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Narrowing the Innovation Gap: Factors Influencing Outcomes of Industry-University Collaborations

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ABSTRACT

Universities have played a continued role in facilitating and enhancing the innovative potential of U.S. companies. Key to these relationships is the transfer of knowledge both from university to industry as well as from industry to university. But, few researchers have explored how different relationships necessitate specific cultural orientations, absorptive capacity abilities, and management tasks. As industry and universities engage in relationships designed to accelerate innovation it is critical to understand the factors that impact the outcomes of these relationships. Based on literature related to open innovation and industry-university relationships, an integrative explanatory theoretical framework is proposed for identifying key factors shown to play a role in the success of industry-university relationships. Applying data from a study of knowledge exchange between university and industry partners, the applicability of the framework in identifying key factors related to successful outcomes is illustrated.

Keywords

Open innovation, industry-university collaboration, knowledge management, organizational culture, organizational learning, absorptive capacity, assessment models

INTRODUCTION

In today's fast-paced global competitive landscape, U.S. corporations must bring innovative products to market faster than ever before to remain competitive[1] (Nambisan & Sawhney, 2008; U.S. Council on Competitiveness, 2008). While the U.S. has a long history of innovation and many assets to pull from, America's position in the global economy is not assured. Corporations both large and small are finding traditional in-house R&D and product development teams are not producing new innovative products quickly enough (Spence, 2005). This is driving many to look for sources of knowledge and innovation outside their corporate walls. The practice of identifying and working with others outside traditional in-house innovation teams is commonly referred to as "open innovation" (Chesbrough, 2003). In contrast to "closed innovation" where all innovation happens inside the corporate walls, "open innovation" involves reaching outside the corporate boundaries for new sources of innovation.

Within both academic and business literature, when it comes to open innovation practices the focus is primarily on large companies (Lee, Park, Yoon, & Park, 2010; van de Vrande et al., 2009). Large companies, in contrast to small- to medium-sized enterprises (SMEs)[2], often have substantially more resources, both financial and human, with which to invest in innovative processes. But scholars caution that this focus on large enterprises may overshadow the innovative potential of SMEs (Laforet, 2007; Lee et al., 2010; van de Vrande et al., 2009). SMEs play a large role in helping to spur new innovation and create employment that moves our economy forward. According to the U.S. Small Business Administration, SMEs create most of the nation's jobs and employ approximately half the nation's workforce (McGibbon & Moutray, 2009). The ability of SMEs to successfully engage in open innovation may be a key differentiator in who succeeds and who falls behind. This in turn may have serious implications for our nation's competitiveness in today's global marketplace.

Universities or institutions of higher learning have played a continued role in facilitating and enhancing the innovative potential of companies. Since the establishment of land-grant colleges in the late 1800's, industry-university collaborations

[1] While the focus of this research was on U.S. companies, the issues and findings outlined in the paper may apply outside the U.S.

[2] While the definition of what constitutes an SME is not uniform across countries, the number of employees is a commonly used measure. SMEs are defined here as enterprise with 20-500 employees (Ayyagari, Bech, & Demirguc-Kunt, 2003).

have facilitated the creation of new innovative products and the transfer of knowledge across the U.S. (Schoenecker, Myers, & Schmidt, 1989). As such, these relationships have contributed to our nation's ability to remain competitive (Damanpour & Wischnevsky, 2006; Laursen & Salter, 2004; Lee, 2000; Perkmann & Walsh, 2007; Schoenecker et al., 1989). But, relationships between industry and universities are often complex and multi-faceted. Understanding the factors that may impact the success of such relationships is key to industry's ability to tap into university knowledge as a source of innovation and to universities' ability to contribute to our nation's competitiveness.

