

Collaborative networks for radical innovation: A science-to-business marketing approach to scientific knowledge commercialisation

Abstract:

The commercialisation of scientific knowledge has become a primary objective for universities worldwide. Collaborative research projects are viewed as a key to successfully achieving this objective and spur radical innovation. The establishment of collaborative networks for radical innovation within these complex multi-stakeholder research projects, however, remains under-researched. This paper is based on case study evidence from 82 stakeholders in 17 collaborative radical innovation projects in Irish and German universities. Utilising qualitative interviews with multiple stakeholders including principal investigators, centre managers, technology transfer managers, industry partners and government funding agents enables analysis of the true value of the various stakeholders' roles. It incorporates a holistic view of the process, as opposed to prior research which has tended to report findings based on analysis of one or two stakeholders. This article explores why and how collaborative networks for radical innovation are established from a multi-stakeholder perspective. It finds that (a) principal investigators play the main role in establishing trusting stakeholder relationships and (b) stakeholder satisfaction and loyalty contribute to the establishment of stakeholder retention. The findings suggest that in order to create collaborative networks for radical innovation it is important to retain industry partners and other stakeholders through repeated joint projects. Overall, the study reaffirms that collaborative stakeholder networks are a key conduit for radical innovation due to network capabilities. Finally, the implications of these findings for future research are discussed.

Keywords:

University Entrepreneurship, Collaborative Networks, Science-to-Business, Relationship Marketing

INTRODUCTION

In comparison with the US, Europe has lower levels of industry-university engagement. The EU has lower overall levels of R&D expenditure and this is particularly noticeable in terms of industry research. In 2006, EU R&D expenditure represented approximately 1.8% of GDP as opposed to 2.6% in the US and 3.4% in Japan. This gap is primarily due to the € 60 billion a year additional industry spending in R&D in the US (European Commission 2008). One of the reasons for the strong performance of the US has been the strong exchange between industry, and particularly high-tech industries, and academia¹. This exchange between science and industry is a necessary prerequisite for radical innovation (Kaufmann and Toedling 2001; Pittaway et al. 2004) and has attracted considerable interest to the role of relationships, networks and interactions in the process of bringing ideas to the market and to commercialise knowledge (Story et al. 2009; Pittaway et al. 2004; Porter and Ketel 2003). Radical innovation, unlike incremental innovation, is characterised by high technical, market, organisational and resource uncertainties. While companies are very good at developing and commercialising incremental innovations, they face difficulties when taking on radical innovation projects as they need diverse abilities to overcome these uncertainties (Leifer et al. 2001). In order to deal with these uncertainties and to acquire different necessary competencies, radical innovation projects require new partnerships between political actors, businesses and higher education institutes including principal investigators (PIs), technology transfer office (TTO) managers, centre managers etc. Polanyi (1966; 1967; 1974) states that scientific knowledge transfer is only possible with communication and interaction between all stakeholders, as tacit knowledge (embodied and embedded in individuals such as PIs and social networks) is needed to transfer the explicit knowledge. Consequently, effective interaction is a prerequisite for knowledge transfer and thus radical innovation success.

Multi-level interaction has not been studied in the required depth. While the contribution to the understanding of linkages is growing (Howells 2006; Azagra-Caro 2007; Bozeman and Gaughan 2007; Kodama 2008; Wright et al. 2008; Adler et al. 2009; Hoye and Pries 2009; Levy et al. 2009) little emphasis is placed on the establishment and management of relationships in order to effectively build networks for radical innovation and the commercialisation of scientific knowledge. This paper uses a multi-stakeholder analysis to analyse how stakeholder relationships are established and managed in order to effectively build collaborative networks for radical innovation.

The paper is novel both in terms of its theoretical approach and research design. It is one of the first to use a relationship marketing framework to examine collaborative networks for radical innovation. Thereby, it contributes to the university commercialisation literature, the relationship marketing literature as well as to the literature on radical innovation. Consistent with the theoretical approach, a holistic research design is employed which incorporates all stakeholders in the collaboration process including: PIs, TTO managers, university research centre managers, industry partners, and government agents, as opposed to prior research which has tended to report findings based on the analysis of one or two stakeholders.

The findings highlight the role of individuals, and in particular PIs, in the radical innovation network. Central to the process are the PI's expertise and their ability to build trusting relationships with industry partners. Stakeholder satisfaction and loyalty contribute to the establishment of stakeholder retention. The findings suggest that it is important to retain industry partners and other stakeholders so as to create collaborative radical innovation

¹ High-tech firms are 28 times more like to undertake R&D than low tech industries (European Commission: 2008).

networks. Overall, the survey reaffirms that collaborative stakeholder networks are the conduit for radical innovation due to network capabilities.

The paper is structured as follows. In the next section the literature on radical innovation and university entrepreneurship is reviewed, focusing on aspects relevant for scientific knowledge commercialisation. Then relationship marketing as an approach is discussed and the theoretical constructs are specified. Section 3, outlines the research methodology and context. This is followed, by the findings in section 4. The paper concludes by discussing the implications of the findings for university industry collaboration and comments on the usefulness of relationship marketing framework employed.

RADICAL INNOVATION AND THE UNIVERSITY ENTREPRENEURSHIP THEORY PERSPECTIVE

Innovation and the different forms of innovation have been studied by many scholars. This paper is concerned with radical innovation. Radical innovation is characterised by high uncertainties about the outcome, long-term high investments but with the potential to create new markets or to restructure existing markets (Leifer et al., 2001; O'Connor and McDermott, 2004). The radical innovation domain is regarded as being of utmost importance for economic growth (Tellis et al., 2009) and radical innovation has garnered considerable interest in the role of relationships, networks and interactions in the process of bringing ideas to the market and commercialising knowledge (O'Connor, 1998; Leifer et al., 2001; Sood and Tellis, 2005; Tellis et al., 2009). This is not only evident in the business-to-business sector but also in the science-to-business sector (Ingemansson and Waluszewski, 2009; Waluszewski, 2009). Universities are key sources of national and regional economic development are often claimed to be the source of radical, breakthrough technologies within collaborative networks (von Hippel, 1988; Mansfield and Lee, 1996; Etzkowitz et al., 2000; Porter and Van Opstal, 2001; Rothaermel et al., 2007). Story et al. (2009) argue that radical innovation endeavours require different resources and competencies than other forms of innovation. For radical innovation and the commercialisation of the ideas stemming therefrom, it is important to understand the links between universities, technology transfer offices, industrial partners and governments and impacts of those links (Howells, 2006; Azagra-Caro, 2007; Bozeman and Gaughan, 2007; Kodama, 2008; Wright et al., 2008; Adler et al., 2009; Hoye and Pries, 2009; Levy et al. 2009;). The paper draws on university entrepreneurship theory to examine stakeholder relationships and networks for radical innovation and scientific knowledge commercialisation. The literature reveals that there are several theoretical approaches to commercialisation of radical technologies but there is no general consensus about the meaning of the commercialisation of university research. In the broadest sense, commercialisation can best be described as a process. This commercialisation “process usually occurs through a complex interplay between different actors and mechanisms” (Waagø et al. 2001:119) and can be identified as a procedure of transferring and transforming theoretical knowledge into commercial value.

A popular approach amongst researchers in the field (Roberts and Malone 1996; Jolly 1997; Ndonzuau et al. 2002; Siegel et al. 2004; Spilling 2004; 2008) is to present the commercialisation process as a stage model. Spilling (2004; 2008) argues that a stage model

implies a form of linearity for an easier understanding, but that interaction happens between the stages and that it will always start at the point of the existing knowledge base. Given the range of stages presented in the literature (mainly focusing on spin-offs rather than different commercialisation strategies) no uniformity can be identified hitherto that would assist policymakers in fostering commercialisation.

In recent years a non-linear recursive interaction of helixes has become an alternative mode, where the different ‘overlapping’ institutional spheres – Academia, State and Industry – generate a knowledge infrastructure and form tri-lateral networks and hybrid organisations (Etzkowitz and Leydesdorff 1997; 2000). The ‘triple helix’ is a useful approach that shows that internal and external partners are integrated and are able to network within the knowledge infrastructure. In order to form a working innovation system the three institutional spheres and the relationships among them are changing worldwide. However, the triple helix fails to provide a holistic understanding of the surrounding environment; a wider, more complex system of knowledge commercialisation that influences the formation of the knowledge infrastructure, scientific knowledge exploitation and commercialisation process respectively.

While acknowledging that a system approach is consistent with the national innovation system or systems of innovation approach, the national innovation system focuses mainly on overall industrial capabilities in innovation and does not take the commercialisation of radical breakthrough scientific knowledge and universities per se into consideration. Edquist (2005) claims that it is necessary to develop the approach further to conceptualise and formalise the work in order to get new insights into the operations of the system. As a result, research has shifted from national innovation systems to sectoral and technological and regional innovation systems. These approaches offer a more detailed view on how innovation happens. However, it is argued that innovation policy should not just target high-tech industries but several sectors (Tödtling and Trippl 2005; Tödtling et al. 2009) and that for these reasons a differentiated policy approach is required. Stemming from the work of these authors, each of the system of innovation approaches may be viewed as not ideal to apply in the same way across different areas in order to enable e.g. specific policy-making for radical innovation. “Policy makers should also deal with the organisational, financial, educational and commercial dimensions of innovation” (Tödtling and Trippl 2005:1211). Furthermore, policy researchers commonly agree that the relationship between innovation, technology and science is of an interactive nature (Morlacchi and Martin 2009). They believe that the innovative power of countries rests upon relations between actors and not just on the ability of the individual and that not only internal R&D, but absorptive capacity is vital for firms to produce new radical technologies.

Empirical evidence shows that university entrepreneurship is emerging as an important academic field in its own right. However, the literature continues to be rather fragmented (Rothaermel et al. 2007). Due to this fragmentation, Rothaermel et al. (2007) conducted a systematic review of the literature for the period between 1981 to the end of 2005. The literature review is based on 173 articles published worldwide in a number of refereed scholarly journals and offers a detailed analysis and synthesis of the state of the art in university entrepreneurship. They find that, although university entrepreneurship is a recent field of research, scholars have already conducted a relatively large amount of quantitative studies and therefore bypass the need for new theory development. Only a few scholars apply sociology, network or strategic management theory to the university entrepreneurship phenomenon, thus limiting the progression of the research field in question. In addition, Rothaermel et al. (2007) point out that the unit of analysis was mainly the university (50%) followed by the firm (23%), individuals (10%), incubators/science parks (9%), technology

transfer offices (5%) and regions (3%). Only a few studies focus on the dyadic interplay of actors and even fewer studies consider a multiple view of interaction. The review reveals that there are several conflicting findings.²

The analysis shows that the literature on scientific knowledge commercialisation is still developing. Whilst there is plenty of research on university entrepreneurship, firm creation and university-based technology transfer in terms of technology transfer offices, little emphasis is placed on what enables and hinders the commercialisation of radical or breakthrough scientific knowledge. There is a lack of complexity in models and richness in data to understand the interdependent processes across different stakeholders (Rothaermel et al. 2007). A deeper understanding of the following issues is required:

1. Diverse linkages and how they impact scientific knowledge commercialisation; and
2. how to effectively build and manage networks of these linkages.

