services, and processes that can fuel economic growth (*Digitalno Inovacijsko Stičišče Slovenije*, 2020). In addition, the SIH has built various innovation centres and clusters around Slovenia that serve as centres for research, development, and innovation activities in specialised fields such as advanced materials, biotechnology, and energy (*Digitalno Inovacijsko Stičišče Slovenije*, 2020; Ministry of Economic Development and Technology RS, 2022).

The current state of technology transfer in Italy

The first explicit university TTOs activities appeared in the early 1970s when TTOs were considered an "epiphenomenon". Universities were often indifferent to explicit technology transfer activities and sometimes even opposed them. Since the mid-nineties, have technology transfer activities aroused growing interest among academics and politicians. Most Italian universities have gradually recognised the monetisation possibilities of their research achievements. Unsurprisingly, most Italian university technology transfers were established during the previous decade. In this regard, the key event happened in November 2002, when several Italian institutions realised the necessity for collaboration to boost the utilisation of their R&D. Italian Research Valorisation Network (from here onwards, NetVal) was founded for this purpose, and its members currently constitute the great majority of Italian institutions (*NETVAL*, 2023).

Furthermore, the Italian Ministry of University and Research (from here onwards, MUR) has lately allocated money to support university technology transfer operations (Balderi et al., 2007). The institutional changes in the national legislative framework have further facilitated technology transfer activities from universities to industry. In this regard, national legislation 297/1999 was the first legislative act to consider - if indirectly - the subject of academic spin-off enterprises (Balderi, 2010).

The technology transfer ecosystem in Italy is heterogeneous and fragmented, with different universities and research organisations using different methods of technology transfer. In the last three years, the Italian government has launched several measures to foster TTO development and university-industry collaboration. These initiatives (such as Research and Innovation 2014-2020, Industry 4.0 National Plan, National Plan for Research and Innovation, and Next Generation EU Plan) include technology transfer finance programs, the construction of a nationwide network of TTOs, and the development of a legislative framework for technology transfer. All the above is making the Italian technology transfer ecosystem fit in the nascent development phase.

The current state of technology transfer in Malta

Also, due to the country's size, the connection of the TTO ecosystem seems better organised than in Italy and Slovenia. The University of Malta (from here onwards, UoM) and Malta College of Arts, Science, and Technology (from here onwards, MCAST) nowadays play a significant role in the technology transfer process. Furthermore, the Malta Enterprise Agency provides financial assistance and consultancy services to Maltese businesses interested in collaborating with universities (*Malta Enterprise,* 2023).

The UoM is home to the Centre for Entrepreneurship and Business Incubation (from here onwards, CEBI), which seeks to strengthen entrepreneurship. The CEBI also houses the so-called TAKEOFF incubator, created to assist start-up firms (European Commission, 2018; Ministry for Finance Malta, 2018). Since 2020, the Ximbassador Programme, conducted by the university's TTO in collaboration with the *Ximbio programme* (*Programme Brings Benefits to Everyone - Malta Ximbassador - Ximbio,* 2020), has assisted researchers and Ph.D./Postdoc students in resolving issues while offering societal effect and value to the institute.

To sum up, Malta has established various activities targeting developing skills and supporting economic activities, particularly in aviation, life sciences and medical services, information and communications technology, digital media, and other services (logistics, healthcare, and maritime services) (European Commission, 2019, p. 39), making Maltese technology transfer ecosystem fit in the nascent phase.

4. Methodology

The methodology employed in this study draws upon the theoretical framework of social fields theory to explore the dynamics of TTOs within the innovation ecosystems of Slovenia, Italy, and Malta. Given the emphasis on understanding the institutional structures, cultural contexts, and individual perceptions shaping technology transfer processes, qualitative empirical research methods were deemed most suitable. Data analysis is guided by the theoretical concepts of social fields theory, allowing for a nuanced understanding of the complexities inherent in university-industry collaboration and technology transfer.