There is an abundance of literature related to open innovation initiatives between industry and universities. Many have examined issues related to transfer of intellectual property (IP), organizational readiness, organizational culture, and the organization's ability to turn ideas into competitive advantage (Cohen & Levinthal, 1990; O'Reilly & Tushman, 2007; Lichtenthaler & Lichtenthaler, 2009; Tushman & O'Reilly, 2002; Laursen & Salter, 2004). Others have outlined the different types of relationships that are common in these collaborations (i.e., research partnerships versus consulting or contract research services) (Drejer & Jørgensen, 2005; Perkmann & Walsh, 2007). And still others have focused on the motivations of industry and academic partners and the disconnects that often derail or limit the success of such initiatives (Bonaccorsi & Piccaluga, 1994; Fontana, Geuna, & Matt, 2003, 2005; Laursen & Salter, 2004; Simpson, 2002). While we have significant research focusing on industry characteristics and outlining the different types of relationships that can be created, researchers are calling for more studies that help create a deeper understanding of the organizational dynamics that manifest themselves in these industry-university relationships (Perkmann & Walsh, 2007).

Based on findings from current literature related to open innovation and industry-university relationships, this paper presents an integrative explanatory theoretical framework designed to bring together existing theory related to organizational culture, organizational structure, and procedural/contractual factors that have been shown to play a role in the success of industry-university relationships. It is our view that by combining these dimensions we gain a better and more complete picture of the complex dynamics that may help explain success. Additionally, this framework shifts the focus from the organizational characteristics typically associated with engagement in open innovation initiatives (e.g., age, size, absorptive capacity), to a focus on the need of the industry as the primary determinant of barriers to and facilitators of successful outcomes. The hope is the proposed framework allows for a deeper theoretical exploration of the key factors that play a role in the success of industry-university relationships. Additionally, this framework can serve as a practical tool for evaluating the "fit" between industry and university participants before entering into a relationship as well as providing guidance as to which collaborative tools may be most appropriate. The relevance of this framework to both theory and practice is demonstrated by its application to research funded by the National Science Foundation (NSF) designed to examine the barriers to knowledge transfer between a research university and regional businesses from different industries[3].

We begin with a review of literature related to key success factors found in open innovation initiatives. This is followed by a description of our theoretical framework and its application to three industry-university collaborations designed to promote regional innovation. Finally, a discussion of results, limitations, contribution to practice and theory along with future research considerations is provided.

LITERATURE REVIEW

Many scholars and economists believe the entire nature of innovation is changing (Kozinets, Hemetsberger, & Schau, 2008; Malone, Laubacher, & Dellarocas, 2009; Tapscott & Williams, 2006; Toffler, 1980). Despite pumping millions of dollars into internal R&D teams, companies are finding that innovative productivity is declining while speed and costs associated with new product development are increasing (Nambisan & Sawhney, 2008; Spence, 2005). This gap – the gap between a firm's ability to generate continuous product and service innovation and the market's demand for innovation – is referred to as the "innovation gap" (Ketchen, Ireland, & Snow, 2007). As such, companies are looking for outside sources of knowledge to help narrow their innovation gap. One such source of new innovation potential is collaboration with universities.

An abundance of research on open innovation reveals success[4] is dependent on a number of factors including organizational culture, an organization's ability to recognize the need for change, as well as its ability to adapt to new ways of collecting and utilizing knowledge (Chesbrough, 2003; von Hippel, 2005; Dodgson, Gann, & Salter, 2006; Gassmann & Enkel, 2004; Hafkesbrink & Schroll, 2010; Nambisan & Sawhney, 2008 ch 12). Additionally, firm size and age have been linked to a firm's participation in open innovation initiatives (Hartl, 2003). These characteristics have also been found to be key in

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[4] Note, "success" in these studies is often defined in a variety of ways including, but not limited to, creation, licensing, and valuation of IP.

industry-university relationships (Fontana, Geuna, & Matt, 2003, 2005; Laursen & Salter, 2004; Muscio, 2009; Simpson, 2002). Next, a brief overview of each of these factors as they relate to open innovation is provided.

2.1 Industry-university relationships

Because this framework is intended to be used within the context of industry-university relationships, it is important to address the different types of relationship that are commonly created. Industry-university relationships can take many forms, from highly collaborative research projects to those requiring limited involvement and collaboration (Perkmann & Walsh, 2007). While divisions between the different types of relationships are not always clear and hybrid relationships are possible, our focus here centers on industry-university collaborations that promote or support open innovation practices. We are specifically interested in examining relationships that facilitate open innovation and knowledge sharing between universities and SMEs. This includes: research partnerships, research services, grants/sponsored research, and academic entrepreneurship. Other types of relationships are not addressed here, as they are often not typically associated with open innovation initiatives.