To assess whether the gap has been addressed a further review of more recent university entrepreneurship literature was undertaken, employing a similar research methodology to update the comprehensive review of Rothaermel et al. (2007). The analysis was based on the identified lack of knowledge and understanding of the diverse linkages and multilevel interaction in university entrepreneurship. The top 5 journals in the field published 73% of all articles on university entrepreneurship as identified by Rothaermel et al. (2007).³ The analysis revealed a total of 50 articles that related to linkages and multilevel interaction.

A total of 68% of the articles were published in the top 5 journals publishing articles on university entrepreneurship, as identified by Rothaermel et al. (2007). Articles were found on factors influencing university-industry interaction and how linkages impact the commercialisation of knowledge. These include articles focusing on how individuals (Azagra-Caro 2007; Hoyer and Pries 2009), industry partners (Levy et al. 2009), networks (van Rijnsoever et al. 2008) and government grants (Bozeman and Gaughan 2007) impact on linkages between the university and industry. Another contribution to knowledge on linkages is the performance of collaborations. This contribution answers questions on the costs of the coordination and the output of university and industry interaction (Cummings and Kiesler 2007; He et al. 2009). Furthermore, the role of intermediaries and intermediation on university-industry linkages was elaborated (Howells 2006; Kodama 2008; Wright et al. 2008). The embeddedness in geographic areas in terms of proximity (science parks, communities, networks) was another category identified in the analysis (Hussler and Rondé 2007). In addition, scholars have published articles on university research centres (Boardman 2008; Boardman and Corley 2008) and tried to identify how the successful collaboration is perceived (Butcher and Jeffrey 2007). It is noteworthy that most of the studies still look at dyadic relationships between university and industry (Plewa and Quester 2008). While some of the studies take the government into account (Boardman 2009; Boardman and Corley

² Researchers question the role of universities or technology transfer offices and what influence these have on scientific knowledge commercialisation. In addition, they disagree over the role of incentive structures and rewards; the effects of policies on patent quality; and whether surrogate entrepreneurs or coached investors and homogenous or heterogeneous founding teams have an impact on the success of new firm creations. Furthermore, there are contradictory findings with regard to the role of the environmental context, especially as to whether innovation networks and science park memberships impact on R&D performance.

³ Keyword combinations or variations of the broadly defined lack of linkages include, but were not limited to “university” and “collaboration”, “partnership(s)”, “relationship(s)”, “link(s)”, “linkage(s)”, “relation(s)”, “interaction”, as well as “academic” or “academia” and “collaboration”, “partnership(s)”, “relationship(s)”, “link(s)”, “linkage(s)”, “relation(s)”, “interaction” etc. As a robustness check a subset of journals were searched and the electronic reference retrieval service Business Source Premier was used to identify articles not part of the top 10 or not mentioned in the Rothaermel article. The top 8 of these 10 journals published 82% of all articles on university entrepreneurship up until the end of 2005 (Rothaermel et al. 2007).

2008), only a few try to incorporate diverse actors to study multilevel interaction (Adler et al. 2009).

In summary, the issue of multilevel interaction has not been studied in the required depth. While the contribution to the understanding of linkages is growing, little emphasis is placed on the establishment and management of relationships in order to effectively build networks for radical innovation and scientific knowledge commercialisation. This paper puts forward the relationship marketing framework to examine the initiation and management of relationships between universities and their industry partners in order to develop collaborative radical innovation networks for the mutual benefit of all participating stakeholders.

RELATIONSHIP MARKETING THEORY PERSPECTIVE

Relationship marketing has its roots in a number of literatures including transaction cost, agency and network theory. According to Bruhn (2003) relationship marketing, however, addresses the deficiencies of some of these theories. Transaction cost theory lacks the ability to explain relational governance and social exchange and does not take the complexity and cultural aspects of different stakeholder relationships into account. In a similar vein, principal-agent theory does not consider the versatile nature of different stakeholders that participate in radical innovation and scientific knowledge commercialisation. In contrast, social exchange theory views personal, noneconomic satisfaction as more important than economic outcomes. Network theory enables the analysis of the embedded context and relationships within this context, but does not explain the different phases that lead to relationship success, mutual benefit and reciprocal commitment and trust. Relationship marketing is “systems-oriented, yet it includes managerial aspects” (Grönroos 1997:332). In view of this, the ‘macro’ approach of relationship marketing, where the network of different stakeholders is taken into account, offers several significant theoretical concepts to explain how stakeholder relationships and stakeholder retention impact the success of radical innovation and the commercialisation of scientific knowledge.

Several researchers provide definitions of relationship marketing (Shani 1992; Gummesson 1996; Grönroos 1997; Parvatiyar and Sheth 2000). Gummesson (1996) and Parvatiyar and Sheth (2000) define that networks as sets of relationships, and interaction as the cooperative and collaborative activities performed within relationships and networks. Complementing the definition, Liebeskind et al. (1996) suggest that firms should have relationships with academic scientists, and therefore access to their social network, in order to benefit considerably. In addition, short time-to-market cycles, high R&D costs and risks from the industry’s perspective postulate the necessity of partnerships to commercialise knowledge (Mohr 2001). The definition above identifies dimensions of relationship marketing including stakeholder, network, value and long-term orientation which exhibit a great deal of salience in the process. In view of this and the fact that relationship marketing is predominantly important for the development of new technology innovation (Mohr 2001) the relationship marketing approach can also be applied to science-to-business (S-2-B) relationships in scientific knowledge commercialisation. Only a few studies have focused on interaction and knowledge of different stakeholders (Story et al., 2009) within the radical innovation domain. O’Connor and McDermott (2004) look at competencies for radical innovation such as discovery, incubation and acceleration from an industry view. Story et al. (2009) also look at competencies but do so from a stakeholder perspective and further examine the resources that are necessary. Little research has, however, been done on the interplay of all participating

actors for the establishment and retention of stakeholder relationships that is necessary to form radical innovation networks.

The task is to adapt the relationship marketing framework to explain the impact of long-term, mutual stakeholder relationships in the radical innovation context and the scientific knowledge commercialisation environment. Considering the objectives of relationship marketing, relationship success can be identified as the overarching aim (Diller 1995) and is measured by customer retention (Werani 2004). Customer retention is regarded as a pre-goal to achieving the overall objectives of relationship marketing. Relationship success can be understood by looking at the intensity of the relationship and the duration of the relationship as exemplified in the customer-relationship life cycle. The intensity of a relationship can be measured in respect of psychological, behavioural or economic indicators. Psychological indicators refer to trust, commitment and relationship quality. Behavioural indicators refer to purchasing, information, integration and communication behaviour (recommendations). Economic signs of relationship intensity are increasing sales, profits the customers contribute and customer lifetime value (Bruhn 2003). Accordingly, core targets are not just the acquisition of customers, but the retention and maintenance of the relationship. Adapting these prior contributions to the science-to-business context the following definition is derived:

Relationship marketing is a proactive endeavour to initiate, manage, intensify and adapt relationships with customers (i.e. industry partners) and other stakeholders to identify, sustain, enhance and strengthen a network for the mutual benefit of all participating stakeholders. This is accomplished by an ongoing process of engagement in cooperative and collaborative activities.

This definition emphasises the polyadic relationships implicit in a relationship marketing perspective. It is not just business-to-consumer relationships that are being looked at, but relationships with other stakeholders and the formation of networks with these stakeholders.

An empirical study by Reicheld and Sasser (1990) outlines that the profit made per customer increases with the length of the relationship due to the fact that loyal customers tend to recommend and contribute to organisations reputation through positive word-of-mouth. Long-term customer orientation reduces costs as retaining and maintaining customers costs less than acquiring new ones. Furthermore, customers who are satisfied with products and/or services are more likely to do business again with the organisation in question. However, it has to be noted, that profits in business-to-business (B-2-B) markets differ as a result of different customer needs cycles (Bruhn 2003). The basis for customer retention is the business relationship between a purchaser and a supplier. With reference to the university, as the supplier of scientific knowledge, retention can be perceived as a bundle of activities to intensify the relationships with the stakeholders. These activities are often associated with the relationship management (Diller 1996). When viewing stakeholder retention it can be noted that loyalty is pivotal to retention. Thus, a stakeholder is retained when he is loyal towards the university. Therefore it is not solely previous behaviours (ex-post considerations) which are an inherent aspect in loyalty, but also future behaviours (ex-ante considerations) (Homburg et al. 2005). The business relationship is the point of reference for stakeholder retention, and the purchaser and supplier (i.e. stakeholders and university) have to be involved to realise retention. The following definition is derived from the work of Diller (1996) and Homburg and Bruhn (2005).

Stakeholder retention exists if repeated information, goods or financial transactions occurred (ex-post consideration) or are planned (ex-ante consideration) between

business partners within an appropriate period of time. Inter alia, stakeholder retention includes all activities a university can undertake to influence the stakeholder's intentional and actual behaviour or improvements in goods and services in order to maintain and expand relationships in the future.

This paper considers stakeholder retention as the most important objective to relationship success. Relationship success and the objective of stakeholder retention contribute to the success in scientific knowledge commercialisation due to repeated information, physical or financial transactions and the formation of collaborative networks. Therefore, it is important to understand how stakeholder retention is facilitated.

In the alliances and inter-organisational network literature, success of relationships is assessed either objectively or subjectively (Mora-Valentin et al. 2004). Objective measurement studies evaluate the stability, continuity and evolution of relationships (Shamdasani and Sheth 1995; Park 1996; Cyert and Goodman 1997; Davenport et al. 1998; De Laat 1999) while other studies look at subjective measurement dimensions such as the level of satisfaction of participating actors (Mohr and Spekman 1994). In this paper, the success chain of relationship marketing is considered in order to evaluate effects on stakeholders and their relationships. The success chain links inter-related attributes to facilitate “structured analysis and derivation of actions” (Bruhn 2003:54). The elementary components of the chain are illustrated in Figure 1.



Figure 1: Elementary components of the success chain Source: Own conception based on Bruhn (2003)

Hereinafter the components and factors that facilitate the attainment of stakeholder retention, and hence the output effects for the university, will be discussed in the context of the findings.

METHODOLOGY

As already mentioned there is a need for qualitative research on scientific knowledge commercialisation. Such an approach is suitable when existing research is incomplete or conflicting and a “how” question is required to clarify the issue (Eisenhardt 1989). Case research is believed to be more appropriate as the analysis of stakeholder relationships is best examined within the phenomenon's real life context. In addition, qualitative data provide for deeper insight into stakeholder relationships as they involve complex social processes that quantitative data cannot disclose (Eisenhardt and Graebner 2007). The research process comprises of two elements: (1) a thorough literature review combined with convergent interviewing process in a pilot case study at the National Centre for Sensor Research (NCSR) in Ireland in order to identify broad research issues⁴ and (2) the main study, which involved 82 interviews with all participating stakeholders. Consistent with the methodological

⁴ Research issues of the pilot case study are provided in the appendix

approach the preliminary results are providing rich and interesting constructs including satisfaction, loyalty, retention, relationship management and entrepreneurial activity. External validity within this study was achieved by (a) identifying research issues before data collection, (b) formulating an interview protocol to provide data for confirming or disconfirming theory. The analysis of the main case studies is based on the results of the pilot case study which enabled the design of an interview protocol.

