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The Adoption of Enabling Technology to Enhance Research Commercialization and Technology Transfer Outcomes at National University of Ireland Galway

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Abstract: This paper examines how the National University of Ireland (NUI) Galway has benefited from implementation of an intellectual property (IP) management tool to enhance its research commercialization outcomes. The paper uses an exploratory research methodology to identify how, in the complex field of innovation management and technology transfer, advances in business process and technology uptake have been achieved. Key themes such as knowledge management in the IP process, policy contextualisation and a discussion of IP management tools are explored and research documents user perspectives from within the Technology Transfer Office to provide an additional dimension to literature and policy review.

1. Introduction

In addition to their well established teaching and research missions, HEI's are increasingly seen as essential contributors to economic development [1]. At the vanguard of this movement is the push toward technology transfer and research commercialization and it is for this reason that many HEI's and government agencies alike have developed departments and offices to develop their capacity to tap into and exploit the value of tacit and tangible intellectual property associated with research institutions.

IT systems that can streamline the commercialization process are not new and have been adopted for well over a decade in countries such as the UK and the USA. Ireland, despite its policy focus on research and development as a key contributor to economic growth, must be viewed as a late adopter [2] of IP management systems, since until four years ago there were no instances of such technology in use in Irish HEIs. Government investment enabled the adoption of IP management technologies in HEIs and as a result, NUI Galway became one of the first to adopt such a system nationally in order to enable greater operational efficiency and underpin commercialization processes.

As the business case will demonstrate, the adoption of IP management technologies was past due for HEIs in Ireland. This paper aims to highlight and document the organizational, structural and technological efficiencies that IP management tools have realised in supporting commercialization activity at NUI Galway. In illustrating this scenario more fully, the case study and associated research outlined in this paper:

- Provides a background of the main themes around IP Management for HEI's and also outlines the government and policy context for investment in research and development.

- Examines in particular the role of Intellectual Property Management at NUI Galway and focuses on the lessons learned from using the enabling technology to enhance and develop commercialization processes.
- Demonstrates the organizational and structural impact of adopting an enabling IP management technology in a collaborative working environment and highlights the key benefits realized through effective government funding.
- Aims to assess how the adoption of a shared IP Management tool has assisted and enabled the realization of value from research and defines the role that such technology plays in the IP commercialization process.

In other words, the objective of this paper is to determine if the system, defined by the people, process and supporting technology itself, is capturing the minimum critical specification in order to optimize commercialization outcomes. Furthermore, an additional objective is to determine whether a stronger process can be achieved by developing a better system of knowledge management for IP at NUI Galway that balances the codification of knowledge with personalized knowledge transfer.

Findings suggest that IP management tools have dramatically reduced the time taken to manage new knowledge and commercialise research innovations while the efficacy of marketing knowledge, funding applications and patent processing has been strengthened. Additionally, this research has been able to establish assistive guidelines to develop a better knowledge management process for IP and illustrate how HEIs or government organisations might approach IP management. Finally, the key knowledge gaps identified have been outlined as suggestions for further research in order to develop the ideas and discussions outlined herein.

2. Methodology

This paper furthers the investigation into policy and literature context by using an exploratory research approach to identify and explore new theoretical insights [3] through the case study of NUI Galway. Research suggests that a holistic understanding of organisations can be developed by using a case study methodology [4] which examines a phenomenon in its naturalistic context [5]. The case study of NUI Galway was selected because firstly, it was the first Technology Transfer Office in Ireland to deploy a computerised IP management system and secondly, there is evidence to suggest that its processes are highly effective given its low ratios of patents per research million.

A review of governmental and institutional policy and strategy related to research and development was undertaken to contextualise the diverse factors inherent in the growth of commercialization activity which attempts to identify the key factors contributed to the successes of the particular case study at NUI Galway. This review focused on international, European and Irish policies with further input from OECD reports. An investigation of policy and strategy on an institutional level at NUI Galway was also carried out.

The retrospective analysis of such interdependencies over a four year period, allowed an opportunity to illustrate firstly the business benefits of adopting such technology in a specific geographical region where it was not previously apparent and secondly to explore how further innovation and benefit might be achieved through more optimal processes.

Furthermore, in line with the objectives of this paper, a literature review of current techniques and practices in IP commercialization for HEI's was undertaken. This process identified themes particular to the HEI sector and highlighted areas of potential process innovation that arise from connecting the theoretical frameworks of knowledge management with the evolving paradigms of research commercialization at HEI's.