2.2 Organizational culture factors

Organizational culture plays a key role in both the success and failure of inter-organizational collaborations (van de Vrande et al., 2009). Organizational culture is most often discussed in terms of shared values, beliefs, and philosophies that drive and define appropriate behavior and processes within an organization (Glisson, 2000; Hurley & Hult, 1998; Martins & Terblanche, 2003; Tushman & O'Reilly, 2002 p 102 ch 4). It includes emphasis on learning and development, the importance of status, approaches to decision making and information sharing, as well as tolerance for conflict and risk taking (Ekvall, 1996; Hurley & Hult, 1998; Martins & Terblanche, 2003; McNabb & Sepic, 1995). Organizational culture directly affects whether innovation is encouraged within an organization and the amount of innovation that is generated (Martins & Terblanche, 2003; Vicere, 2002). It also has been found to be a significant barrier to success in open innovation initiatives involving SMEs (van de Vrande et al., 2009).

2.3 Structural factors

While organizational culture is closely tied to individuals within organizations, structural factors are organizational characteristics that lie outside individuals (Hurley & Hult, 1998). A key structural factor associated with a firm's ability to innovate is its absorptive capacity. Absorptive capacity consists of two unique dimensions: 1) the firm's ability to recognize that knowledge outside the corporate boundaries may be critical for innovation and competitive advantage and 2) a firm's ability to manage and coordinate external sources to extract value from that knowledge (Cohen & Levinthal, 1989, 1990; Spithoven, Clarysse, & Knockaert, 2010). The absorptive capacity of an organization is demonstrated in the set of organizational processes and routines used to acquire, assimilate, refine and exploit knowledge gained from outside sources for competitive advantage (Asakawa, Nakamura, & Sawada, 2010; Spithoven et al., 2010).

Absorptive capacity is often measured as the existence of a separate R&D unit and the employment of qualified personnel specifically for innovation (Spithoven et al., 2010). Because of their smaller size and more limited access to resources, both financial and personnel, SMEs typically have less formal R&D efforts therefore they are often seen as having low or limited innovation capacity (Spithoven et al., 2010; van de Vrande et al., 2009; Chesbrough, 2010).

2.4 Procedural/Contractual factors

While not all institutions use the same terminology, there are some relevant differences between types of industry-university relationships. Research partnerships and grants/sponsored research are typically highly collaborative and formal relationships. They are designed to produce outputs of high academic relevance for universities and breakthrough innovations that lead to competitive advantage or access to new markets for industry partners (Perkmann & Walsh, 2007). Because of the nature of the research, these partnerships often have a high degree of uncertainty requiring an understanding on the part of industry regarding the nature and pace of research (Drejer & Jørgensen, 2005). In contrast to open-ended research partnerships, research services are typically more tightly defined. In these relationships, industry partners leverage a university's domain expertise to solve a specific issue or problem related to product improvement or differentiation.

Administration and project management issues have also been found to impact the success of open innovation projects with SMEs (van de Vrande et al., 2009). Issues related to divisions of responsibilities and tasks, day-to-day project management, communications, and quality of the final product were most commonly reported. In short, outside partners often did not meet the expectations of the SMEs in terms of quality of deliverable and/or meeting deadlines.

In summary, when it comes to industry-university relationships, a variety of relationships can be created to facilitate open innovation practices. Key to managing these relationships is clearly articulating goals and clarifying interests early in the relationship to minimize risk and expectations related to outcomes (Drejer & Jørgensen, 2005). Additionally, organizational culture, absorptive capacity, and procedural/contractual factors have all been shown to impact the success of these open innovation initiatives. However, as noted by Perkmann & Walsh (2007) few researchers have explored how different relationships necessitate specific cultural orientations, absorptive capacity abilities, and procedural management tasks. Our framework seeks to address this gap by aligning factors identified in the literature related to successful outcomes to the specific industry-university relationship that is created. Within the context of this explanatory model, a "successful outcome" is defined as university and industry participants' perception of the success of the relationship.