Research context

Following Yin (1984; 2009) replication logic, and not sampling logic, is used for multiple-case studies. Literal replication (predicts similar results for predictable reasons) and theoretical replication (produces contrary results for predictable reasons) are the basis for the case selection. Three comparisons are central to the analysis. Firstly, the performance of industry funded designated centres of excellence and faculty-based research centres are compared. Secondly, as most prior research focuses on leading academic institutions a comparison of leading academic institutions and smaller university institutions is considered. Thirdly, a comparison of practices in Germany and Ireland is also provided. Germany and Ireland have been chosen as both have similar policy initiatives with regard to creating centres of excellence for long-term research but with different economic and financial infrastructures. In particular, Bavaria has a long tradition of industry university partnerships with a base of global companies such as BMW and Siemens. In Ireland the industry context is primarily multinational subsidiaries, which are generally less embedded in the local economy. The challenge is to encourage multinationals to undertake more research in Ireland. By addressing these comparisons nine excellence research centres and eight faculty-based centres located in Ireland and Germany were identified.

	Ireland	Germany
Excellence Centre	4 CSETs: Centres for Science, Engineering and Technology (CSET) are interdisciplinary Irish state funded (approx. 5 Mio per annum) research centres whose aim is to provide excellence in research and to exploit opportunities in science, engineering and technology. Currently there are 10 CSETs; in addition they acquire their funding by applying for government or EU grants	5 Centres of Excellence: Clusters of excellence are state funded (3-8 Mio per annum) centres which are one of three funding lines of the German excellence initiative and whose aim is to establish internationally visible, competitive research facilities to enhance scientific networking and cooperation ; in addition they acquire their funding by applying for government or EU grants
Faculty based centre	4 Faculty-based research centres: are research centres or research of faculties which are located within a faculty and are not funded through a specific policy initiative; they acquire their funding by applying for government or EU grants	4 Faculty-based research centres: are research centres or research of faculties which are located within a faculty and are not funded through a specific policy initiative; they acquire their funding by applying for government or EU grants

Table 1: Case characteristics

As indicated in Table 1 excellence centres in both countries are funded by dedicated government initiatives and get allocated on average € 5 million per year. They were introduced to create excellence and radical innovations in research, and to form interdisciplinary research hubs for collaboration and networking. The funding incorporates funding for research as well as administration and equipment. These initiatives moved the universities to the centre of the science system. The Irish excellence centres (Centres for Science Engineering and Technology or CSET) focus on life science, energy and information technologies. Industry involvement is a requirement for funding and one of the main aims of the CSETs. German centres of excellence cover several sectors with promising research potential and, while industry involvement is desired and plays an important role, the main aim is to improve cutting-edge research in Germany and to improve international competitiveness. The cases were selected in universities that had provided both, excellence centres as well as faculty-based research in the life science, engineering and information technologies sector. These sectors were chosen for several reasons. Firstly, they reflect the focus of the Irish CSETS and secondly, they mirror the sectors of firm-university cooperation (Forfas 2011). Thirdly, and more importantly, it is believed that collaborations are more important to firms and academics than spinning out or licensing (Perkmann and Walsh 2009). All research centres collaborate with multinationals and SMEs, and some have their own spin out companies. Thus, the cases present a broad spectrum of collaborative activity. Comparative analysis will reveal root causes of the performance differential and hence further research possibilities, whilst the existence of similar research results should enable us to build theory.

Data collection and analysis

As the study is designed to include all stakeholders collaborating on a specific project, stakeholder interviews constitute the primary unit of analysis for our research. A letter of introduction from the DCU president enabled the first contact with the excellence centre managers. The centre managers were asked to identify a collaborative project within the centre. By choosing a particular project they were in the position to provide the names and contact details of all participating stakeholders. This was not only beneficial for identifying the participating stakeholders but the possibility of talking about a specific project also helped the stakeholders to identify specific issues more easily as they could refer to a particular example. The managers of the excellence centre provided details of faculty-based research centres and/or scientists that matched their research interest or were in the engineering or information technology sector. Once a contact to a faculty-based centre was established a collaborative project and stakeholders were also identified. When all stakeholders were identified emails were sent out seeking participation, which were supported by centre managers. It is worth mentioning that the industry partners and government agents were faster in responding and organising the meetings than the PIs. This might also reflect their tight schedules as proposed in the findings.

The data is based on 82 semi-structured interviews of which 75 were face-to-face interviews and 7 were telephone interviews. The interviews were conducted with all stakeholders within the centres listed in Table 2.

	Ireland		Germany	
	Trinity College	Dublin City University	Ludwig Maximilian University	Technical University Munich
Excellence Centre	CRANN – Centre for research on adaptive nanostructures and nano devices	BDI – Biomedical diagnostics institute	MAP – Munich advanced photonics NIM – Nano initiative Munich	COTESYS – Cognition for technical systems
	CTVR – The telecommunications research centre	CNGL – Centre for next generation localisation	CIPSM – Centre for integrated protein science	Universe Cluster – Origin and structure of the universe
Faculty-based centre	TCIN – Trinity college institute of neuroscience	RINCE – research institute focused on engineering technologies	CeNS – Centre for nano science	Faculty for aerodynamics
	Trinity centre for bioengineering	ICNT – International centre for neuro-therapeutics	BioImaging centre	Faculty for flight system dynamics

Table 2: Case study selection

The interviews were conducted with 23 principal investigators, 12 research centre managers, 13 TTO managers, 22 industry partners and 9 government agents who participated in collaborative projects. The research centre managers were, apart from two, all principal investigators as well. All government agents were responsible for multiple centres. Where they covered two projects, they were interviewed once but were asked to discuss both projects. The same applied for the 4 TTOs of the 4 universities. Interviews lasted between 45 and 60 minutes.

A semi-structured interview protocol was used for the main study. Firstly stakeholders were asked to outline their backgrounds and jobs. The participants were then asked to reflect on the following topics: (a) how projects are initiated, (b) project objectives and (c) differences in the initiation process across projects. They were also invited to reflect on (a) how they evaluate the success or failure of a project, (b) what sort of information they shared with the partners and (c) whether they shared all information. The respondents were questioned on whether they have or will undertake another project with current partners and were asked to explain their answers. They were invited to make suggestions in relation to what the individual players can do to encourage additional projects. More general questions were asked in relation to (a) who establishes and manages the relationships and (b) how a collaborative network of relationships is being facilitated/developed. Finally, they were asked to (a) reflect on the barriers and enablers to collaborative relationships and commercialisation in general and (b) the benefits of network involvement. In order to ensure validity we followed Perkmann and Walsh's (2009) methodology and asked for facts to reduce cognitive bias and to limit impression management. The identification of specific projects enabled this process. Confidentiality was assured to encourage participants to provide truthful answers.

The multi-stakeholder approach enables the analysis of the true value of all stakeholders' roles as it incorporates a holistic view as opposed to prior research which comprised single

units or dyadic units of analysis. While it is acknowledged that qualitative analysis does not account for statistically significant results, a multi-stakeholder analysis will, if the stakeholders agree on certain topics irrespective of size, type or location of the centre, inform a general understanding. The 82 stakeholder interviews from the 17 projects (within the 9 centres of excellence and 8 faculty-based research centres) were transcribed and formed the basis for the analysis. The design facilitates analytical generalisation as it refers to generalisation from empirical observations to theory, rather than a population (Yin 1984; Gibbert et al. 2008).

CASE STUDY EVIDENCE

The literature to date provides little insight into (a) how collaborative stakeholder networks are established and (b) how stakeholder retention for successful network creation is achieved⁵. The following discussion is based on the elementary success chain as illustrated in Figure 1 and interprets the findings using relationship marketing theory to explore these questions.

University input

When looking at the establishment of science-industry research collaborations, it is important to look at the initiation of these relationships. Why do certain partners use the university? The findings indicate that PIs play an important part in the initiation of these relationships as indicated by one of Irish centre manager (and lead PI) who stated:

“the PI can be part of the establishment...you just can’t have someone else establish it who doesn’t know the nitty gritty of the research...I don’t think it works any other way.”

The involvement of the PI in the initiation of a relationship was confirmed by almost all of the participating stakeholders. One centre acknowledged that it is the centre manager who deals with all industry inquiries. However, this does not mean that the PI’s reputation is not the reason for the initial contact. The case research found that the reputation of the PI is a key factor used by industrial partners when choosing a research centre. A PI (and commercialisation manager) of one of the centres stated that “when you are good, you catch people’s attention and then people will come to you, you don’t need any help”. This view is shared by almost all PIs and industry partners. A R&D manager of a German multinational company highlighted this by declaring:

“it is not about universities; it is about professorships. I am not looking where a good university is, but it is a matter of where is the professor...I am looking for professors and what they know...we are looking around the world to figure out who studies a certain topic and then we get in contact with a few locations to just see who is doing what. So it is not about universities. It is always about people”.

This finding implies that it is important for PIs to publish in high ranking journals, attend conferences to disseminate their knowledge and build their reputations. The Government also

⁵ Sample findings on the establishment of collaborative networks from this study are provided in the appendix

requires high quality research from PIs, as continuous funding of the centre is dependent on the quality of the PI's work. An Irish Government agent noted:

“a lot of it is down to the quality of the work they [PI] do. You know, so if a centre isn't producing quality work and it isn't internationally recognised as a leader in its field, then, we would have to think very carefully about whether we want to continue funding it”.

This indicates that the PI is not just accountable for his or her own reputation but that of the centre as well, which in turn enhances the relationship with industry and the State.

Furthermore, there was a general consensus that the PI has to show a willingness or interest in collaborating in order for industrial partners to consider working with them and therefore the centre. A German TTO manager referred to the issue as follows:

“As a matter of principle and what is elementary to transferring or commercialising knowledge is a fundamental willingness to continue working on a certain topic and not to say: *Great I have a patent and now I'll do something else*”.

An Irish Government agent confirmed this by saying that “there's no point if the technology is good but the people aren't interested in doing commercialisation”. This view is shared by government agents, TTO managers as well as 15 industry partners who pointed out that this was one of the most important issues.

In summary, the findings show that the PI is important and involved in initiating the contact with industry. This is achieved by (a) showing their own interest in collaborating, transferring or commercialising knowledge and (b) contributing to their reputation or the centre's by publishing in high ranking journals. These findings add to prior research on motives for exploiting the technology and taking part in the research. It demonstrates that the PIs are required by the government, industrial partners and centre managers to show interest in transferring and commercialising knowledge and to produce world class science in order to be published in high ranking journals. The latter is quite likely to be achievable as it is consistent with the findings that scientists' major motive is recognition within the scientific community (Siegel 2003; Siegel et al. 2003a; Siegel et al. 2004) and therefore one of the PI's aims. Encouraging an interest in collaboration for radical innovation is more difficult to achieve, however, as it may not be an important motive for researchers. The findings reflect the need to advance “the people side of radical innovation”. While O'Connor and McDermott (2004) report the challenges firms face to elate their employees to engage in collaborative radical innovation projects, this paper outlines that the university encounters a similar necessity to encourage PIs to work towards radical innovation. In addition, reputation appears to have a mutual validity when it comes to potential collaborative partners (O'Connor and McDermott, *ibid.*).

Effects on Stakeholders

Looking at the effects on stakeholders, there was general agreement that the relationship plays an important part in retaining stakeholders. An Irish industrial partner summarised this by stating that “it all depends on the relationship, how it works and are things delivered.” A German industrial partner said that they were really satisfied at the start but that they are not anymore due to people leaving the research centre. He believes that it is down to the relationship with the people. The findings show that satisfaction with the relationship and the quality of work is of importance for industrial partners. Government agents, on the other side,

have to remain unbiased. Nevertheless, peer-reviews for additional funding depend on the satisfactory attainment of targets (publication numbers and quality, number and quality of collaborations etc.).

