2019

An Exploratory Study of the Role and Contribution of University Knowledge Transfer Offices (KTOs) in Knowledge Transfer and Value Creation

Anthony Paul Buckley
Technological University Dublin, anthony.buckley@tudublin.ie

Paul Maguire
Technological University Dublin, paul.maguire@tudublin.ie

David Gardiner
Technological University Dublin, david.gardiner@tudublin.ie

Recommended Citation

Buckley AP, Maguire, P, Gardiner, D (2019). An Exploratory Study of the Role and Contribution of University Knowledge Transfer Offices (KTOs) in Knowledge Transfer and Value Creation, 14th European Conference on Innovation and Entrepreneurship (ECIE), Kalamata, Greece, 19-20 September 2019. DOI: 10.21427/HT3E-1B19

An Exploratory Study of the Role & Contribution of University Knowledge Transfer Offices (KTOs) in Knowledge Transfer and Value Creation.

Anthony Buckley, College of Business, Technological University Dublin, Ireland
Paul Maguire, Hothouse, Technological University Dublin, Ireland
David Gardiner, Hothouse, Technological University, Dublin, Ireland
Anthony.buckley@dit.ie
Paul.maguire@dit.ie
David.gardiner@dit.ie

Abstract

Developed European countries place emphasis on innovation as an important growth driver. Higher educational institutions, within these developed countries, actively participate in regional economic initiatives to proactively transfer and *commercialise* knowledge to business and society. This knowledge transfer is now performed in a more direct way than heretofore and the commercialization remit is now regarded as the Universities 3rd mission. This is in addition to its traditional remits of education and research. This study explores the effectiveness of the University knowledge transfer process and the contribution that knowledge transfer offices play in knowledge transfer and commercialisation (Value creation).

This study uses exploratory in-depth interviews of selected knowledge transfer professionals across the EEA (European Economic Area) to identify the perceived value contributing aspects of the knowledge transfer process and also to evaluate the role and contribution of the Knowledge Transfer office itself in that process.

The research finds that:

- Research institutions in the EEA have between 10 and 25 years in knowledge and technology transfer utilising a systematic approach through a KTO system. The research suggests that the time is appropriate for Universities to recognise knowledge transfer as a 'mission critical' activity (3rd mission) in their wider societal remit and that they should therefore prioritise funding for these activities accordingly. Evidence so far suggests that this 3rd mission has yet to achieve' parity of esteem' within Universities.
- The more successful KTOs perform important boundary–spanning roles for the University by marketing the knowledge production skills and abilities in their HEI whilst establishing deep links with indigenous industry and also by attracting multinational clients and projects. This requires the leadership and staff in successful KTOs to possess high levels of cognitive, contextual and organisational ambidexterity.
- Although difficult, there is also a need to develop appropriate transnational evaluative measures of the output, outcomes and impact for University knowledge transfer processes in the short, medium and long term. Theory–based evaluation utilising a balanced scorecard of evaluative measures (Hard & Soft, Short & Long term) is a methodological approach which can help policymakers and University management to obtain a 'true and fair' view of the contribution of the knowledge transfer process to value creation.

Key words: Knowledge transfer, Technology transfer, Innovation, value creation.

1. Introduction

Countries within Europe aim to provide an innovation ecosystem that creates economic and societal benefits. Knowledge creation by its nature acts as a driver of innovation, sustainable economic growth and social well-being (OECD, 2004). In the past few decades higher educational institutions have actively participated in regional economic development and have tried to transfer knowledge to business and society in a more direct way than heretofore and this commercialization remit is regarded as the Universities 3rd mission – in addition to educational and research. This knowledge commercialisation is usually accomplished through a Technology transfer office (TTO) or an industrial liaison office (ILO). Knowledge Transfer is also sometimes referred to in the literature as technology transfer or research commercialization.

For industry, rapid technological change and intense global competition coupled with shorter product life

cycles have transformed the competitive landscape (Wright, Clarysse, Lockett, & Knockaertd, 2008). There is societal pressure on universities to transform themselves into conduits for economic growth *in addition* to their traditional roles of teaching and knowledge generation (Blumenthal, 2003; Philbin, 2008). Pressure on both industry and higher education have led to an increase in the appetite for developing UICs (University Industry Collaboration) which aim to improve innovation and competitiveness at firm, sectoral and national level through increased knowledge exchange between the academic and commercial domains (Perkmann et al., 2013). Moreover, Universities have realised that working more closely with industry can also be an important source of innovation for them also.