The discussion was organised within the frame of focus groups, with the university-industry actors invited to discuss and evaluate different aspects of technology transfer in their respective countries. The discussions lasted around 1,5 hours, and participants were offered full anonymisation.

Three focus groups (one per country) were organised in January 2021. Due to the COVID-19 pandemic, relevant Malta, Slovenia, and Italy actors participated via the online meetings application. Each focus group consisted of three participants. Besides universities (all three countries), some participants represented a spin-off of a hospital (Italy), a consortium of research infrastructures (Italy), a research institute (Slovenia), and a research funding entity (Malta), as listed in Table 1.

Table 1: Number of expert participants per focus group.

No.	Country	No. of participants	Participants profiles
1	Slovenia	3	1 university representative 1 research institute representative 1 TTO representative
2	Italy	3	1 university representative 1 spin-off representative (medical hospital) 1 representative of consortium of research infrastructures
3	Malta	3	1 university representative 1 research funding entity representative 1 TTO representative

Source: own work

Throughout the discussion, the participants discussed the open-ended questions prepared for this research. It consisted of specific 5 topics jointly containing 18 different questions for discussion.

Following the focus group discussions, we transcribed the records and transcriptions were analysed through code assignature and categorisation. We refined the categories iteratively, discussing and revising the findings to verify the validity and reliability of the study. In this sense we followed the approach outlined by Bogdan and Biklen (2003). The categories for analysis encompassed several key dimensions of technology transfer and collaboration within the innovation ecosystems under investigation and are presented in Table 2 below.

Table 2: Categories for analysis.

Categories for analysis	Description of category
Role of TTOs	Focuses on understanding how TTOs perceive their roles, particularly regarding IP management, commercialization, and international collaboration.
Institutional Overview	Delves into the institutional support and regulatory frameworks affecting TTO operations, highlighting challenges such as bureaucratic hurdles and funding mechanisms.
Cognitive Frames	Explores stakeholders' attitudes towards entrepreneurship, learning, competition, and risk, shedding light on cultural differences and their impact on collaboration dynamics.
Networks	Centers on cooperation, trust, and networking among stakeholders involved in R&D activities, emphasizing the importance of trust-building and international collaboration.
TTOs and Their Services	Focuses on the operational aspects of TTOs, including the services they offer and the obstacles encountered during the commercialization process.
Innovation Policies	Examines the influence of innovation policies on TTO operations and University-Industry collaboration, highlighting the need for targeted policies and increased support to enhance technology transfer outcomes.

Source: own work

5. Results and discussion

The results below, presented as descriptive narratives, offer a joint response to the first of the two research questions, which elaborate on the views, strengths, and shortcomings of TTOs in three unique innovation ecosystems.

Starting with the first question, participants discussed the role of the TTOs in their country of origin. Here, we can join the explanation of university members from Slovenia and Italy: the main role of TTOs, it is to ensure the commercialisation of the developed technology. The participant from Slovenia explained the role of TTOs is also in taking care of the IP. The role of TTOs is similarly understood in Malta, with one TTO in the country somehow obliged to seek collaboration internationally.

In contrast, the dispersion of information needs to be revised in Slovenia and Italy, as interviewees admit the information is too dispersed and comes from too varied sources. Companies' Involvement in R&D activities varies by country; in Malta, such engagement is limited due to the economy and national market structure. Nevertheless, Slovenian and Italian representatives also express awareness of the need to stay competitive in the international market. Participants reflected on the attractiveness of their location and their countries' potential to keep talented people within their territory. Representatives of all three countries agreed that their respective countries are attractive to talented people. Additionally, they all agreed their countries can retain talented people. It was Malta's representatives who were aware the country's size was a limitation from the perspective of talented people.