In general no difficulties exist with the term satisfaction. In research, by contrast, several approaches exist to explain and define the construct of satisfaction (Homburg et al. 2005). For example, Wilson (1995) defines performance satisfaction (both product specific performance and non-product attributes) as the level at which the business transaction meets the business performance expectations of the partner. Thus, numerous studies draw on the confirmation/disconfirmation paradigm (Day 1977; Oliver 1980; Woodruff et al. 1983; Backhaus and Bauer 2001). Satisfaction can also be understood as a result of a cognitive evaluation process, whereby an expected or desired normative output is compared to a perceived actual output. Thus, satisfaction is achieved if the actual output equals or exceeds the expectation. Consequently, the result of an evaluation process where expectations are not fulfilled is dissatisfaction. However, discrepancies exist as to whether exact fulfilment causes satisfaction or whether it occurs with only over-fulfilment (Homburg et al. 2005). In addition, scholars argue that satisfaction may not merely be built up during the course of a single major transaction, but rather through an evaluation process of reiterated experiences. Newer attempts at explanations take the affective view of satisfaction into account as well (Werani 2004). In this respect, satisfaction can be understood as an emotional reaction to a cognitive evaluation process. In B-2-B markets, particularly, satisfaction is defined as a positive affective condition, which does not emerge by virtue of single transactions, but through business relationships. Both, the affective and cognitive approach, are based on the evaluation of all aspects of a business relationship and embraces economic and psychosocial perspectives of satisfaction. Economic satisfaction shows to what extent economic expectations in relation to business relationships are met. Psychosocial satisfaction is positively assessed relational aspects such as reciprocal support, mutual appreciation or amicable relations.

The case study findings illustrate that industrial partners, academics and government agents are aware that their collaboration is evaluated in terms of the deliverables, service and quality of the interaction by the other parties. A German cooperation manager of a multinational company explained the issues as follows:

“It is a combination of the whole [cooperation]. First aspect is always the subject matter. We wouldn’t do a project which wouldn’t be of interest to us with regard to contents. It just costs too much. If you know what you want to do you are going to look for potential partners who a) have the competence and b) you enjoy working with – who are reliable partners.”

The analysis shows that industrial partners appraise the collaboration based on (a) professionalism, (b) industry and market awareness of the centre and PIs, and (c) realistic evaluation of IP and feasibility. While professionalism (a lack of management experience among PIs) was mentioned by a few industry partners, almost all industry partners mentioned industry and market awareness and the inherent unrealistic evaluations. Some industry partners were talking about significant overestimations when TTOs assess the IP situation while others held the PI responsible for being overenthusiastic and naïve about the feasibility of a project. A commercialisation manager of one of the CSETs admitted:

“I think they have to have; they have to be careful and realistic in the negotiations around intellectual property. Really in terms of putting values on.... They have to be more professional in managing the relationships. They have to see the world from the industry perspective and I think they need to be more flexible and dare I say honest.

In that if it's something they're not interested in really getting involved in industrial led research then, then don't.

In contrast to the proposition that capabilities such as market learning, creation or testing are necessary at the incubation stage and not at the early stage (O'Connor, 1998; 2006) the findings suggest that it is important for industry that the university partners can judge the market feasibility or potential of their ideas from the start. Thus, the findings support the idea that incubation capabilities are necessary at the early stages of radical innovation (Story et al., 2009).

Communication and timing as evaluation aspects, on the other side, were acknowledged by all participating stakeholders. An executive director of the CSETs acknowledged:

“the company satisfaction in what we are doing...if they didn't feel that you would deliver something at the end they wouldn't bother. Because it's not just the funding, it's the management time it's the interface time, it's the energy you have to put into maintaining the relationship”

With regard to the commercialisation of scientific knowledge, the exchange and transfer of knowledge or products and the commercialisation process are the foci of interest. In this context, satisfaction of stakeholder demands becomes a relevant aspect. Hence the success of scientific knowledge commercialisation, and successful exchange and transfer of technologies, relies on the fulfilment of specific expectations and on the perceived quality of the technology and service. As this study is concerned with stakeholder relationships which are based on business relationships the business-to-business market perspective of satisfaction is taken into account. Thus, stakeholder satisfaction can be understood as both a cognitive evaluation process of technology and service (commercialisation process) and a positive affective condition, which results from an assessment of economical and/or psychosocial aspects of the business relationship (relationship quality) between stakeholder and university. Relationship quality, as added value, becomes particularly important when other universities are able to provide similar knowledge and competencies. Holistic stakeholder satisfaction indicates that stakeholder satisfaction is determined by an evaluation of the pre-commercialisation, commercialisation and post-commercialisation process and the relationship⁶.

After the clarification of stakeholder satisfaction construct the effects of satisfaction and dissatisfaction were examined. While a dissatisfied stakeholder will possibly leave, complain or distract from to the university's reputation through negative word-of-mouth, satisfaction might entail positive word-of-mouth or loyalty (Homburg et al., 2005). There is theoretical consensus that loyalty primarily results from satisfaction with the product (i.e. technology) and/or service (commercialisation process) (Hermann et al. 2000). Numerous studies postulate a positive relationship between the constructs satisfaction, loyalty and retention and several empirical studies confirm this. Albeit taking different functional forms into account, the prevalent relation function, which is empirically observable, is a progressive or saddle-shaped curve (Homburg et al. 2005). These functions show that in the convex part, a small increase in satisfaction has a strong positive effect on loyalty. Loyalty is the result of a psychological evaluative decision process where different alternatives, in consideration of relevant criteria, are judged (Homburg and Bruhn 2005; Weinberg and Terlutter, 2005). A positive attitude is regarded as a subjectively perceived suitability (Kroeber-Riel et al. 2003). It reveals profound emotional and cognitive judgements (Weinberg and Terlutter 2005).

⁶ Holistic stakeholder satisfaction figure can be found in the appendix

Thus, the assessment is based on saved opinions and the knowledge of the university. Other influential factors on loyalty are switching costs. Long-term stakeholder orientation is more cost efficient because retaining and maintaining stakeholders costs less than acquiring new ones. These costs consist of three types of costs (Plinke and Söllner 2005). Direct costs refer to costs associated with the search, initiation and arrangement of new business relationships as well as potential investments in them. Sunk costs are previous irreversible costs or investments that were made in order to benefit from the relationship. As these costs are specific to the particular business relationship they cannot be transferred to another and are therefore lost. The third type of costs are opportunity costs and relate to the lost net benefit of the deserted relationship. The higher each of these costs are the higher is the tendency to persist. In order to maintain and retain stakeholders and to establish long term relationships it is of utmost importance to satisfy them and gain their trust. The more successful a partner (i.e. the university) is in doing this, the sooner the stakeholder becomes committed and loyal (Kleinaltenkamp 2005).

In terms of loyalty the findings show that there is a common consensus that if the results are right loyalty will evolve. A German excellence centre manager indicated that loyalty to him means getting new requests to collaborate and solve problems together. An Irish CSET director reinforces this by saying that the industry partner “came back and they renewed their commitment for another four years basically just do that on the basis of success”.

The construct of trust has been discussed by several authors (Moorman et al. 1992; 1993; Morgan and Hunt 1994) and is regarded as the key to facilitating exchange relationships. Trust exists if a customer believes that a relationship partner is “reliable and [has] a high degree of integrity” (Hennig-Thurau et al. 2002:232). In the commitment-trust theory, trust is believed to be a key mediator between antecedents and relational outcome (Morgan and Hunt 1994). Sole trust approaches, however, see trust as an antecedent to relational outcomes (Moorman et al. 1992). Individual, interpersonal, organisational, inter-organisational or project related factors influence the establishment of trust (Moorman et al. 1993). In relation to trust the findings show interesting results. The case study participants were asked if they share all information with each other. A German industrial partner stated that “we’re not that open about it; we only share new ideas with the people we trust”. Most industry partners, however, while having a similar view on sharing information and trusting the partners, mentioned that they have IP agreements in place protecting information. Trust, nevertheless, was important to industry partners. Setting up a contract prior to doing collaborative research cannot always cover all eventualities. One industry partner said that “it is 90% trust and 10% contracts”. Trust is viewed as necessary to start collaborating in the first place. A German industry partner of a multinational pharmaceutical company said:

“the point is to build trust. And if you have created mutual trust, then they [academics] know that they can rather come to us and say *look I have an idea, are you interested in it*. And then trust and reliability are fundamental aspects, because if not they [academics] would just go to somebody else... and if we ultimately are known to be a reliable partner and have shown that you can collaborate well with us, then we will profit from it, as they come to us first, it in the long term.

Technology transfer manager and government agents did not view trust to be of importance for sharing information. They believe that IP agreements are sine qua non. They do not believe that industry partners become loyal. In their view industry partners will go to another university if they can offer better terms and conditions. This view contradicts the strategic aspect industry partners see in becoming loyal and trustworthy partners. Government agents, as stakeholder themselves, cannot be viewed as loyal or committed to the university as they

have to remain unbiased. However, distrust and a negative attitude have an impact on further funding opportunities. Similarly, TTO managers do not become committed to a research centre as their main remit is to provide a service for the whole university but associate trust and a positive attitude with a higher chance of working more closely with certain PIs. Academics and centre managers, on the other side reflect the industry view. Both, German and Irish academics and managers referred to trust as the antecedent to start a collaboration and negotiations. They suggest that relationships with a company are like personal relationships based on some level of mutual respect and trust. They further believe that you have to maintain this trust to have a second or third engagement with industry partners.

In summary, one could say that loyalty is an extremely uncertain construct that is difficult to plan. Stakeholder loyalty comprises of trust, a positive attitude towards the university and stakeholder's acceptance regarding the high performance of the university's research centre. At this stage the stakeholder shows a reduced willingness to change the university they want to collaborate with and are more likely to recommend or reuse the service. The stakeholder becomes committed and has "an enduring desire to maintain [the] valued relationship" (Moorman et al. 1992:316) with the university. Loyalty exists if the stakeholder shows the first signs of a lower intention to change and is considering using the service of the university again at a later stage. The transition from stakeholder loyalty to stakeholder retention takes place when the positive attitude, acceptance of the university, as well as trust and commitment, actually result in recommendations or re-use of the service. The findings show that all participants, but two have recommenced the university research centre they are based in or have collaborated with. The two participants who mentioned that they have not recommended and would not recommend the research centre were industrial partners. They explained their behaviour by stating that they were unsatisfied with the service they had received. Repeated collaborations on the other side elucidate the retention of stakeholders. The industrial participants acknowledged that they were satisfied with the service, quality of the work and the relationship with the partners. They explained that the only reason for not repeating a collaborative research project would be an entire change in company strategy. The interviews with the academics confirmed that companies who did not continue to collaborate and thus leave the network did this because of strategic or leader changes.

Stakeholder retention embraces all activities a university can undertake to influence the stakeholder's intentional and actual behaviour or to improve its knowledge base and services in order to maintain and expand relationships in the future. Stakeholder retention exists if repeated knowledge transfer, technology transfer or financial transactions occurred or are planned between the stakeholder and the university research centre. Stakeholder retention is regarded as the most important objective to relationship success. Relationship success and the objective of stakeholder retention contribute to the success in scientific knowledge commercialisation due to repeated transactions.