3. Contextualising Research Innovation

3.1 Policy Framework

Ireland has promised to invest \$5 billion in research driven innovation between 2006 and 2013 as part of its National Development Plan [6]. This investment in technology and innovation is designed to double the number of Ph.D. graduates and attract young people into research careers in knowledge-driven companies. The investment, which will be implemented between 2006 and 2013, is certainly linked to commercialization outcomes and the sheer body of knowledge that will be generated and tested as part of PhD programmes. Additionally investment in knowledge and innovation at an EU level will be stimulated by the research Framework Programme 7 which encompasses the new Competitiveness and Innovation Framework [7]. During this timeframe the European Technology Institute is due to be created which will provide a locus for research innovation at an EU level [8].

At a national level, the Irish government has admitted that there are deficits in the area of IP identification, protection and commercialisation [9] and that strengthening embedded specialist centres within HEIs is one of the approaches required to address the issue. Enterprise Ireland (EI) is the dedicated government body for investment in research and innovation on the island and within its remit was the implementation of a coherent commercialization strategy to achieve this goal.

Even these amounts of investment will not unlock the true value of Ireland's knowledge and innovation potential. In 2007 the EU recognized that in itself FP7 would only represent 1/50th of the target amount required to truly drive forward the knowledge economy. In fact, the Lisbon Strategy, and subsequent Barcelona agreement [10] outlines that the target amount for investment in research and development and the amount judged to be necessary in order to drive forward the knowledge economy is 3% of GDP with 2/3 coming from private sector. This approach embeds industry, academic and governmental relationships in a strategic and unified system.

Based on the planned levels of investment from national and EU sources, HEI's in general could therefore expect a massive upsurge in knowledge creation associated with their mission of teaching and research. Additionally, the desire in the EU to increase funding to the Barcelona target will mean that there will be a clear future for knowledge creation into the future. The challenge for NUI Galway, and indeed any HEI operating within this context, is to take knowledge creation from the realm of the traditional teaching and research mission and create assets for the knowledge economy with this innovation by increasing the number of invention disclosures, patent applications, licensing outcomes and spin-out companies.

As such a discussion of managing such newly created knowledge in the context of HEI's will illuminate further how innovation can lead to economic development through the commercialization process.

3.2 Managing Innovation and New Knowledge

As discussed, the organizational impact of managing such knowledge creation also warrants discussion, particularly as it relates to the theme of this paper. As the boundaries between basic and applied research and product development become blurred [11] new knowledge and the optimisation of existing knowledge are increasingly woven into a complex knowledge supply chain [12] that encompasses aspects of a linear commercialisation pathway with knowledge management practices.

Knowledge can be explicit (tangible) or tacit (intangible) and is broadly classified as declarative (what has occurred), procedural (how something occurs) or causal (why

something occurs) [13]. Depending on the type of research being undertaken and the research area, intellectual property at NUI Galway could be classified under just one of these categories, or in some cases the knowledge asset would come under many or even all of the categories. The complexities of knowledge management are further compounded by the ability and propensity of the supporting IT or organisational systems to codify (record) knowledge or to take a personalised approach for example recording scientific tests using a laboratory diary can be used to prove ownership of an innovation however quantifying a lunchtime meeting with investors is far more difficult.

Recent commentators [14] who have examined the IP system from the perspective of knowledge management have concluded that there is a question around how much knowledge to codify and the balance between codified and tacit knowledge in the commercialisation process. Certainly the productisation of IP relies on codified knowledge to provide evidence that certifies the claims of inventors and researchers. This aspect of the process can be defined as an essential component. However it has also been noted that more flexible forms of organisations need to deal with changing environments with a less mechanistic approach [15] and the need for entrepreneurial, less measured approaches to innovation is also proven to be of benefit [16].

This creates a tension between what to codify and what to personalise and while the answer to this question remains unique for each organisation, it has been found that the culture of that organisation will determine the structure and elements of approaches to innovation management [17]. It is within this tension, between the necessary codified and structured knowledge of the legal IP system and the more tacit personalised knowledge of marketing and networks, that the definition of a minimum critical specification for commercialisation can be found.