Institutional overview

The institutional overview section focuses on the country's approach toward TTOs, competencies, and legislation. According to a focus group participant working in a research hospital, a lack of proper policy regulation is seen as a problem in Italy. The same person also mentioned the state does not give the impression of being positive towards initiatives supporting TTOs. However, the universities fund Italian and Maltese TTOs and use national funds and programs supporting technology transfer, and the same goes for Slovenia. In this context, the Italian participants emphasised the need to simplify the bureaucracy. Additionally, as emphasised by Italian participants, more knowledge is desired on the state of the art of academic rules regarding academic careers. In most EU countries, academic progress rules do not support collaboration between universities and industries. Hence, the researchers need to be sufficiently stimulated to engage in such activities. It would be worth exploring whether other factors are hindering University-Industry collaborations.

Slovenians, however, refrain from mentioning any particular problems regarding legislation but admit the spin-off creation is somewhat uncommon.

Despite this, in all three focus groups, interviewees agreed the TTOs in their countries employ competent persons, consequently, the services TTOs offer are of good quality. To be able to keep a high standard and even improve the quality of services, constant education and cooperation with other TTOs are crucial.

Cognitive frames

Within this topic, the perception of the population toward entrepreneurship, learning and competition was discussed.

Interestingly, the first topic that emerged within the discussion was topic of fear. Both Slovenian and Italian participants mentioned the existing people's mindset working against the entrepreneurial spirit. Slovenian and Italian people seem to be scared of failure. In this respect, both representatives of Slovenia explained that when thinking about entrepreneurship, we should also consider risks and challenges, so that's why entrepreneurs should be more respected. The respect should also be derived from understanding entrepreneurship is challenging and demanding.

In in the context of learning, focus groups participants recognise the slight improvement in their countries, as people seem to exhibit higher levels of interest in learning. However, in southern parts of Italy, respondents feel small groups of people are not interested in education. One of the reasons for such a relationship toward education could also be the fact that the level of education, at least in Italy, as one interviewee explained, sometimes doesn't match a good working position. And here comes competition, generally seen as good, desirable, and normal for all businesses that wish to improve. On the other hand, in Malta, an interviewee working in TTO at the university explained that the competition among Maltese is not very well accepted.

Networks

This topic predominantly discussed cooperation and trust as two important aspects of entrepreneurship. Regarding cooperation in the field of R&D, focus group respondents detect networking as very intensive on the national and international levels, particularly as interested partners are involved in numerous projects. The cooperation is widely spread and involves partners from universities, faculties, Small and Medium-sized Enterprises (from here onwards, SMEs), research institutes, and other relevant organisations. In all three countries, the collaboration is perceived positively by the public. Yet, one focus group participant from Slovenia mentioned that more media space should be given to positive cases of successful University-Industry collaboration.

Collaboration is only possible if there is trust and participants recognise its necessity when establishing new partnerships. Furthermore, trust is seen as a crucial element, and focus group participants all recognise that establishing it takes a long time. Slovenian focus group participants agree that the process of establishing trust is slow. The general opinion was that after initial contact, partners should first find some external funding sources for their joint research activity. This is how partners who previously didn't cooperate slowly become more trusting through a project they are working on. An interesting point of view was presented by an Italian participant. He claimed that the wider you geographically go, the lower the level of trust. Similarly, Maltese interviewees only emphasise the importance of trust in Malta in the opposite direction. The geographical constraints of a small island are inevitable, and, as one interviewee concluded, one cannot simply replace one stakeholder with another.

TTOs and their Services

The last topic went more deeply into the operation of TTOs and the quality of their services. All participants were also asked to think about the crucial obstacles and difficulties they saw during the commercialisation of a product. Finally, participants gave some suggestions for possible improvement of TTOs. In the case of all three countries, no special weaknesses were observed when the operation of the TTOs was in question. Let's mention here the point of view of the Slovenian representative of the university, who wished that more funds would be available so the TTOs could expand the outreach activity.