Stakeholder retention can be differentiated through either "dependence" or "solidarity" type relationships (Georgi 2005). Solidarity refers to a voluntary retention. The stakeholder acknowledges the advantages of the relationship with the university has and weights these against the non-existence. Two influential aspects are the above mentioned transaction quality (i.e. the evaluation of the technology and commercialisation process), and the relationship quality (i.e. a positive affective condition, which results from an assessment of economical and/or psychosocial aspects of the business relationship as well as trust and commitment). The success of stakeholder retention rests upon a high quality of the overall business relationship including the interaction behaviour in form of flexibility in providing the outputs, quality of the personal involved, interaction and openness of the selling party (Homburg 1998).

Retention through dependence exists for a certain period of time. Although the stakeholder enters the relationship voluntarily in the first place, his or her decision making will be restricted due to certain parameters such as contracts. While stakeholders, in the context of scientific knowledge commercialisation, can be economically bound, through the establishment of economical switching barriers, and legally bound through, for example, contracts, it is difficult for the university to technically/functionally bind them. Establishing switching barriers, as a university internal moderating factor, can help to increase the dependent retention.

Aside from the quality of the transaction and the quality of the relationship, the benefits that a relationship yields influences stakeholder retention. Relationship benefits are those which a business partner obtains from long-term business relationships beyond those initially expected (Gwinner et al. 1998). The above-mentioned strategy aspect, which the industry partner gains, is one relational benefit. Relational benefits for all participating stakeholders are the formation of a network and the network capabilities. As radical innovation is infrequent, requires routines and depends “on people over processes” (O’Connor and McDermott, 2004 p27), the importance of stakeholder retention in forming radical innovation networks is evident.

Understanding the influences of stakeholder retention is the sine qua non for stakeholder relationship success and meeting the objectives of stakeholder retention. This, in turn, contributes to the success in radical innovation and scientific knowledge commercialisation which arises from repeated transactions in the areas of knowledge, technology and finance. The success chain concludes with forming collaborative stakeholder networks and inherent network capabilities on the basis of the resulting effects of the success chain components.



Figure 2: Stakeholder retention success chain Source: Own conception based on B-2-C success chain (Homburg 2005)

University Output

Relationship marketing theory suggests that relationships and interactions with different stakeholders are prerequisites for collaborative stakeholder networks. The output of collaborative stakeholder networks for radical innovation is evident. There is a need, however, for scientists to be able to recognise and identify the commercial value of their discoveries and breakthrough innovations. In the context of scientific knowledge commercialisation, this is most effectively achieved if the necessary knowledge about the market is embedded within the research of scientists and/or when scientists get access to external contacts (O’Gorman et al. 2008) within scientific networks which include local and international networks in industry and entrepreneurial communities (Degroof and Roberts 2003; 2004) that possess commercial knowledge. Furthermore, access to industry external networks and the scientists’ technical knowledge is deemed to be an important factor for successful commercialisation in industry (Thorburn 2000; Jensen and Thursby 2001; Knockaert et al. 2009) as well as for radical innovation (O’Connor, 1998; 2006; Leifer et al., 2001; O’Connor and McDermott 2004; Story et al. 2009). Relationships and interactions between persons with market and technical knowledge influence entrepreneurship. Indeed, networks are crucial to the entrepreneurial process (Dubini and Aldrich 2002) and to radical innovation (O’Connor, 2006; Leifer et al., 2001; Story et al. 2009) and act as conduits for resource mobilisation and information flows (Stuart and Sorenson 2003; Story et al., 2009), as well as for social, financial and human capital (Thornton and Flynn 2003). Managed appropriately, they can accelerate the performance of technology transfer (Singh 2003). Granovetter (1992:4) argues that “economic action is constrained and shaped by the structures of social relations in which all real economic actors are embedded” and that economic activity is undertaken not just by isolated individuals, but by entrepreneurial individuals within these social networks. Embeddedness prioritises personal linkages and networks of such linkages in generating trust and non-opportunistic behaviour (Granovetter 1985) which in turn is relevant for resource mobilisation. He argues that weaker relationships (weak ties) can be more valuable to individuals in achieving their goals than personal relationships with family or friends (strong ties). Thus, entrepreneurs with more diverse networks are expected to get more useful information to identify opportunities, acquire resources and undertake entrepreneurial activities (Hoang and Antoncic 2003; Stuart and Sorenson 2003). Furthermore, investors are more likely to provide seed-finance or venture-finance if they have direct or indirect social ties with the entrepreneurs (Shane and Eckhardt 2003). A useful definition of networks is provided by Tijssen (1998:792):

“as an evolving mutual dependency system based on resource relationships in which their systemic character is the outcome of interactions, processes, procedures and institutionalization. Activities within such a network involve the creation, combination, exchange, transformation, absorption and exploitation of resources within a wide range of formal and informal relationships”.

Scientific knowledge commercialisation networks, as social networks, refer to interaction and linkages among individual stakeholders in the scientific commercialisation process. These networks imply norms of reciprocity and trustworthiness which enable the mobilisation of resources, acquisition and utilisation of information. In sum, entrepreneurship theory recognises the importance of stakeholder relationship within networks. Stakeholder relationships create the context of the entrepreneurial decisions made by the individual. Stakeholder relationships influence opportunity identification, entrepreneurial decision-making, access to resources and resource mobilisation. The case study findings reinforce this

perspective. They show that the existence of collaborative stakeholder networks is of importance as it acts as a conduit for entrepreneurial as well as radical idea generation and identification, access to resources and a base for repeated success. Fifteen industrial partners explained that it is not just access to knowledge which is of importance to being part of such a network but also the possibility of generating and evaluating better ideas. This view is shared by industrial managers, ten PIs and all TTO managers. An Irish PI stated that

“you get a real understanding of ... what the real problem is because otherwise you are starting with ... an impression of how things work rather than a real understanding, whereas with ... a few different projects you could really get to understand how a company does what it does and then ... there is a real chance to ... make some real change ... and all the time you are innovating the technology or you are innovating the approach and so I do think there is definitely a benefit in a network”.

While industrial partners are interested in generating new ideas and absorbing the knowledge (O'Connor and DeMartino, 2005; Story et al., 2009), this statement refers to PIs learning the ability to judge the commercial viability by virtue of being part of a network. This confirms the resource-based view of entrepreneurship (Alvarez and Busenitz 2001) the knowledge spillover theory of entrepreneurship (O’Gorman et al. 2008) and adds to the view of relational resources and capabilities for radical innovation (O’Connor and DeMartino, 2005; Story et al., 2009). It recommends that those PIs – who are not fully conscious of how to exploit the technical knowledge – should be integrated in networks where other stakeholders possess the necessary entrepreneurial knowledge. Access to resources was probably the most important issue for PIs who stated that it is particularly important for them to get funding for their research. A centre manager outlined the network effects by saying that they are able to put their case forward more competitively than a school, because they bring together a range of researchers from different disciplines. They are therefore able to tackle larger scale problems and are able to do that more effectively. He believes that they are more competitive for research funding as they are part of a wider network. A commercialisation manager of an Irish CSET summarised the network capabilities as follows:

“The main thing is that no one company can do everything and therefore the whole benefit of being in a consortium or in a partnership is that everybody brings different skills sets and different ideas and different resources to the table”.

The findings in relation to access to resources confirm Shane’s (2003) idea that the entrepreneurial process is stimulated by access to information, social capital and financial resources.

In addition, the relationship marketing view that success builds on success was highlighted in the interviews. It was acknowledged by the PIs and centre managers that companies are only interested in engaging with PIs and a centre if they have demonstrated a certain set of skills, competence or a certain level of infrastructure or expertise. They outlined that you continually need to generate new ideas and new innovations that allow you to plan with the company about where a programme might go beyond the initial two or three years of a project. The understanding that success will lead to repeated projects was shared by the industrial partners who claimed that if you are satisfied with the service or product you received you will continue working with them. Similarly, a difficult experience has the potential to end a working relationship.

It is necessary that managers of radical innovation projects recognise that it is important to have incubation capabilities at the discovery part of the radical innovation process. As noted above, the findings suggest that it is important for industry that the university partners can judge the market feasibility or potential of their ideas from the start. While it is true, therefore, to say that these capabilities should be possessed by industry partners (Story et al. 2009), it is also necessary that these capabilities are possessed by PIs as the existence of this capability will be a factor determining whether or not a collaboration is perceived as having been successful. This can, to some extent, be self fulfilling as the existence of these competencies is one of the key factors in the industry partner's decision to repeat projects with a particular network. Conversely, where these capabilities are not possessed by the PI then the satisfaction derived from collaboration can be undermined by the setting of unrealistic expectations at the discovery stage in the project.

In summary, the outcome of the stakeholder success chain is the formation of a collaborative network for radical innovation. The development of the network is achieved as retained stakeholders repeat collaborations. The network capabilities in turn encourage further projects and strengthen the relationships even more. Collaborative networks have positive outcomes for the university as well as the industry partners as radical innovation depends on repeated engagements with the same people (O'Connor and McDermott, 2004). The government agents benefit from the formation of collaborative networks as it fulfils their aim of establishing internationally visible, competitive research facilities to enhance scientific networking and cooperation.

CONCLUSION AND DISCUSSION

This paper presented a qualitative study on why and how collaborative networks for radical innovation are established in the science-to-business sector. Clearly, given the nature of case study design it is not possible to generalise the findings and the intention is rather to show the applicability of relationship marketing, provide some preliminary analysis on the establishment of stakeholder relationships and collaborative networks and suggest directions for further research. The findings show why it is important to establish stakeholder relationships and networks in order to enable radical innovation and scientific knowledge commercialisation. It is the PI who initiates contacts and is the key reason why industrial partners start the relationship. In addition, the research found that relationships are established if the PIs show a willingness to collaborate with industry. Previous research looked at PIs motivations for commercialising their research (Gulbrandsen 2005), as well as, the provision of monetary incentives. Additional research on the benefits to PIs for undertaking research with industries including how universities acknowledge these commercialisation endeavours in terms of promotions need closer examination. Future research should look at whether there are differences in the PIs engagement activities and interests when taking on different types of academic consulting i.e. problem-solving, accelerating development or strategic advice (Perkmann and Walsh 2008). Furthermore, additional research is necessary to clarify the extent to which TTOs account for establishing relationships and if they are successful at winning over stakeholders.

The paper also shows how relationship quality, knowledge base and commercialisation service contribute to stakeholder satisfaction. It proposes that trust, commitment and a positive attitude contribute to the creation of loyalty and in turn retention of the stakeholders. Stakeholder retention thus influences the establishment of collaborative stakeholder networks due to repeated collaborations. Yet additional research is necessary to look at relationship

management aspects and how collaborative networks in the science-to-business sector are managed for radical innovation to happen.

University entrepreneurship is not able to explain the complexity of scientific knowledge commercialisation process and radical innovation. Entrepreneurial opportunities can either be exogenously discovered by those involved or endogenously created. Networks and network capabilities enable both the endogenous creation of opportunities through the commitment of investment to create knowledge and the exogenous discovery of opportunities through the provision of social capital. The findings indicate that collaborative stakeholder networks are the conduit for radical innovation due to network capabilities.