4. IP Management Structures at NUI Galway

4.1 Background of NUI Galway Commercialisation Structures

NUI Galway was established in 1845 as Queen's College Galway and claims over 15,000 students attending its seven faculties in Arts, Science, Engineering, Celtic Studies, Medicine and Health Sciences and Law [18]. NUI Galway has defined five areas of research specializations in Biomedical Science & Engineering, Informatics, Physical and Computational Science, Environment, Marine & Energy; Applied Social Science and Public Policy and Humanities in Context. Many research clusters and centres have evolved from its highly effective research strategy and a strong focus exists for developing links with industry partners in areas of regional and national strategic importance.

Additionally NUI Galway was the first university in Ireland to establish an incubation facility for start-up campus companies. The incubation centre caters for up to 24 start-up companies in the ICT, software development and e-learning areas and in addition a bio-incubation facility exists to foster innovation in the biotech, medical device and drug delivery sectors. The university also has links with offsite incubation facilities.

In 2005 NUI Galway became the first university in Ireland to establish a dedicated Technology Transfer Office [19]. Its objective is to support the commercialization of all university intellectual property in order to maximize the benefit to society, the inventor and the university itself. Since its launch some five years ago, the Technology Transfer Office (TTO) has had substantial successes in realizing research commercialization outcomes in licensing, invention disclosures, industry collaborations and spin-outs (refer tables 1 and 2). This contributes to attracting industry involvement and research funding to align with its research mission.

In addition to institutional factors (research specializations), Best practice research suggests that organizational practices are a key factor in the success of research

commercialization [20]. In line with this, NUI Galway quickly moved to develop and implement an IP policy which was adopted in 2007 [21]. This policy outlined the main instruments and mechanisms of approaching commercialization at the university and was integrated, strengthened and emphasized within the institutional framework through the university's four year strategy for research [22].

Table 1: Actual Outcomes – Courtesy of the NUI Galway Technology Transfer Office

Metric	2006	2007	2008
Invention Disclosure	26	34	57
Patent Applications	24	42	59
Licenses	0	24	9

Table 2: Target Outcomes – Amended from NUI Galway Strategy for Research 2006-2011

	2006	2007	2008
Invention Disclosure	20	24	29
Patent Applications	15	17	20
Licenses	4	4	5

These organizational changes consolidated the position of the TTO as the key agent within the institution with the potential to enable NUI Galway to fulfil its new societal role in economic development [23] as a progression of its research mission. Indeed, for the most part policy has identified the natural home for research innovation at HEI's with much of the EU and national policy being directed toward stimulating these new engines of the knowledge economy. Commentary [24] links science-based innovation to a triple helix relationship between universities, industry and government and having discussed one element of this triad, an overview of policy context will be beneficial to our understanding.

4.2 Technology Business Case for Adopting an IP Management Tool

Before NUI Galway adopted Inteum a paper-based filing system was in place. In the initial stages of the TTO, commercialization specialists handled a diverse portfolio of cases from any of the five research areas outlined previously. Over time and with the greater human capital enabled by a combination of government policy and IP management software, these specialists grew to a team of five dedicated experts based in the TTO and embedded in the organizational structure of each of the research units at NUI Galway. This allows for the development of relationships and provides an embedded specialist to develop ideas, a model that has been proven to be highly effective [25]. The growth in numbers of commercialisation specialists also meant that there was an increased need for collaboration amongst the TTO as a team.

NUI Galway had laid the foundations for structural and organizational change and the business case for NUI Galway to replace its paper-based administration system was very clear. The massive upsurge in invention disclosures and patent requirements that was expected from the investment mechanisms outlined in earlier sections formed one driver. However, if oversight of patent applications and licensing formed one part of the rationale for adopting a software solution, managing relationships across the HEI and between stakeholders was another key driver.

For these reasons, the adoption of a technology that could allow collaboration, provide key functionality, scalability and security was essential. NUI Galway chose to implement Inteum, the market leader in the education sector, as their IP management tool. At NUI Galway Inteum is run using an Oracle back-end environment where there is a single instance of the software installed on a server. This instance is accessible by all users

providing they are on campus and enables a collaborative approach to IP management. Firewall and password security are utilized to ensure high levels of security.

IP management tools are designed to codify intangible intellectual materials that can be utilized, and in the case of HEI's can be commercially exploited and IP is associated with a raft of legal, technical and regulatory issues. As such IP management tools are characterized by their ability to codify and record such knowledge to ensure that it is usable and visible. Additionally, IP management tools are context sensitive with many products on offer to cater for the demands of varying industry sectors. In HEI's for example, a key concern is the depth and complexity of funding relationships, particularly when government or industry are backing all or part of research with a potential commercial outcome. HEI's also require a strong reporting capability to provide accountability and in order to report outcomes as a result of investment.