EXPLANATORY THEORETICAL FRAMEWORK

One critical factor that is under researched in the literature on industry-university relationships is an approach that focuses primarily on the need of the industry participant as a determinant for defining and shaping the relationship moving forward. Taking the perspective of industry, it is critical to match the collaborative partner in an open innovation initiative to the objective or goal of the collaboration (Petrick, 1995; van de Vrande et al., 2009; von Stramm, 2004). Understanding the industry need is a critical first step in explaining the factors most likely to contribute to successful outcomes. As such, our explanatory theoretical framework focuses on the need of the industry participant as the critical dimension for determining the most appropriate relationship to be created. Additionally, the framework highlights key implications of such relationships in regards to factors shown to impact successful outcomes.

Industry need is determined based on the interplay of two factors – 1) specificity of need and 2) urgency of need. The interaction between urgency and specificity can be illustrated by combining these two dimensions to create four distinct quadrants (see Figure 1).

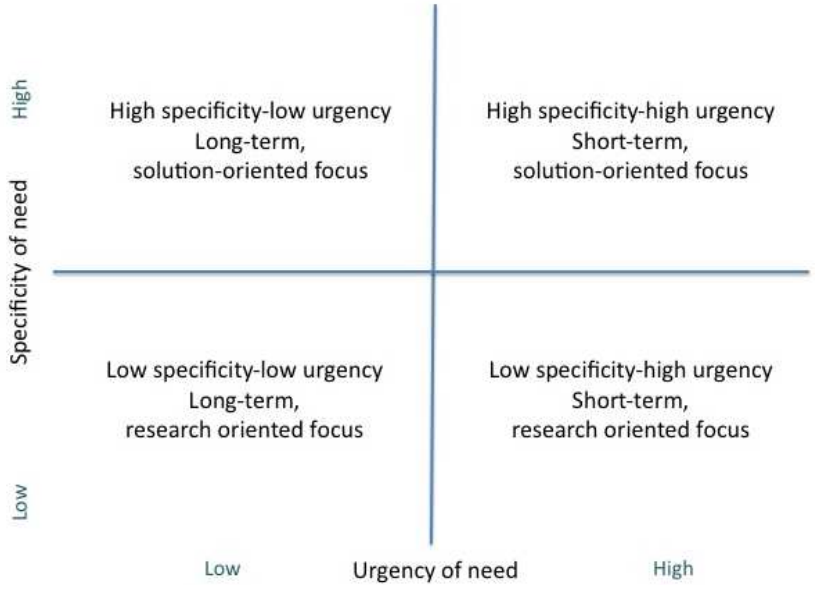

Figure 1. Industry Needs Quadrants

By mapping factors, as defined by current literature, to each quadrant the framework provides guidelines for organizational culture orientation fit, absorptive capacity implications, and procedural/contractual factors best suited to the identified industry need (see Table 1). These framework guide rails can prove helpful in defining the best "fit" between industry need, relationship type, and factors that act as barriers or aids in achieving successful outcomes.