The paper indicates that managerial challenges in relation to the encouragement of people who want to do radical innovation are not solely an issue for industry, (O'Connor and McDermott, 2004) but that these challenges exist for universities as well. Furthermore, it is necessary that managers of radical innovation projects recognise that it is important to have incubation capabilities at the discovery part of the radical innovation process. These capabilities should be possessed by industry partners (Story et al. 2009), but the view of industry partners is that these capabilities should also be possessed by PIs. The research confirms that the required competencies for radical innovation are likely to be inherent in a radical innovation network comprising different stakeholder relationships and that this is particularly the case where that network is used repeatedly. The paper also confirmed that the acquisition of resources for the radical innovation project is enhanced by virtue of being part of the radical innovation network.

The findings of the paper entail policy implications for the individual institutions at a micro level as well as at the macro level. While the 'triple helix' shows that internal and external partners are integrated and are able to network within the knowledge infrastructure, it does not provide for a better understanding of the complex system of knowledge commercialisation and the commercialisation process. The science-to-business approach, however, constitutes the process of commercialisation and thus enables policy makers to take the process into account. Furthermore, policy makers should recognise the differences between radical and incremental innovation and should not solely rely on hard metrics such as patents and invention disclosures. For radical innovation to happen, it is important to supply an environment where people can work long-term and do repeated collaborative projects.

By placing stakeholders at the centre of a relationship marketing and entrepreneurship framework where they are integrated into a network of different relationships helps to show why and how collaborative networks for radical innovation and science-to-business commercialisation are established. The paper showed that relationship marketing as a theory can contribute to the university entrepreneurship and the radical innovation literature as well as broaden the applicability of the approach in its own field.

Bibliography

Adler, N., Elmquist, M. and Norrgren, F. 2009. The challenge of managing boundary-spanning research activities: Experiences from the Swedish context. *Research Policy*, 38(7), pp.1136-1149.

- Alvarez, S.A. and Busenitz, L.W. 2001. The entrepreneurship of resource-based theory. *Journal of Management*, 27(6), pp.755-775.
- Azagra-Caro, J.M. 2007. What type of faculty member interacts with what type of firm? Some reasons for the delocalisation of university–industry interaction. *Technovation*, 27(11), pp.704-715.
- Backhaus, K. and Bauer, M. 2001. The impact of critical incidents on customer satisfaction in business-to-business relationships. *Journal of Business to Business Marketing*, 8(1), pp.25.
- Boardman, P.C. 2008. Beyond the stars: The impact of affiliation with university biotechnology centers on the industrial involvement of university scientists. *Technovation*, 28(5), pp.291-297.
- Boardman, P.C. 2009. Government centrality to university–industry interactions: University research centers and the industry involvement of academic researchers. *Research Policy*, 38(10), pp.1505-1516.
- Boardman, P.C. and Corley, E.A. 2008. University research centers and the composition of research collaborations. *Research Policy*, 37(5), pp.900-913.
- Bozeman, B. and Gaughan, M. 2007. Impacts of grants and contracts on academic researchers' interactions with industry. *Research Policy*, 36(5), pp.694-707.
- Bruhn, M. 2003. Relationship marketing: Management of customer relationships. New York: Pearson Education.
- Butcher, J. and Jeffrey, P. 2007. A view from the coal face: UK research student perceptions of successful and unsuccessful collaborative projects. *Research Policy*, 36(8), pp.1239-1250.
- Cook, K.S. 1977. Exchange and power in networks of interorganizational relations. *The Sociological Quarterly*, 18(1), pp.62-82.
- Cummings, J.N. and Kiesler, S. 2007. Coordination costs and project outcomes in multi-university collaborations. *Research Policy*, 36(10), pp.1620-1634.
- Cyert, R.M. and Goodman, P.S. 1997. Creating effective university-industry alliances: an organizational learning perspective. *Organizational Dynamics*, 25pp.45-57.
- Davenport, S., Davies, J. and Grimes, C. 1998. Collaborative research programmes: building trust from difference. *Technovation*, 19(1), pp.31-40.
- Day, R.L. 1977. Toward a process model of consumer satisfaction IN: Hunt, H.K. (ed.) *Conceptualization and Measurement of Consumer Satisfaction and Dissatisfaction*. Cambridge Marketing Science Inst, pp.153-183.
- Degroof, J.J. and Roberts, E.B. 2003. Spinning-off new ventures from academic institutions in areas with weak entrepreneurial infrastructure: Insights on the impact of spin-off processes on the growth-orientation of ventures. Cambridge: MIT Sloan School of Management Working Paper 4311-03.

Degroof, J. and Roberts, E.B. 2004. Overcoming weak entrepreneurial infrastructures for academic spin-off ventures. *Journal of Technology Transfer*, 29(3-4), pp.327-352.

De Laat, P. 1999. Research and development alliances: Ensuring trust by mutual commitment IN: Ebers, M. (ed.) *The formation of inter-organisational networks*. Oxford University Press, pp.146-173.

Diller, H. 1996. Kundenbindung als Marketingziel. *Marketing ZfB*, 18(2), pp.81-94.

Diller, H. 1995. Beziehungs-Marketing. *Wirtschaftswissenschaftliches Studium*, 24(9), pp.442-447.

Dubini, P. and Aldrich, H. 2002. Personal and extended networks are central to the entrepreneurial process Vol 2 IN: Krueger, N.F., Jr. (ed.) *Entrepreneurship: Critical perspectives on business and management*. London: Routledge, pp.217-228.

Edquist, C. 2005. Systems of innovation: perspectives and challenges IN: Fagerberg, J., Mowery, D.C. and Nelson, R.R. (eds.) *Oxford handbook of innovation*. Oxford University Press, pp.181-208.

Eisenhardt, K.M. 1989. Agency theory: An assessment and review. *The Academy of Management Review*, 14(1), pp.57-74.

Eisenhardt, K.M. and Graebner, M.E. 2007. Theory building from cases: Opportunities and challenges. *The Academy of Management Journal*, 50(1), pp.25-32.

Etzkowitz, H. and Leydesdorff, L. 1997. Universities and the global knowledge economy: A Triple Helix of university-industry-government relations. London: Cassell Academic.

Etzkowitz, H. and Leydesdorff, L. 2000. The dynamics of innovation: from national systems and "Mode 2" to a Triple Helix of university-industry-government relations. *Research Policy*, 29(2), pp.109-123.

Etzkowitz, H., Webster, A., Gebhardt, C. and Terra, B.R.C. 2000. The future of the university and the university of the future: evolution of ivory tower to entrepreneurial paradigm. *Research Policy*, 29(2), pp.313-330.

Forfas 2011. Analysis of Ireland's innovation performance. Dublin: Forfas.

Georgi, D. 2005. Kundenbindungsmanagement im Kundenbindungslebenszyklus IN: Homburg, C. and Bruhn, M. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.229-249.

Gibbert, M., Ruigrok, W. and Wicki, B. 2008. What passes as a rigorous case study? *Strategic Management Journal*, 29(13), pp.1465-1474.

Granovetter, M. 1985. Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology*, 91(3), pp.481-510.

Granovetter, M. 1992. Economic institutions as social constructions: A framework for analysis. *Acta Sociologica*, 35(1), pp.3-11.

- Grönroos, C. 1997. Value-driven relational marketing: from products to resources and competencies. *Journal of Marketing Management*, 13(5), pp.407-419.
- Grönroos, C. 1997. Keynote paper From marketing mix to relationship marketing - towards a paradigm shift in marketing. *Management Decision*, 35(4), pp.322-339.
- Gulbrandsen, M. 2005. But Peter's in for the money: The liminality of entrepreneurial scientists. *VEST Journal for Science and Technology Studies*, 18 (1/2), pp.49-75.
- Gummesson, E. 1996. Relationship marketing and imaginary organizations: a synthesis. *European Journal of Marketing*, 30(2), pp.31-44.
- Gwinner, K., Gremler, D. and Bitner, M. 1998. Relational benefits in services industries: The customer's perspective. *Journal of the Academy of Marketing Science*, 26(2), pp.101-114.
- Harmon, B., Ardishvili, A., Cardozo, R., Elder, T., Leuthold, J., Parshall, J., Raghian, M. and Smith, D. 1997. Mapping the university technology transfer process. *Journal of Business Venturing*, 12(6), pp.423-434.
- He, Z., Geng, X. and Campbell-Hunt, C. 2009. Research collaboration and research output: A longitudinal study of 65 biomedical scientists in a New Zealand university. *Research Policy*, 38(2), pp.306-317.
- Hennig-Thurau, T., Gwinner, K.P. and Gremler, D.D. 2002. Understanding relationship marketing outcomes: An integration of relational benefits and relationship quality. *Journal of Service Research*, 4(3), pp.230-247.
- Hermann, A., Huber, F. and Braunstein, C. 2000. Ein Erklärungsansatz der Kundenbindung unter Berücksichtigung der wahrgenommenen Handlungskontrolle. *Die Betriebswirtschaft*, 60(3), pp.293-313.
- Hoang, H. and Antoncic, B. 2003. Network-based research in entrepreneurship: A critical review. *Journal of Business Venturing*, 18(2), pp.165-187.
- Homburg, C. 1998. Kundennähe von Industriegüterunternehmen.: Konzeption - Erfolgsauswirkungen - Determinanten. 2nd ed. Wiesbaden: Gabler.
- Homburg, C., Becker, A. and Hentschel, F. 2005. Der Zusammenhang zwischen Kundenzufriedenheit und Kundenbindung IN: Bruhn, M. and Homburg, C. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.93-123.
- Homburg, C. and Bruhn, M. 2005. Kundenbindungsmanagement - Eine Einführung in die theoretischen und praktischen Problemstellungen IN: Bruhn, M. and Homburg, C. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.3-37.
- Howells, J. 2006. Intermediation and the role of intermediaries in innovation. *Research Policy*, 35(5), pp.715-728.
- Hoye, K. and Pries, F. 2009. 'Repeat commercializers,' the 'habitual entrepreneurs' of university-industry technology transfer. *Technovation*, 29(10), pp.682-689.

Hussler, C. and Rondé, P. 2007. The impact of cognitive communities on the diffusion of academic knowledge: Evidence from the networks of inventors of a French university. *Research Policy*, 36(2), pp.288-302.

Ingemansson, M. and Waluszewski, A. 2009. Success in science and burden in business. On the difficult relationship between science as a developing setting and business as a producer-user setting. *IMP Journal*, 2(3), pp. 20-56.

Jensen, R. and Thursby, M. 2001. Proofs and prototypes for sale: The licensing of university inventions. *American Economic Review*, 91(1), pp.240-259.

Jolly, V.K. 1997. Commercializing new technologies: Getting from mind to market. 3rd ed. Massachusetts: Harvard Business School Press.

Kaufmann, A. and Tödtling, F. 2001. Science–industry interaction in the process of innovation: the importance of boundary-crossing between systems. *Research Policy*, 30(5), pp.791-804.

Kleinaltenkamp, M. 2005. Kundenbindung durch Kundenintegration IN: Homburg, C. and Bruhn, M. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.361-378.

Knockaert, M., Ucbasaran, D., Wright, M. and Clarysse, B. 2009. How does tacit knowledge transfer influence innovation speed? The case of science based entrepreneurial firms. 2009/554. Gent: Working Paper Universiteit Gent.

Kodama, T. 2008. The role of intermediation and absorptive capacity in facilitating university–industry linkages—An empirical study of TAMA in Japan. *Research Policy*, 37(8), pp.1224-1240.

Kroeber-Riel, W. and Weinberg, P. 2003. Konsumentenverhalten. 8th ed. München: Vahlen.