Knowledge transfer is now a political priority in most developed European Countries, forming an integral part of the national innovation policy. This is a relatively recent development, unfolding since the turn of the century. According to a Knowledge Transfer Ireland (2015) study the third mission - commercialisation of research - which sits alongside education and scholarly research has changed the relationship with public research organizations (PROs). The inclusion of the third mandate or mission has been accompanied by a move for the University to own the intellectual property arising from publicly funded research in the hope that this will help encourage and incentivise entrepreneurial behavior in the population. Research institutions now have between 10 and 25 years in knowledge transfer using a systematic approach - usually through a KTO. Most KTOs however are now looking at developing improved ways of managing their boundary-spanning roles so that that they can achieve better outcomes, outputs and ultimately make a bigger impact. There has been significant improvement made within the past decade in KTO practice however there is need for continued improvement in the outputs, outcomes and impacts from the KTO process.

This study focuses on the process of government-funded knowledge transfer activities, in particular it focuses on the relationship between Public research organisations (PROs) and industry and wider society. The structure of the paper is as follows: The next section is a literature review covering 'The role and contribution that KTOs are expected to play in value & knowledge creation in an innovation ecosystem'. It is divided into a number of sub-sections. These sub sections outline the theoretical and empirical literature on TTOs/KTOs, in particular it looks at how knowledge transfer outputs from RPOs are evaluated and measured. This section is then followed by a section describing how knowledge transfer practices in the five different knowledge transfer offices (TTOs) based across EEA were researched. The paper concludes with a discussion on the research findings and recommendations for future research in the knowledge transfer domain.

The research seeks to answer the following research question; what is the role & contribution of University Knowledge transfer Offices in knowledge transfer and value creation? This is translated into the two research objectives - an investigation of the role that KTOs are expected to play in the knowledge transfer process and a critical evaluation of the contribution of KTOs in the Knowledge transfer process.

2. Literature Review

Knowledge transfer was formally known as 'technology transfer' and the two terms have been used interchangeably in the literature. There are myriad definitions of 'technology transfer' (Reisman, 2005). Indeed knowledge transfer itself, can be described in various ways, depending on the context in which it is used (Bozeman). Reisman (2005) further lists 182 independent technology transfer attributes, transaction characteristics, disciplines, motivations, and perceived roles, highlighting - no matter what definition is used - that the knowledge transfer process is complex by its very nature. According to Gibson and Rogers (1994) technology transfer is 'the application of information into use'. The 'technology transfer' process is described as the movement of a technological innovation from a Research and Development organisation to a receptor organisation. However, technology transfer can be considered a multi-dimensional process as it involves more than just the movement of an innovation. Technology transfer can be regarded as a complex type of communication process which spans the stages from R&D to commercialisation but which primarily focuses on the interface between R&D and commercialisation. Technology transfer also has a relationship dimension. According to Autio & Laamane (1995) technology transfer refers to deliberate, goal-oriented relations between parties and organisations to exchange technological knowledge and/or objects and rights. Levin (1993) also added a social dimension to the definition. Technological development can be viewed as a social process in which the subsequent technology developed cannot be considered separate

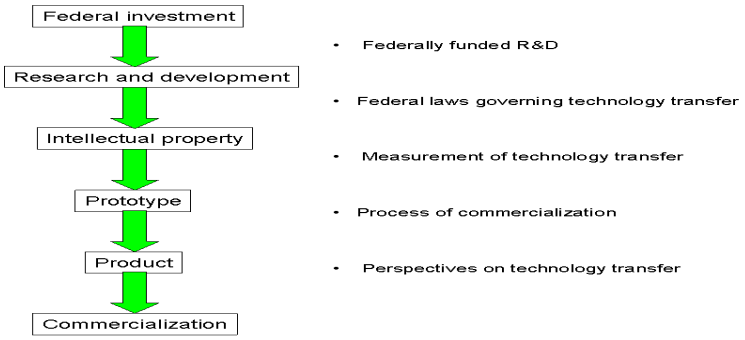
from the actors involved in developing it (Levin, 1997).

There is also be a commercial dimension to technology transfer. According to Power and McDougall (2005), technology transfer is the process of transforming university developed technologies into marketable products. Decter et al. (in press) describe technology transfer as the transfer of new knowledge, products and processes to benefit the business and it is dependent on the availability of skills to utilise the technology, and level of transfer support. Finally, The Irish Council for Science, Technology and Innovation define it as 'a formal transferring of new inventions, discoveries, creations, processes, innovations which result from scientific research conducted at public research organisations to a commercial environment' (ICSTI, 2004).

2.1. The Technology Transfer Process

Figure 1 outlines the core steps in the technology transfer process as observed by Wang et al (2003). Successful adoption by customers who use or might use the technology is the ultimate objective of the process. Technology transfer involves several different individuals and organisations with diverse needs. It can therefore be difficult to define appropriate measures of transfer effectiveness.