Regarding the services TTOs offer, here are the most often requested ones: The first is IP assessment, which is the entry point for all interested researchers. IP assessment is followed by services like business modelling, patent strategy, licensing IP protection, and product commercialisation at a later stage. All participants see IP protection as the most requested service. Apart from IP protection, commercialisation is an essential service. Before a product is market-ready, TTOs help with commercialisation strategies, like presenting technology offers to companies and visiting them. When discussing market entry obstacles, participants from Slovenia mentioned time, as the industry operates at a different pace than other sub-ecosystems, demanding short commercialisation time. On the other hand, the innovations

TTOs IP protect are oftentimes not market ready, as they reach a TRL between 5-6. Such innovations still require investment and more development work before they reach the market.

The same goes for Malta. As explained by the interviewee from a University TTO, it takes many years for the technology to finally turn into a finished product. So, dedication and commitment are very desirable if not demanded. From the Italian perspective, the biggest obstacle is choosing the right market for a product, its manufacturing, and its commercialisation process. Italian participants also added that money plays a very important role. One statement notes: "If you want to sell a product in the United States or China, you must also patent it there. That is, speaking from the point of view of an Italian university, it is quite expensive, and more money is needed".

Within the second research question, we are interested in how innovation policies, in the aspect where they operationalise the work of TTOs, can be modified to improve University-Industry collaboration and commercialisation of research results.

Based on the discussion and answering the second research question, the understanding of the necessity to work in an international setting appears stronger in Slovenia and Malta than in Italy. Operating in the commercialisation of research results, it is more evident that smaller countries must have stronger internationalisation aspirations and shorter information flows. As an example of a larger market with scattered technology transfer support, Italy recognises the need for a more centralised information flow. Malta and Slovenia's nascent technology transfer ecosystems experience financing challenges, and the same holds true for Italy. TTOs in all countries are generally sponsored by the state through project-based financing. Finally, the results show that experts desire more targeted innovation policies and further support (also financial) in accelerating the commercialisation of university-developed technologies. Given the particular characteristics of each innovation environment, each country should adopt a distinct strategy for technology transfer. The results of the present study can contribute towards shedding light on how TTOs understand their mission and deal with the problems arising from University-Industry partnerships and policies.

Additionally, the experts aspire to improve TTOs. The Italian representative mentioned the need to increase the number of TTO employees. Moreover, he also suggested an increase in policy elaboration. Apart from that, two participants from Slovenia see the possible improvement in contributing to raising the TRLs of innovation to speed up the commercialisation process. The second Italian suggestion aims towards more trust in collaboration, especially from the side of the companies. From the point of view of a Maltese TTO officer, more funds should be available for researchers, and when it comes to promoting new products, more focus should also be placed on the local market. As additionally elaborated, a more robust conversation between individuals and stakeholders would be needed, especially when commercialising a product. It was outlined that working on a national level in Malta is quite different from working on the national level in, for example, Germany or the UK. Apart from that, as another Maltese solution, stronger collaboration between TTOs and governmental entities is needed.

6. Conclusions

The paper highlights the growing interest in the university's third mission (Iakovleva et al., 2022), promoting economic growth and social development through technology transfer and partnership with industry and other stakeholders. The European Union has made significant efforts to support the creation of framework conditions that will allow universities to engage in the third mission, as highlighted in the Commission Communication "Improving knowledge transfer between research institutions and industry across Europe: embracing open innovation" and the Green Paper "The European Research Area: New Perspectives (European Commission, 2007a)." Apart from that, universities remain a vital actor within NIS. In recent years, the idea of NIS has expanded to include a larger spectrum of social and institutional elements influencing innovation, aligning with the concept of NIS as a social field (Beckert, 2010; Rončević et al., 2022). According to the concept of social fields, institutions and networks are formal and informal structures that influence NIS actors' behaviour.