Leifer, R., O'Connor, G.C. and Rice, M. 2001. Implementing radical innovation in mature firms: The role of hubs. *Academy of Management Executive*, 15(3), pp.102-113.

Levy, R., Roux, P. and Wolff, S. 2009. An analysis of science–industry collaborative patterns in a large European University. *The Journal of Technology Transfer*, 34(1), pp.1-23.

Liebeskind, J.P., Oliver, A.L., Zucker, L. and Brewer, M. 1996. Social networks, learning, and flexibility: Sourcing scientific knowledge in new biotechnology firms. *Organization Science*, 7(4), pp.428-443.

Mansfield, E. and Lee, J. 1996. The modern university: contributor to industrial innovation and recipient of industrial R&D support. *Research Policy*, 25(7), pp.1047-1058.

Markman, G.D., Siegel, D.S. and Wright, M. 2008. Research and technology commercialization. *Journal of Management Studies*, 45(8), pp.1401-1423.

Martinelli, A., Meyer, M. and von Tunzelmann, N. 2008. Becoming an entrepreneurial university? A case study of knowledge exchange relationships and faculty attitudes in a

medium-sized, research-oriented university. *The Journal of Technology Transfer*, 33(3), pp.259-283.

Mohr, J.J. 2001. Marketing of high-technology products and innovations. Upper Saddle River, N.J.: Prentice Hall.

Mohr, J. and Spekman, R. 1994. Characteristics of partnership success: Partnership attributes, communication behavior, and conflict resolution techniques. *Strategic Management Journal*, 15(2), pp.135-152.

Moorman, C., Deshpandé, R. and Zaltman, G. 1993. Factors affecting trust in market research relationships. *Journal of Marketing*, 57(1), pp.81-101.

Moorman, C., Zaltman, G. and Deshpande, R. 1992. Relationships between providers and users of market research: The dynamics of trust within and between organizations. *Journal of Marketing Research*, 29(3), pp.314-328.

Mora-Valentin, E.M., Montoro-Sanchez, A. and Guerras-Martin, L.A. 2004. Determining factors in the success of R&D cooperative agreements between firms and research organizations. *Research Policy*, 33(1), pp.17-40.

Morgan, R.M. and Hunt, S.D. 1994. The commitment-trust theory of relationship marketing. *Journal of Marketing*, 58(3), pp.20.

Morlacchi, P. and Martin, B.R. 2009. Emerging challenges for science, technology and innovation policy research: A reflexive overview. *Research Policy*, 38(4), pp.571-582.

Ndonzuau, F.N., Pirnay, F. and Surlemont, B. 2002. A stage model of academic spin-off creation. *Technovation*, 22(5), pp.281-289.

O'Connor, G.C. 1998. Market learning and radical innovation: A cross case comparison of eight radical innovation projects. *Journal of Product Innovation Management*, 15, pp. 151-166.

O'Connor, G.C. 2006. Open, radical innovation: Toward an integrated model in large established firms IN: Chesbrough, H.W., Vanhaverbeke, W. and West, J.(ed.) Open innovation: Researching a new paradigm. Oxford University Press, 62-81.

O'Connor, G.C. and McDermott, C.M. 2004. The human side of radical innovation. *Journal of Engineering and Technology Management*, 21, pp.11-30

O'Gorman, C., Byrne, O. and Pandya, D. 2008. How scientists commercialise new knowledge via entrepreneurship. *The Journal of Technology Transfer*, 33(1), pp.23-43.

Oliver, R.L. 1980. A cognitive model of the antecedents and consequences of satisfaction decisions. *Journal of Marketing Research*, 17(4), pp.460-469.

Park, S.H. 1996. Managing an interorganizational network: A framework of the institutional mechanism for network control. *Organization Studies*, 17(5), pp.795-824.

Parvatiyar, A. and Sheth, J.N. 2000. The domain and conceptual foundations of relationship marketing IN: Sheth, J.N. and Parvatiyar, A. (eds.) *Handbook of relationship marketing*. Thousand Oaks Sage Publications, Inc, pp.3-38.

Perkmann, M. and Walsh, K. 2008. Engaging the scholar: Three types of academic consulting and their impact on universities and industry. *Research Policy*, 37, pp. 1884-1891.

Perkmann, M. and Walsh, K. 2009. The two faces of collaboration: impacts of university-industry relations on public research. *Industrial and Corporate Change*, 18(6), pp.1033-1065.

Pittaway, L., Robertson, M., Munir, K., Denyer, D. and Neely, A. 2004. Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews*, 5(3-4), pp.137-168.

Plewa, C. and Quester, P. 2008. A dyadic study of “champions” in university-industry relationships. *Asia Pacific Journal of Marketing and Logistics*, 20(2), pp.211-226.

Plinke, W. and Soellner, A. 2005. Kundenbindung und Abhaengigkeitsbeziehungen IN: Bruhn, M. and Haomburg, C. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.67-91.

Polanyi, M. 1966. The logic of tacit inference. *Philosophy*, 41(155), pp.1-18.

Polanyi, M. 1974. Personal knowledge: towards a post-critical philosophy. Chicago: University of Chicago press.

Polanyi, M. 1967. The tacit dimension. Gloucester, Mass: Peter Smith.

Porter, M.E. and Ketels, C.H.M. 2003. UK competitiveness: Moving to the next Stage. Management Research Forum, Summary Report 6. London: Advanced Institute of Management Research.

Porter, M.E. and Van Opstal, D. 2001. US competitiveness 2001: Strengths, vulnerabilities and long-term priorities. Washington, D.C.: Council on Competitiveness.

Reichheld, F.F. and Sasser Jr., W.E. 1990. Zero defections: Quality comes to services. *Harvard Business Review*, 68(5), pp.105-111.

Roberts, E.B. and Malone, D.E. 1996. Policies and structures for spinning off new companies from research and development organizations. *R&D Management*, 26(1), pp.17-48.

Rothaermel, F.T., Agung, S.D. and Jiang, L. 2007. University entrepreneurship: a taxonomy of the literature. *Industrial and Corporate Change*, 16(4), pp.691-791.

Shamdasani, P.N. and Sheth, J.N. 1995. An experimental approach to investigating satisfaction and continuity in marketing alliances. *European Journal of Marketing*, 29(4), pp.6-23.

Shane, S.A. 2003. A general theory of entrepreneurship : the individual-opportunity nexus. Cheltenham, UK ; Northampton, MA: Edward Elgar.

Shane, S. and Eckhardt, J. 2003. The individual-opportunity nexus IN: Acs, Z.J. and Audretsch, D.B. (eds.) *Handbook of entrepreneurship research-An intersiplinary survey and introduction*. New York: Springer, pp.161-191.

Shani, D. and Chalasani, S. 1992. Exploiting niches using relationship marketing. *Journal of Services Marketing*, 6(4), pp.43-52.

Siegel, D. 2003. Data requirements for assessing the private and social returns to strategic research partnerships: Analysis and recommendations. *Technology Analysis & Strategic Management*, 15(2), pp.207.

Siegel, D.S., Waldman, D.A., Atwater, L.E. and Link, A.N. 2003a. Commercial knowledge transfers from universities to firms: improving the effectiveness of university–industry collaboration. *The Journal of High Technology Management Research*, 14(1), pp.111-133.

Siegel, D.S., Waldman, D.A., Atwater, L.E. and Link, A.N. 2004. Toward a model of the effective transfer of scientific knowledge from academicians to practitioners: qualitative evidence from the commercialization of university technologies. *Journal of Engineering and Technology Management*, 21(1-2), pp.115-142.

Singh, R.P. 2003. Improving technology transfer through the management of stakeholder networks: theoretical perspectives. *International Journal of Technology Transfer and Commercialisation*, 2(1), pp.1-17.

Sood, A. and Tellis, G.J. 2005. Technological evolution and radical innovation. *Journal of Marketing*, 69, pp.152-168.

Spilling, O.R. 2008. On the role of academic staff as entrepreneurs in university spin offs: case studies of biotechnology firms in Norway IN: Landström, H., Crijns, H. and Laveren, E. (eds.) *Entrepreneurship, Sustainable Growth and Performance: Frontiers in European Entrepreneurship Research*. Cheltenham Edward Elgar Publishing, pp.267-298.

Spilling, O.R. 2004. Commercialisation of knowledge - A conceptual framework. NCSB 2004 Conference, 13th Nordic Conference on Small Business Research: Tromsø.

Story, V., Hart, S. and O'Malley, L. 2009. Relational resources and competences for radical product innovation. *Journal of Marketing Management*, 25(5), pp.461.

Stuart, T.E. and Sorenson, O. 2003. Social networks and entrepreneurship IN: Acs, Z.J. and Audretsch, D.B. (eds.) *Handbook of entrepreneurship research - An interdisciplinary survey and introduction*. New York: Springer, pp.231-252.

Tellis, G.J., Prabhu, J.C. and Chandy, R.K. 2009. Radical innovation across nations: The pre-eminence of corporate culture. *Journal of Marketing*, 73, pp. 3-23.

Thorburn, L. 2000. Knowledge management, research spinoffs and commercialization of R&D in Australia. *Asia Pacific Journal of Management*, 17(2), pp.257-275.

Thornton, P.H. and Flynn, K.H. 2003. Entrepreneurship, networks, and geographies IN: Ács, Z.J. and Audretsch, D.B. (eds.) *Handbook of entrepreneurship research : an interdisciplinary survey and introduction*. New York: Springer, pp.401-433.

Tijssen, R.J.W. 1998. Quantitative assessment of large heterogeneous R&D networks: the case of process engineering in the Netherlands. *Research Policy*, 26(7-8), pp.791-809.

Tödting, F., Lehner, P. and Kaufmann, A. 2009. Do different types of innovation rely on specific kinds of knowledge interactions? *Technovation*, 29(1), pp.59-71.

Tödting, F. and Trippel, M. 2005. One size fits all?: Towards a differentiated regional innovation policy approach. *Research Policy*, 34(8), pp.1203-1219.

van Rijnsvoever, F.J., Hessels, L.K. and Vandeberg, R.L.J. 2008. A resource-based view on the interactions of university researchers. *Research Policy*, 37(8), pp.1255-1266.

Waagø, S.J., Rasmussen, E., Kvaal, T., Gulbrandsen, M. and Trondsen, E. 2001. The role of the university in economic development-An analysis of six European universities of science and technology. Trondheim: GREI-NTNU.

Waluszewski, A. 2009. When science shall mean business from multifaceted to limited use of science. *IMP Journal*, 2(3). pp.3-19.

Weinberg, P. and Terlutter, R. 2005. Verhaltenswissenschaftliche Aspekte der Kundenbindung IN: Homburg, C. and Bruhn, M. (eds.) *Handbuch Kundenbindungsmanagement*. 5th ed. Wiesbaden Gabler, pp.41-65.

Werani, T. 2004. Bewertung von Kundenbindungsstrategien in B-to-B-Maerkten - Methodik und praktische Anwendung. Wiesbaden: Gabler.

Wilson, D.T. 1995. An integrated model of buyer-seller relationships. *Journal of the Academy of Marketing Science*, 23(4), pp.335-345.

Woodruff, R.B., Cadotte, E.R. and Jenkins, R.L. 1983. Modeling consumer satisfaction processes using experience-based norms. *Journal of Marketing Research*, 20(3), pp.296-304.