Figure 1. Overview of Technology Transfer Activities



(Source: Wang *et al.*, 2003)

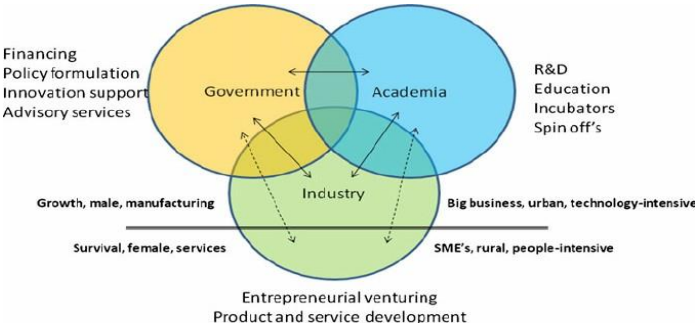
There are a number of mechanisms identified by the Interagency Committee of Federal Technology for successful transfer which include: Development agreements, licensing, co-operative research, consulting, technical assistance, use of facilities, exchange programmes and collegial interchange, conferences and publications. According to Wang et al. (2003) other categories can include patents, manufacturing innovations, web hits on a science database and knowledge spillovers amongst others. While Wang et al's model is a simplification of the process, it does have a number of limitations. It is overly prescriptive and ignores the relationship or softer aspects of the innovation process. It also does not deal with the tacit knowledge aspects of the process, only the codified knowledge dimensions.

2.2 Triple Helix Model

Technology Transfer offices originated in the US and were established to transfer commercial knowledge from universities to practitioners and also to manage the intellectual property generated by the university.

A study by De Cleyn et al. (2010) reveals that TTOs were subsequently established in Europe from the late 1990s. Etzkowitz (1993) developed the concept of the Triple Helix seen in figure 2 below. This refers to university–industry–government relationships. The concept highlights the importance and value of knowledge in the triadic relationship between government, Academic research and industry.

Fig. 2 The partially blind Triple Helix model



(Source: Lindberg et al, 2014)

Etzkowitz notes that research institutions around the world have just 25 years' experience at most of organising the structure of knowledge transfer through TTOs (Spin- outs or technology licensing). Change within society and the European Innovation Paradox have forced research intuitions in Europe to reconsider their role and contribution to society and business. One way to address this is to set up KTOs and to intensify the support for academic entrepreneurship within these institutions.

It is widely recognised that productivity growth is key to economic success in the global knowledge-based economy. Academic research and development can be a great source of innovation, however the translation of research results to market useable products, services and processes depend on the universities research intensity and the existence of an entrepreneurial culture to commercialise the research generated. According to Isenberg (2014), an entrepreneurship ecosystem consists of elements that can be grouped into six domains: a conducive culture, facilitating policies and leadership, availability of dedicated finance, relevant human capital, venture friendly markets for products, and a wide set of institutional and infrastructure supports (including Universities and HEIs). Common practice now is for Research Performing Institutions (RPOs) – primarily Universities and HEIs - to set up their knowledge transfer offices (KTOs) as the focal point for all university inventions and commercialisation activities. These centralised KTOs were created to help regulate and monetise the transfer of knowledge for commercial benefit, from the universities to the marketplace. They do this by requiring all university faculty members to work through these offices, notifying them of their discoveries and delegating to the KTO, all rights to file patents and to negotiate licenses on their behalf.

2.3 How Knowledge Transfer is Currently Evaluated

Evaluation (as part of management processes) attempts to identify and measure the efficiency (use of resources) and effectiveness (value-created) of an activity in terms of the initial objectives' set or agreed (Papaconstantinou & Polt, 1997:10). In the case of state-funded Knowledge transfer offices it can be a real problem linking provision of knowledge transfer support and services to subsequent economic outcomes (Storey & Greene, 2010). Given the complexities in the process (Bozeman, 2000), Knowledge Transfer activities are therefore much more difficult to evaluate than for example, research (Publication quality, citation numbers) or teaching (student-staff ratio, student feedback).

Generally, certain KT outputs are normalized to research spend, and used as national and international comparators. KT metrics typically consist of research collaboration, Consultancy, Patent and IP creation, licensing, and spin-out company creation. Within Europe, the Association of European Science and Technology professionals (ASTP-Proton) collect these sets of output measures annually from members and it is these metrics that have been adopted by RPOs and governments as the representation of knowledge transfer activity (Scanlon, 2018).

However, these metrics do not take into account the quality - from the inputs, the output from the

engagement or from the process itself. Sorensen and Chambers (2018) question if these metrics are wholly appropriate for accessing the contribution of knowledge transfer activities. Comparing one RPO to another on simplistic bases, does not include valuable information which might be used for benchmarking or quality assurance/assessment (Friedman and Silberman 2003; Kim et al., 2008).