Inteum allows a collaborative overview of action items and information that users at NUI Galway have found highly effective. Several features of the product are highly desirable in the HEI environment such as the ability to manage the patent application process and track dates, meetings and contacts with industry. NUI Galway users find that structured support services such as effective user training and feedback can enhance their experience of the tool.

5. Findings

5.1 Business Benefits and Lessons Learned

It is evident that at NUI Galway that Inteum has enhanced operational efficiencies through its functionality. Furthermore compliance with patent management is now far more effective and auditable than previously. Contracts and records can be seen holistically and the granularity and power of its reporting function is reported to have contributed to further investment in commercialization activity from government bodies such as Enterprise Ireland due to the visibility and clarity of results and outcomes.

Table 3: Actual vs. Targeted Outcomes 2006-2008 – Invention Disclosures

Invention Disclosures	2006	2007	2008
Actual	26	34	57
Target	33	37	42

Table 4: Actual vs. Targeted Outcomes 2006-2008 – Patent Applications

Patent Applications	2006	2007	2008
Actual	24	42	59
Target	22	25	57

Interviews undertaken as part of this research indicate that the commercialization outcomes achieved at NUI Galway would not have been possible under the older system and that the TTO grew alongside its supporting IP management tool (refer to tables 3 and 4). Amidst the key trends identified in this paper of an evolving policy and funding context, institutional policies and the growing functionality and importance of IP management software, the TTO itself has grown in number from two to seven experts which also demonstrates an organizational change over the time period considered. Correspondingly, NUI Galway users report that the IP commercialization process and the role of the IP management technology are highly interconnected, this research has identified that that commercialization processes could be influenced by the codification capabilities of IP management tools, this is a process which is underpinned by customer relationship management strategy, a capability that Inteum intends to progress.

The research suggests that

- Inteum, as an IP management tool, was an essential contributor to the successes realized at NUI Galway TTO
- the tension between legalistic codified knowledge and entrepreneurial tacit knowledge has been significantly reduced since its adoption.
- the system has created a higher standard of statistical data available for funding applications
- the greater the capacity to input, illuminate and report results, the greater the ability to create targeted funding applications and acquire further resources.
- IP management tools allow the user to gain greater insights into the system and process while making sense and order out of individual, organizational and systemic knowledge.

5.2 The Role of IP Management Tools in Successful Technology Transfer at NUI Galway

This paper sought to determine the role that IP management systems played in the technology transfer process at NUI Galway by examining the specificities of the Technology Transfer Office. Qualitative interviews revealed that IP management processes were highly correlated with the IP management tool and that commercialisation experts indicated that the system played a significant role in the realisation of targets as outlined in Tables 2, 3 and 4 above.

In collating and triangulating this qualitative data with the business case, policy research and an exploration of innovation management theory, the research suggests that there is an essential and enabling role for IP management software. Table 5 below outlines the steps undertaken by NUI Galway upon embarking on their commercialisation targets.

Table 5 – Processes and Dependencies in Developing and Improving Effective Technology Transfer at National University of Ireland, Galway

Process Step	Inputs/Dependencies
Set Strategic Direction	<ul style="list-style-type: none"> • Prevailing policy and funding environment • Institutional buy-in and commitment • Definition of people, process, technology needs • Create new structures to support Tech Transfer
Define Commercialisation Processes and Targets	<ul style="list-style-type: none"> • Conduct best-practice review • Benchmark against international best-practice • Develop ambitious targets to align with institutional research goals
Access Funding	<ul style="list-style-type: none"> • Government policy set • Funding calls advertised, institutional response • Allocate resources within institute
Engage Commercialisation Team	<ul style="list-style-type: none"> • Identify skills gap • Engage market for specialists/experts • Embed experts in specialised research areas
Select IP Management Tool	<ul style="list-style-type: none"> • Functional and non-functional requirements definition • Market assessment • Software procurement and implementation • User training and advanced functionality
Execute strategy, monitor and adjust using metrics enabled by IP management tool	

NUI Galway Technology Transfer Office appears to have created an environment where policies, processes, people and IT systems are working optimally to achieve ambitious targets. Interviewees report that while the US and UK average ratio of research

expenditure per patent €million is 3.00, the NUI Galway Technology Transfer Office demonstrated a ratio of 1.00 in 2007 and only 0.75 in 2008.