In contrast, cognitive frames are common ideas and understandings that influence how actors perceive and respond to new technologies (Beckert, 2010). Social fields theory is the basis for the SOFIA methodological tool (Rončević et al., 2022) used for our study of the role of TTOs in University-Industry collaboration. The study focuses on three EU countries, Slovenia, Malta, and Italy, which have culturally comparable foundations. Still, their approaches to technology transfer vary, with a specific focus on each of the social dynamics of respected NIS. In this context, we were interested in the strengths and weaknesses of TTOs and how innovation policies can be modified to improve collaboration and commercialisation of University-industry-developed products. Slovenia, Italy, and Malta

Results showed that generally, the TTOs of the three countries share the services and concerns towards implementing their mission. We note different attitudes towards entrepreneurship, especially in the context of failure, risk, and competition, all related to cultural differences among countries. However, trust remains the main lubricant for collaboration, as noted in several prior research, especially in bonding and bridging social capital (Adam & Rončević, 2003). What is noted as interesting is the emphasis on geographical proximity as a trusted driver. This result gives a tentative conclusion about the role of interpersonal relationships that can not be replaced by digital means, which can effectively overcome the time/geographical distance issues.

Further research would be needed to elaborate on the peculiarities of the three technology transfer ecosystems. The nature of University-Industry partnerships in terms of national origin and the role of interpersonal relationships in trust building can be the subject of the research.

TTOs in all three countries seem to operate adequately but need help. Human resources is noted as a prominent challenge, as TTOs need more experienced personnel for project-based work funded by national or EU projects. The second challenge arises from the different paradigms in which academia and industry operate. Here, the main distinguishing element is time. Industry oftentimes employs "first to market" commercialisation strategy (Xin et al., 2010), whereas TTOs support more strategical innovation that includes IP protection.

On the other hand, academia stereotypically seems to be characterised by a more relaxed attitude towards time. In such contexts, both parties rarely share a joint understanding of time, more particularly in shared market strategies.

Some of the presented conclusions can serve as a guiding tool for future research. On the one hand, we see the potential for a more individualised approach in examining the cultural aspects of each NIS, as we can note that the cultural background of relevant actors impacts their actions. Cultural backgrounds inevitably shape the micro worlds of individuals, including researchers, and impact the establishment of research collaborations, trust among partners, or entrepreneurial spirit as a driving force of the most desired spillover effect of the enhanced University-Industry collaboration). Regarding geographical proximity as a trust enabler, further research is needed to obtain more substantial results.

As the main limitation of the present research, we identify the sample size. Focus group discussions included only experts from the field. As the research was qualitative in nature, we were interested in including only a few speakers, thus intentionally limiting the scope of discussants. The data was collected via an online tool, as the COVID-19 measures were iimplemented in time when research was taking place.

To sum up, by researching the state of the art and functioning of TTOs in three countries, we can contribute to understanding some peculiar characteristics of the functioning of nascent technology transfer ecosystems of Malta, Slovenia and Italy. Additionally, we detected particular cultural characteristics that can result as a differentiation factor when measuring the success of the work TTOs.

Appendix 1: list of Acronyms and their definitions

- TTOs - Technology Transfer Offices - offices or departments within universities or research institutions that transfer technology from research to the commercial sector;
- IP - Intellectual Property - intangible creations of the human intellect, such as inventions, literary and artistic works, designs, symbols, names, and images used in commerce;
- R&D - Research and Development;
- SMEs - Small and Medium-sized Enterprise;
- EU - European Union;
- NIS - National Innovation Systems;
- ARIS - Slovenia Research Agency;
- MESS - The Slovenian Ministry of Education, Science, and Sport;
- KTT - Knowledge and Technology Transfer;
- SIH - Slovenian Innovation Hub;
- NetVal - Italian Research Valorisation Network;
- MUR - The Italian Ministry of University and Research;
- UoM - The University of Malta;
- MCAST – the Malta College of Arts, Science, and Technology;
- CEBI - The Centre for Entrepreneurship and Business Incubation;
- PRO - Public Research Organizations.

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