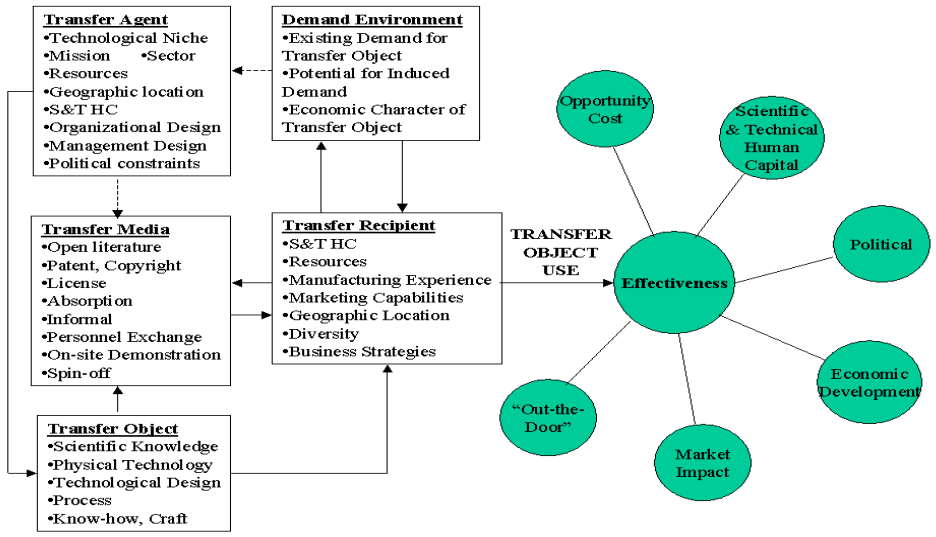
2.4 Determinants of knowledge transfer activity

Several models and studies of KT and research commercialization have been developed which attempted to tackle the *quality* of knowledge transfer measurement issue. Examples include the balanced score card to evaluate knowledge transfer (Goh, 2002) which include managerial and impact evaluation. A popular model is the Contingent Effectiveness Model of Technology Transfer (Bozeman, 2000) which looked at the various stakeholders within KT and their significance to different RPOs.

2.5 The Contingent Effectiveness Model

The Contingent Effectiveness Model assumes that parties involved in the technology transfer process have numerous goals and effectiveness criteria. The model states that impacts of technology transfer can be understood in terms of who is doing the transfer, how they are doing it, what is being transferred and to whom. The categories in the model are broad enough to include most factors involved in technology transfer activities. Arrows in the model show relations among categories and broken lines show the contingencies impacting on technology transfer. The model however is subject to two critical challenges. Firstly it fails to address how KT data from one RPO to another RPO can be compared when they substantially differ in their research missions. Secondly, it cannot identify the differences in 'quality of practice' between differing KT operations. Scanlan's (2018) KT Maturity framework attempts to address these deficiencies.

Figure 3: Contingent Effectiveness Model of Technology Transfer



(Bozeman, 2000)

2.6 The KT Maturity Framework

Scanlan (2018) derived the KT maturity framework from frameworks used in other business domains. This was created to address the issues of managing a consortium of RPOs – with quite different contexts and with different objectives. The KT maturity framework deals with five maturity levels, which go from a basic level of operation to a more experienced and mature level with robust and repeatable processes. The framework also lists seven core competencies of a KTO. These core competencies are presented in the Figure 4.

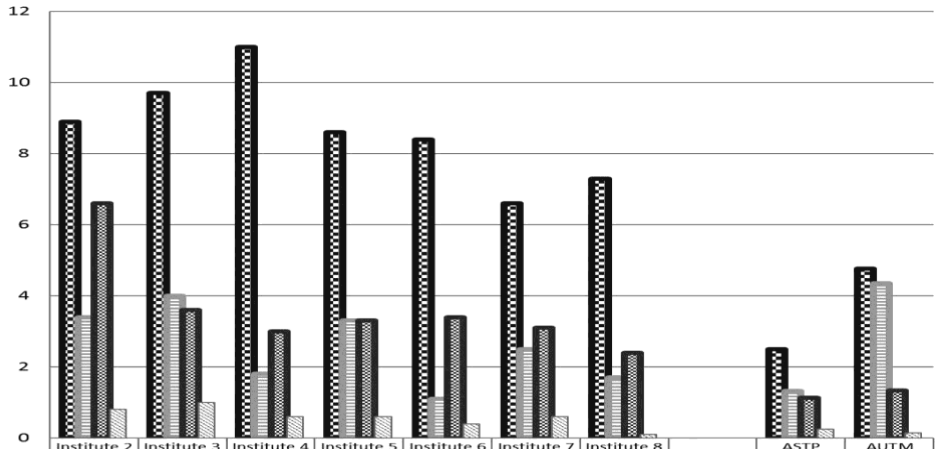
In order for a culture of excellence within a KTO to develop, it must be driven by all core competencies and also include buy in of the 'opportunity creators' (Scanlan, 2018). This KT capability maturity framework is based on empirical findings and over 10 years' experience by Scanlon working in the industry. Best practices from ASTP and AUTIM are also incorporated into the KT maturity framework. From a benchmarking perspective, the framework not only focuses on the familiar annual monitoring of standard metrics, but also on the ratios from which meaningful comparative information can be extracted and used. The ratios remove some bias concerning university size and mission and permits measurement of one key output - which is based on a common baseline activity. Figure 5 shows standard metrics normalized to €10 million of annual research spend as a reference of how metrics are reported across the EU. IDF means 'invention disclosure form', LOA means 'Licence, option or assignment', or option to transfer - a piece of created IP to industry. Using these normalized metrics, Institutes can be compared to each other in Europe and the USA. The analysis however still misses the more subtle factors of difference between Institutes – particularly around mission, strategy and context.