5.3 Limitations

One limitation of the system that has been identified is that the system can only be accessed on campus and relies on user discretion to succeed. This is a barrier to knowledge codification, however users would argue that not all information should or can be recorded explicitly, for example certain data is commercially confidential. The potential value gained from codifying such data could be easily eroded by its risks to commercial success. Inteum relies on the user to enter relevant data and such a degree of discretion is enabled by the system.

IP management tools must be robust enough to encode the required information and yet flexible enough to meet the challenges presented by tacit knowledge. Despite the implementation of IP management systems at HEIs globally, commentators still suggest that universities may still not be maximizing the true potential of their knowledge reservoir, particularly for tacit knowledge [26]. Interviews confirm this hypothesis and suggest that IP management tools are limited in their ability to capture certain kinds of tacit knowledge.

The process of finding balance between codification and personalisation is culturally connected and it is poignant in light of the preceding discussion to reflect that commentators have identified that the 'cultural software' [27] of organisations as a definer of the prevailing innovation system. Although Inteum has features that increase its usability, there is still room for further efficiencies with increased uptake by users codifying more entrepreneurial types of knowledge. Interviews revealed that other Irish HEIs use a dedicated officer to carry out quality assurance, act as a central resource to assist in knowledge codification and spread awareness amongst users.

6. Conclusion

The problem of managing a growing portfolio of research innovations using a paper-based system was outlined. In examining the role of IP management at NUI Galway and focusing on the lessons learned from using an enabling technology this paper has discussed and defined the key aspects of commercialisation from a systemic perspective and taken the illustrative example of an Irish HEI as an organisational case study. This research has furthered the discussion of the organisational and structural impact of adopting and enabling technology to drive growth in commercialisation activity at a leading Irish HEI and has identified the key benefits and lessons learned by using an exploratory research methodology.

The case study at NUI Galway highlights that

- the minimum critical specification for IP related knowledge begins at the point where there is a critical mass of information to enable the delivery of personal, organisational and societal goals as laid down in the research strategy, institutional IP policy and broader legislative environment. This also includes legally required information and information that will enhance the quality of commercial results such as marketing and financial data.
- the tension between legalistic and entrepreneurial knowledge for individual commercialisation cases cannot always be resolved using the existing IP system either through lack of user acceptance or through an identified system limitation in capturing or codifying knowledge.
- one approach to optimise IP knowledge management could be to develop and utilise assistive guidelines to identify where and if codification is desirable and where a more personalised approach is necessary. In this way new knowledge can be created and managed more effectively to enhance research outcomes.

While IT solutions such as Inteum will only ever form a part of the complex environment that Technology Transfer Offices operate within, they are nonetheless an essential and proven tool in enabling these themes to be realized. New product developments are enhancing the systems ability to act with contact and customer management functionality and this will be of immense importance in developing further efficiencies or for other HEIs and government organisations who seek to implement IP management processes, tools and systems and benefit from the network effects of a highly evolved paradigm.

6.1 Suggestions for Further Research

Research to date has also shown that there are further efficiencies still to be gained at NUI Galway through the use of Inteum and that these predominantly relate to the quality assurance of the myriad of interrelated data that can be captured by the system and the future development and uptake of customer relationship management functionality. A recommendation of this paper is to develop a measurement tool that can assess how closely the commercialization processes in use at NUI Galway align with the information stored in the system. This would provide a baseline that measures the extent of process integration with Inteum and illustrate areas of improvement for the future.

Additionally, expanding the scope of the study to encompass further HEI's in Ireland would validate the exploratory research approach and could allow a greater network effect to enable HEI's who are yet to implement an IP management system to do so more efficiently. The development of a measurement tool to assess the efficacy of how IP management processes are mapped into the supporting IT infrastructure could provide a lasting contribution to any organization who wishes to implement or improve in this space.

This paper has discussed the investment of public monies that have been committed to research expenditure at a European and national level and recent commentary has discussed the complexities of measuring return on investment from such expenditure [28], outlining the potential risk of relying too much on research investment to fuel the growth of the new knowledge economy [29]. This commentary is timely given the current economic climate however, when commercialisation outcomes between academia and industry are compared, the rates of success are not dissimilar. Whilst 90% of academic research will never be commercialised compared with industry-based research where 70-80% of research is not suitable for commercialisation [30]. For this reason, further research into the levels of private investment compared with public investment would be illuminating, especially when contextualised within case study research to provide an indication of the overall economic contribution that research innovation can make. This would also provide an insight into how the efficacy of technology transfer processes and systems can be measured.

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