Wright, M., Clarysse, B., Lockett, A. and Knockaert, M. 2008. Mid-range universities' linkages with industry: Knowledge types and the role of intermediaries. *Research Policy*, 37(8), pp.1205-1223.

von Hippel, E. 1988. The sources of innovation. New York: Oxford University Press.

Yin, R.K. 2009. Case study research : design and methods. 4th ed. Thousand Oaks, Calif.: Sage Publications.

Yin, R.K. 1984. Case study research : design and methods. Beverly Hills, Calif: Sage Publications.

Appendix

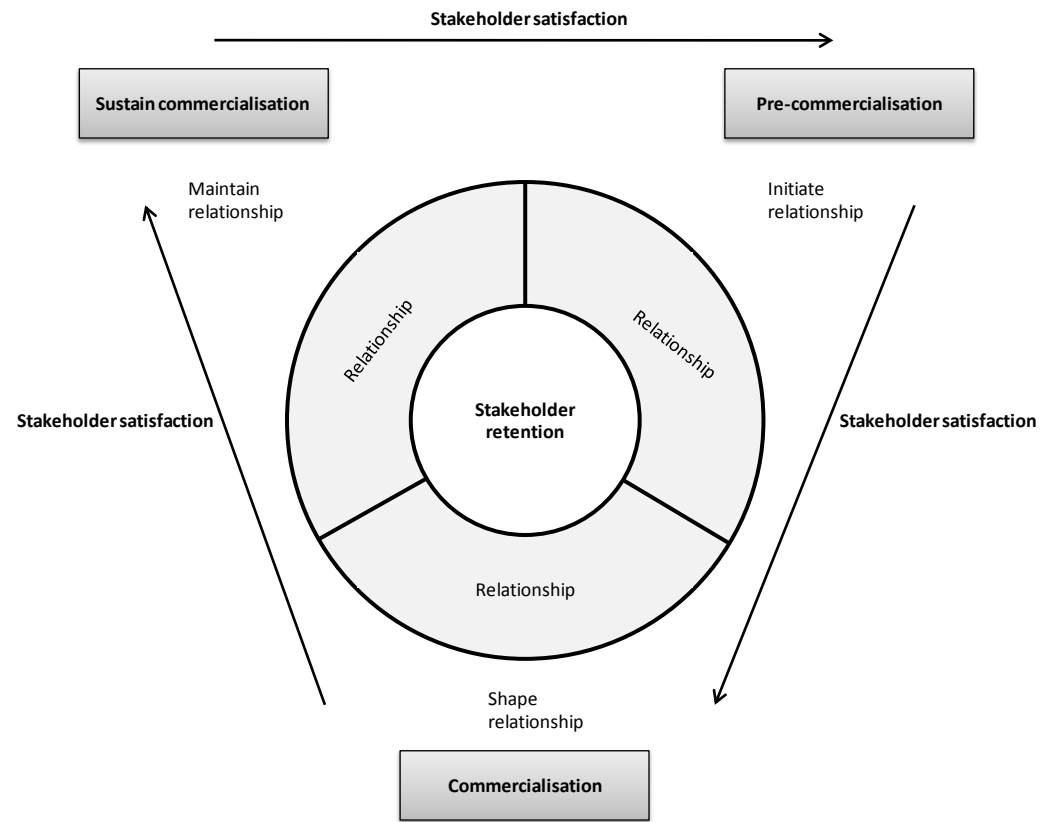


Figure 3: Holistic stakeholder satisfaction Source: own conception based on Bergmann (1998)

Extraction of meaning units and descriptive concepts from the interviews	Category	Constructs
University approaches industry; problem statement from industry partner	Initial contact	Use of university
Solved particular problem before; good experience	Experience	
Good reputation, great reputation	Reputation	
Focus research around certain areas; champions; islands of competence	Knowledge	
Science relevant to Business drivers; set expectations; meeting deadlines; outcome	Evaluation	Satisfaction
Good experience	Affective condition	
Create and maintain trust; trust has to be established; trust has to come first	Trust	Loyalty
Combination of commitment, trust and satisfaction; commitment because of risky projects	Commitment	
Good experience want to replicate; repeat business because of experience	Repeat business	Retention
Bad experience no recommendation	Recommendation	
Build up portfolio; ability to identify the right people	Build network	
Success on success; snowball effect; multidisciplinary competences; access to resources	Network capabilities	Entrepreneurial activity

Table 3: Research issues identified in the pilot case study and literature review

<p>Use of University</p> <p>PI's Role and willingness to participate</p>	<ul style="list-style-type: none"> • So it's difficult to ring up a company. Call them and say hey you are in [this area]we are in [this area]; do you want to come in and see what we do?... if they [PIs] are very hot in their space, they would already have links with them. So a lot of the contacts would actually come through the PI's kind of network (TTO 1- Ireland) • I think, networks, how scientists get contacts...the scientists have to do it themselves in order to work properly (PI 4 - Germany) • I think if you are sitting in a university and you are waiting for a company to come to you it's a very passive and I don't think a very fruitful experience. Of course really high profile researchers will have companies come and approach them (Centre Manager 2 -Ireland) • There's no point if the technology is good but the people aren't interested in doing commercialization (GOV 1 – Ireland) • It depends how market oriented the centre is (Industry 1 – Germany); • [we don't collaborate if] the people at the top don't have enough industrial experience (Industry 2 – Ireland)
<p>Satisfaction</p> <p>Evaluation of project and relationship</p>	<ul style="list-style-type: none"> • If we are not satisfied... we have left projects (Industry 5/7/12 – Germany) • In the first few years we were really satisfied. Now we are not anymore... I think it always depends on the involved people and the relationship with them (Industry 3 – Germany) • A lot of it depends on the communication (Industry 4 – Germany) • There is an element yeah of customer satisfaction there. I mean the centre has a number of if you like customers that it has to keep happy. There are industrial partners obviously. It's the Irish government, the Irish tax payer. [I am satisfied because] they are industrially aware or commercially aware. They.... not massively but certainly they're not really, really naïve. And they do know that if they have an idea people won't just... academics, all academics tend to think their idea is brilliant and if they have an idea for what they think might be a product they think this is going to be a billion dollar sell out and things like this. And [name of centre]'s vision is tampered with a bit of reality (Industry 10 – Ireland) • Like all relationships the first part is the product, our service whichever you want. If you go somewhere the people might be terribly nice you come out with an awful result...you never want to go back there again and it will take a lot of persuasion to go back...So the product or the service is wrong the people were nice, the environment was nice. ...So I think if you get sort of combinations there (Industry 2 – Ireland) • Dissatisfaction exist where people say we don't want to work with them anymore (TTO 1 – Germany) • We have several contacts but the best ones are the direct contacts where the communication is right (PI 9 – Germany) • Company satisfaction in what we're doing...if they didn't feel that you would deliver something they wouldn't bother. Because it's not just the funding, it's the management time it's the interface time, it's the energy you put into maintaining the relationship (Centre Manager 2 – Ireland) • The most important thing is clear definition of what is it you're trying to achieve. Followed closely by an established accountable consistent process for management of the relationship in terms of review process and communications processes (Commercialisation Manger 3 – Ireland)

<p>Loyalty</p>	<ul style="list-style-type: none"> • A lot of the contacts would come from initially from the PIs themselves because they could already be a level of trust built up (TTO 2 – Ireland) • I suppose at the beginning it was loyalty...it was trust. I was very fortunate in that the academic I was working with, she had worked with me before so she had done her stint in industry....So she understood where I was (Industry 3 – Ireland) • Trust is the absolute basis. Paper doesn't blush, so you first have to gain a partner's trust and that is a really important precondition for a collaboration. Without mutual trust you will never be successful. (Industry 2 – Germany) • A contract is a legal security, but personally I don't care, I work with people I trust (Industry 6 – Germany) • Trust is established by you know by good relationships with people you know. And again it comes down to just a general level of honesty you know and if people are honest with us... and I find honesty and a good relationship with the PIs is possibly you know is possibly the best way to create an environment for future collaboration (GOV 2 – Ireland) • Previous experience...even more than that I guess, they trust us, they showed that they trust us in the same way we show that we trust them so they exchange. They give us stuff and we give them stuff so there is, it's not just a one way relationship, right? It's a two way relationship of confidential material so that definitely assists the process of building trust (PI 8 – Ireland) • There had to be some building of trust done with those because it's a new company so it was, it was the trust that had been built with the original founding members of the [old company] that was able to relay and portray the institute in a good light with the management of the [new company]. So again they were coming with a positive attitude and they were able to come and see that the positive attitude was justified (Commercialisation Manager 3 – Ireland) • If the results are right loyalty will evolve (Centre Manager 1 – Germany)
<p>Retention and building a network</p>	<ul style="list-style-type: none"> • We did another project with them because we had a very good experience with them. We worked with them on another project a couple of years ago and it was so good that we decided to do it again (Industry 5 – Germany) • We are satisfied in the fact of the first five years to go into the next five years which obviously says quite a lot (Industry 3 – Ireland) • People building relationships and experience. If you have some rocky patches along the way and you see how people deal with those and how we resolve those and you can see that the relationship works (Industry 8 – Ireland) • I would say it is often the case that companies do a second project if you have done this successfully before and they would then think of you too (Industry 4 –Germany) • You're competence and you're credibility over time build a relationship (TTO 1 – Ireland) • Collaborative projects are often handled by the scientists and then there are succession projects...I would say the scientists and the industrial partners build certain internal networks based on trust and I would say trust is indispensable for technology transfer (TTO 2 – Germany) • If loyalty is there... you will get new requests to collaborate (Centre Manger 1 – Germany) • Success, yeah the only reason that they'll come back is if they feel they are getting value... So you know they came back and they renewed their commitment for another four years basically just do that on the basis of success (Centre Manager 2 – Ireland) • If you get on well with a company and everything is running smoothly then you will work with them again (PI 9 – Germany) • Yes, to start it was just one company [multinational]... and then it was [second multinational] and then we grew company by company (PI 5 – Ireland) • It is our aim to provide the framework in the form of excellence centres to enable network formation (GOV 1 – Germany)

<p>Network capabilities</p> <p>Generation and identification of innovative ideas and access to resources</p>	<ul style="list-style-type: none"> • Because you get a real understanding of how, what the real problem is right because otherwise you are starting with kind of an impression of how things work rather than a real understanding whereas with of course a few different projects you could really get to understand how a company does what it does and then you, then there is a real chance to break some and make some real change. And all the time you are innovating the technology or you are innovating the approach and so I do think there is definitely benefits in a network (PI 8 – Ireland) • We have had the experience that especially in local networks, where people work, compete and communicate on a daily basis that this generates big successes (GOV 1– Germany) • Quick access to information (Industry 5 – Germany) • Test ideas broadly (Industry 10 – Germany) • If universities could get their academics more networked and into cohesive groups either within the university or the university with hospital or universities industry that could be a way to attract more funds (GOV 3 – Ireland) • We are able to put forward the case more competitively because we bring together a range of researchers from different disciplines. So we're able to tackle larger scale problems and we are able to do that more effectively (Centre Manager 2 – Ireland) • Networks develop and I've recently been contacted by somebody in SFI [Government agency] with regard to a technology that he'd seen somewhere else... would I be interested in it? So I think again it's as they get more, more knowledge of what companies are doing and what they're interested in, then they'll start leveraging those networks more... this networking capability (Industry 10 – Ireland)
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Table 4: Sample findings on the establishment of collaborative networks