Figure 4: The proposed KT capability maturity framework model

	KT MATURITY FRAMEWORK	Level 1	Level 2	Level 3	Level 4	Level 5
Staff	TT Staff Experience	TT activity new to RPO, no dedicated TT/KT staff.	TT/KT staff at early experience level.	TT/KT staff with developing expertise and skills.	Staff at RTTP or equivalent.	Highly experienced and skilled TT/KT staff mix.
Office	Spin-outs / LOA Activity	Very low, sporadic and unplanned activity.	Developing TT output, first LOA deals, some spin-out possibilities.	LOAs regular and planned, emerging pipeline of spin-outs.	Several years' experience in LOA and HPSU type spin-out creation.	Large portfolio of deal experience. Well-developed activity pipeline.
Office	Industry Engagement	Emerging industry engagement.	Pockets of industry engagement.	Good industry engagement across several research groups.	RPO wide targeted industry engagement.	Large portfolio of RPO wide industry contracts.
Office	Consultancy Activity	No institutional consultancy strategy, private capacity only.	Pockets of RPO administered and planned consultancy.	RPO wide policy and mechanism for consultancy.	Managed and marketed consultancy offering by RPO.	Significant and mature consultancy activity across RPO.
Office	TT / KT Culture	TT/KT culture not well established.	TT/KT culture accepted at management and researcher level.	TT/KT activity considered in staff promotion evaluation.	RPO wide recognition that TT/KT activity is an important activity.	TT/KT embedded as core RPO activity along with teaching and research.
Institute	IP Management Processes	RPO IP management policies not in place.	First version policies relating to LOAs and spin-outs in place.	Developed IP and campus company policies.	First RPO wide processes for IP Management as per IP Protocol.	RPO broad IP management developed and monitored.
Institute	Transaction Speed and Quality	Institutional inexperience in TT/KT activity.	TT/KT contract negotiation laborious and time consuming.	TT/KT contract negotiation slow due to multiple review / sign-off.	TTO has remit to negotiate and sign off on all TT/KT deals.	Very efficient and effective TT/KT transactions.

(Source: Scanlan, 2018)

Figure 5: Standard metrics comparison, normalized to €10 million in research spend:



	Institute 2	Institute 3	Institute 4	Institute 5	Institute 6	Institute 7	Institute 8		ASTP	AUTM
IDF	8.9	9.7	11	8.6	8.4	6.6	7.3		2.50	4.76
Patents	3.4	4	1.8	3.3	1.1	2.5	1.7		1.32	4.35
LOA	6.6	3.6	3	3.3	3.4	3.1	2.4		1.12	1.33
Spin-outs	0.8	1	0.6	0.6	0.4	0.6	0.1		0.24	0.15

(Source: Scanlan 2018)

What emerges, even in this basic analysis, is that there are considerable differences between the Universities/Institutes that are being compared. Is it fair to compare a university with a focus on research or technology to one with a broad arts and humanities remit? To try and address this issue, Scanlon (2018) looks at the comparison or ratios of these metrics. Through the use of ratios it is possible to remove research volume bias and biases concerned with core mission. Take for example a comparison the amount of licence deals to the amount of Invention Disclosure forms, a measure of how good the KTO is at turning an opportunity into a commercialisation deal is obtained. This is quite useful as a measurement of the conversion rate even if there are only a few IDF's per research spend than other, smaller Institutes. While the KT maturity framework is useful for cross-comparisons of RPOs, it is important to remember that the output and outcome measures are intermediate measures of the effectiveness of the KTO process when considered in the context of commercial 'value creation'.

2.7 Evaluating Knowledge Transfer Programmes using Theory Based Evaluation (TBE)

McLaughlin and Jordan (2004) proposed that logic model theory of change (TOC) which is useful for designing evaluation and performance measurement. This model focuses on the important elements of a programme which helps to identity what evaluation questions need to be asked and what performance measures should be used (Clark, 2012). Lenihan (2011) further notes that:

> Well-constructed logic models can serve as ex-post measures to see whether objectives have been attained, enabling robust ex-post evaluations that can ultimately feed back into future programme design. (p. 7).

This methodology then can be used for Technology or Knowledge Transfer evaluation as it already is in related domains (Buckley, 2016; Buckley & Davis, 2018). Theory-based evaluation (TBE) involves examining the assumptions underlying a causal chain form inputs to outcomes and impact (White, 2009:3). The theory-driven method is based on the rationale that 'evaluation should not be dictated by one particular method' (Chen, 2015:25) and that 'the success of a programme is accessed on context and not only on its results' (Chen, 2015:26).There are five interrelated areas generally evaluated in theory based evaluations. These are: Inputs: are dedicated resources consumed by the programme', Activities: Processes are what the program does with the inputs to fulfill its mission, Outputs: are the products that come from program activities, Outcomes: are the benefits during and after program activities' and Impact: The term impact is the ultimate long-term impact of the knowledge transfer process (Chen, 2015:60).
Evaluating the outcomes of the process, can allow policy makers to recalibrate the inputs and activities in an attempt to achieve improved outcomes for the future. This can be an effective solution for effective policy leaning in a complex domain such as knowledge transfer.

2.8 Final Comment on Literature

An overview of key concepts within knowledge transfer is presented in the literature review. Several themes emerge in the review of the literature regarding characteristics that are common in effective, or ineffective, technology commercialisation and also in its evaluation. The evaluation of KT *quality* is currently not well

developed beyond reporting standard measures. It is clear that there is currently little consensus around performance metrics – other than the need for perhaps hard and soft measures. Evaluating the knowledge transfer process, and indeed the rationale for it – is therefore complex. What co-produced inputs, outputs, outcomes and longer-term impacts are stakeholders seeking from the knowledge transfer process? Much research remains to be done to develop a scorecard of metrics around the KT process which will give a 'true and fair view' of its contribution to wider society in the short, medium and long-term.

3. Research Methodology

Given the exploratory nature of the research it was determined that semi-structured interviews would be the optimal data collection for this study. The Knowledge transfer professionals interviewed were regarded as the 'key informants' as they would provide their individual experience of KTOs - which might differ in each jurisdiction. Saunders et al. (2012) suggest that managers are more likely to agree to interviews when the topic is seen to be of interest to their current work.

Table. 1 Interview Participants

Job Title	KTO
Technology Transfer Manager	Swansea University, Wales
Director of Enterprise and Commercialisation	UCD Nova, Ireland
Business development Manager	Bergen Teknologioverføring AS Norway
Technology Transfer Manager	Cambridge Enterprise, England
Licensing Executive	DIT Hothouse, Ireland

Key topics identified were derived from the literature and shaped by the research objectives. The open-ended questions and free following structure allowed the participants to discuss the key topics freely. The interviews varied in structure and length as the participants were from a variety of Universities and countries with very different experience and views on the topic of KT. Key themes – linked to the research question and research objectives were identified through cross – interview analysis.

4. Findings

This paper investigates the role and contribution that the Knowledge transfer office makes to the creation of value in a regional innovation ecosystem. In the past few decades higher educational institutions have actively participated in regional economic development and have tried to transfer knowledge to business and society by adding knowledge diffusion and transfer to its core mission (3rd mission).

Table 2: Interview Themes Emerging

Objectives >	**An investigation of the role that KTOs are expected to play in the knowledge transfer process**	**A critical evaluation of the contribution of KTOs in the Knowledge transfer process.**	
Themes Emerging	Going forward, the respondents suggested that KTOs should be regarded as a core 'mission –critical' function within RPOs – if RPOs are taking their 3rd mission as seriously as their other core missions of teaching and research.	All agreed that there is a need to develop widely accepted and agreed measures of KTO impact which include hard & soft /short, Medium and long-term measures with appropriate weightings linked to the RPOs 3rd mission	There is currently a mismatch between the speed that industry requires work developed and completed versus RPOs internal processes, and priorities. .

	The interviewees noted the importance of Research Performing Organisations in establishing closer links with industry - to increase relevance to indigenous entrepreneurs/ SMEs and to attract multinational clients for their research, teaching and students.	The 'key informants' Identified that there are- in their opinions - major flaws in the current methodologies derived for benchmarking performance across RPOs as these measures do not adequately take account of the divergences in mission and scale of RPOs across regions and countries.	Respondents all clearly recognised the link between funding certainty & funding priority and successful knowledge transfer activity.

The first objective of the paper was to explore the role that KTOs are expected to play in value and knowledge creation. Research institutions now have between 10 to 25 years in knowledge and technology transfer experience using an organised approach usually through a KTO. KTOs are mostly funded through government initiatives and are deemed a support function for University enterprise development. Research commercialisation has been described as the third mission of research institutions in addition to research and education (Etzkowitz, 1998). It is time for RPOs to recognise the practice of commercialization as 'mission critical' and to fund and promote it accordingly. The interviewees in the study noted universally that they would like to see a more central role for the KTO in their Universities. They further highlighted the resource constraints and resource uncertainty that they work under. If the RPO takes its remit as seriously as its other core missions of teaching and research then developing long-term relationships with Industry is regarded as important by the interviewees. Developing these relationships takes time and resources and this relationship-building cannot be done if staff are on temporary contracts and funding for the KTO has a short-term horizon. This is a long-term (strategic) activity and needs to be treated as such by RPOs going forward or else the KTO has been 'set-up' for failure rather than success.

The second objective of the paper was to investigate and identify the determinants of successful Knowledge Transfer – i.e. what contribution does the KTO make to successful knowledge transfer and value creation. The study found that in the case of state-funded Knowledge transfer offices, it is currently a real problem when attempting to link provision of knowledge transfer support to subsequent economic outcomes (Storey & Greene, 2010). Within Europe, the Association of European Science and Technology professionals (ASTP-Proton) collect sets of output measures annually from members and it is these metrics which are used by governments as the key metrics of knowledge transfer activity. However, these metrics do not take into account project quality or the efficiency of the process or indeed the quality of the academic research base that the KTO must work with. Although difficult, there is a need to develop more appropriate measures of the inputs, process, outputs, outcomes (and the quality of the linkages between these phases) and the longer term impacts from the knowledge transfer process. Some interviewees suggested that a 'balanced scorecard' of hard and soft/short, interim and long-term measures which demonstrate potential and/or realised value creation and capture are required to give a 'true and fair view' of the contributions of the various phases to the overall process.

An additional finding in the study (See: Table 2) suggests that there is a mismatch between the speed that industry wants to work at andthe speed that higher education works at. Time-to-market is a crucial factor in technological and global competition (Amesse & Cohendet, 2001). The speed of the transfer must be addressed in an institutional context. Within PROs currently, it would seem that there is not enough emphasis on the 'need for speed' for effective knowledge transfer. So RPOs should be moving towards a speed that matches industry needs. However expectations still must be managed from the outset with the industry partner.

Finally another theme emerged in the interviews around the importance of 'certainty of funding' as a necessary factor for effectiveknowledge transfer. According to Flanagan (2017), there is a direct correlation between top EU performing countries for spin-outs and license agreements per 100 researches and certainty in resourcing. According to one interviewee:

'90% of the knowledge transfer activity is between the co-funded research and the research funding into our

> office, if you got rid of that, it'd be back to where we were 20 years ago with one or two spin outs every year……I think, from what I've seen, so those two funding streams are hugely important'.

Now that there is more pressure than ever to show measureable benefits to business and society to justify the public funding received. Higher educational institutions face increasing pressure with tighter funding to contribute towards regional development through their research endeavors. However it is important that evaluation measures adequately reflect the complexity of the KT process so that learning's can be employed to make evidence-based decisions and also improve the contribution of the KT process to societal value creation.

5. Conclusion

This exploratory study set out to address a research question on the role and contribution of KTOs to the KT transfer process. It reviewed selected literature on the KT process (and the role and contribution of KTOs to it) and concluded that whilst the KTO industry is over 25 years old, there is still a dearth of academic research on the KT process and indeed on the role and contribution of KTOs in that process. The research is particularly deficient in the *evaluation* of the role and contribution of KTOs to Universities 3rd mission and to economic value creation. Much work remains to be done but theory–based evaluation (TBE) methodologies appear to hold out the best potential for identifying the contribution of KTOs. Additionally TBE will provide evidence–based data for helping improve managerial decision making on the future role of KTOs.

Bibliography

Amesse, F. and Cohendet, P. (2001). Technology transfer revisited from the perspective of the knowledge-based economy. *Research Policy*, 30, 1459 –1478.

Autio, E. and Laamanen, T. (1995). Measurement and evaluation of technology transfer: review of technology transfer mechanisms and indicators. *International Journal of Technology Management*, 10 (7/8), 643 – 664.

Blumenthal, D. (2003). Academic—industrial relationships in the life sciences. *New England Journal of Medicine*, 349, 2452—2459.

Bozeman, B. (2000). Technology transfer and public policy: a review of research and theory. *Research Policy*, 29, 627 –655.

Buckley, A. P. (2016). Using Contribution Analysis to evaluate small & medium enterprise support policy. *Evaluation*, *22*(2), 129–148.

Buckley, P., & Davis, S. (2018). University-based Technology Start-up Incubators – Evaluating their contribution to the co-production of knowledge, innovation and growth. Experience from the Edge. *Industry and Higher Education,* vol. 32, no. 4, pg. 253 - 268.

Clark H (2012). *Theory of Change: Value Added and complementarity with Results-based Frameworks and Scorecards*. New York: ActKnowledge technical paper.

Chen, H. (2015). *Practical Program Evaluation: Theory-Driven Evaluation and the Integrated Evaluation Perspective,* 2nd Edition. Sage, Los Angeles.

De Cleyn, S. H. (2011). The early development of academic spin-offs: A holistic study on the survival of 185 European product-oriented ventures using a resource-based perspective. Antwerp: University of Antwerp, Faculty of Applied Economics.

Decter, M., Bennett, D. and Leseure, M. (in press). University to business technology transfer– UK and USA comparisons. *Technovation*.

Etzkowitz, H. (1998). The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. *Research Policy*, 27, 823 –833.

Flanagan, T (2017). The evolution of technology transfer in Ireland 2006–2016:a practitioner's perspective, *Small Enterprise Research*, 24:3,316-325

Friedman J and Silberman J (2003). University technology transfer do incentives, management, and location matter? *Journal of Technology Transfer* 28(1): 81–85.

Gibson, D. and Rogers, E. (1994). *R&D collaboration on trial: the microelectronics and computer technology consortium.* Harvard Business School Press, Boston, MA.

Goh, S. C. (2002). Managing effective knowledge transfer: an integrative framework and some practice implications. *Journal of knowledge management*, *6*(1), 23-30.

Isenberg, D. (2014). What an entrepreneurship ecosystem actually is. *Harvard Business Review*, *5*, 1-7.

Kim J, Anderson T and Daim T (2008) Assessing university technology transfer: a measure of efficiency patterns. *International Journal of Innovation and Technology Management* 5(4):495–526.

Lindberg, M., Lindgren, M., & Packendorff, J. (2014). Quadruple Helix as a way to bridge the gender gap in entrepreneurship: the case of an innovation system project in the Baltic Sea region. *Journal of the Knowledge Economy*, *5*(1), 94-113.

Knowledge Transfer Ireland (2015). Annual Review & Annual Knowledge Transfer Survey

Lenihan, H. (2011). Enterprise policy evaluation: Is there a 'new' way of doing it? *Evaluation and program planning,* 34 (4), 323-332.

Levin, M. (1993). Technology transfer as a learning and developmental process: an analysis of Norwegian programmes on technology transfer. *Technovation*, 13, 8, 497 – 518.

Levin, M. (1997). Technology transfer is organizational development: an investigation into the relationship between technology transfer and organizational change. *International Journal of Technology Management*, 14 (2/3/4), 297 – 308.

McLaughlin, J. A., & Jordan, G. B. (2004). Using logic models. *Handbook of practical program evaluation*, *2*, 7-32.

OECD (2004). Evaluation of SME Support Programmes. Paris: OECD.

Papaconstantinou, G., & Polt, W. (1997). Policy evaluation in innovation and technology: An overview. In OECD (Ed.), Policy evaluation in innovation and technology: Towards best practices (pp. 9–14). Paris: OECD.

Perkmann, M., Tartari, V., Mckelvey, M., Autio, E., Brostro¨m, A., D'este, P., et al. (2013). Academic engagement and commercialisation: A review of the literature on university—industry relations. *Research Policy,* 42, 423—442.

Philbin, S. (2008). Process model for university—industry research collaboration. *European Journal of Innovation Management,* 11,488—521.

Power, J. B. and McDougall, P. (2005). Policy orientation effects on performance with licensing to start-ups and small companies. *Research Policy*, 34, 1028 – 1042.

Reisman, A. (2005). Transfer of technologies: a cross-disciplinary taxonomy. Omega: *The International Journal of Management Science,* 33, 189 – 202.

Saunders, M., Lewis, P & Thornill, A. (2012). *Research Methods for Business Students*. Essex: Pearson Education Limted.

Scanlan, J. (2018). A capability maturity framework for knowledge transfer. *Industry and Higher Education* Vol 32, Issue 4, pp. 235 – 244.

Sorensen J and Chambers D (2008) Evaluating academic technology transfer performance by how well access to knowledge is facilitated—defining an access metric. *Journal of Technology Transfer* 33(5): 534–547.

Storey, D. J., & Greene, F. J. (2010). *Small business and entrepreneurship*. Financial Times/Prentice Hall.

Wang, M., Pfleeger, S., Adamson, D. M., Bloom, G., Butz, W., Fossum, D., & Rippen, H. (2003). Technology transfer of federally funded R&D. In *Conference Proceedings: Perspectives from a forum. Prepared for the Office of Science and Technology Policy*.

White, H. (2009). Theory-based impact evaluation: principles and practice. *Journal of development effectiveness,* 1(3), 271-284.

Wright, M., Clarysse, B., Lockett, A., & Knockaertd, M. (2008). Midrange universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy.*