	Industry Participant's Need			
Implications	**High specificity, low urgency** **Long term, solution-oriented focus?**	**High specificity, high urgency** **Short term, solution-oriented focus**	**Low specificity, low urgency** **Long term, research oriented focus**	**Low specificity, high urgency** **Short term, research oriented focus**
Relationship suitability	Well suited for traditional academic researchers. Best suited for research services if limited collaboration with industry required. Best suited for research partnership if high levels of collaboration required.	Most difficult for traditional university researchers as conflicts with research culture and mindset. Best suited for research services.	Best suited for traditional university researchers. Potential for high-value for industry participant who understand nature of the research process. Best suited for research partnerships.	Difficult for traditional university researcher due to time pressures conflicting with research processes. Creates most risk for industry partner. Best suited for research services.
Organizational culture orientation	Somewhat conflicting cultural orientations. Requires industry to clearly articulate specific need to university. Requires university to focus research on specific solution versus exploration of knowledge.	Solution orientation mindset required. Requires university participant to clearly understand impact of outcome on company's bottom line. Requires intense focus on finding the right solution versus exploration of knowledge.	Research orientation mindset required. Requires industry participant to clearly understand exploratory dimension of research methods and uncertainty of outcomes. University participant needs to determine if low urgency is related to being proactive and ahead of market or perceived low need for innovation	Research mindset with understanding of time pressures required. However, difficult to set timeline as nature of research unpredictable. Requires industry participant to embrace research mindset. Requires university participant to adjust processes to expedite processes.
Absorptive capacity implications	Industry has time to retool and make necessary changes to adopt solution. University participant must clearly understand industry participant's ability to modify processes and methods.	Solution must match industry participant's current absorptive capacity or require no or little re-tooling due to time pressures.	Industry participant should have high absorptive capacity to realize highest potential from proposed solution.	Industry participant must be willing to adapt processes or methods to implement outcomes. Industry participant must work closely with university to clearly define which processes and methods can be adapted within timeframe and which cannot. If company has low absorptive capacity may signal need for partnership or additional outside resources.
Procedural Contractual factors	University participant needs to take the lead in moving project forward. Will require proactive project management. Clearly articulate roles and responsibilities of all participants. Getting industry participant's time may be problematic as project is of low priority, requires buy-in from all levels within company.	Industry participant must clearly articulate problem to be solved, issues related to IP, and requirements for acceptable solution. Requires frequent communications, clear deliverables, timelines, and defined responsibilities for both industry and academic project team members.	University needs to clearly articulate issues related to IP and ensure researchers understand vision of company leaders. Important for industry participant to clearly articulate vision of company and to keep university up-to-date on vision. Important for university to update industry on regular basis regarding progress and potential new areas of exploration related to industry participant's vision.	Requires university participant to clearly define risks associated with undefined nature of task. University must clearly articulate issues related to IP, as well as timeframe, and responsibilities of team members. Requires frequent communication and project updates with industry participant project team and leadership.

Table 1. Needs-based Industry-University Relationship (NIUR) Framework

APLICATION OF FRAMEWORK

To illustrate the applicability of the Needs-based Industry-University Relationships (NIUR) framework in providing guidance on industry-university relationships, we applied data collected from an NSF-funded study examining the challenges associated with knowledge exchange between university researchers and legacy industrial era businesses. In this study, a mid-Atlantic land grant university worked with three SMEs in an effort to better understand knowledge transfer barriers and facilitators. Participating companies were located in an economically depressed area of the state and had differing needs with regard to innovation (Trauth & Juntiwasarakij, 2010; Juntiwasarakij & Trauth, 2009). Funding for university researchers was provided by the NSF grant, thereby requiring no financial investment on the part of the companies for the university's participation. All three SMEs were seeking solutions for issues currently impacting their ability to remain competitive within their industry. As such, this data provides an excellent opportunity to evaluate the NIUR framework specifically related to SMEs relationships with universities.

Data for the NSF study were collected between March and November of 2009 and consisted of semi-structured interviews with both industry and university participants, a statement of work (SOW), progress reports, and final reports produced by the university participant. An interpretive thematic analysis employing the NIUR theoretical framework was conducted on the interview transcription documents of participants as well as on project documentation.

Based on the NIUR framework and prior to data analysis, two major coding categories were created. The first major category outlined factors related to industry need and included themes related to urgency and specificity of need. The second major category outlined factors that have been identified within the literature as predictors of success in industry-academic relationships and included relationship suitability, organizational culture, absorptive capacity, and procedural/contractual factors. Finally, participants' perceptions of the success of the project were used as the measure of whether relationships were defined as successful or not successful.

Based on the needs quadrant in which the company resided, coding summaries for each relationship were compared to the associated NIUR guidelines for that need. Specifically, recommendations identified for the specific needs quadrant were compared with the coded data from industry and university interviews and available project documentation. For each category within the NIUR framework, the actual events were either said to be "aligned" or "not aligned" with framework recommendations. This process was repeated for each of the three companies participating in the NSF study.

A review of results from the three industry-university relationships provides support for the proposed framework. Of the three relationships analyzed, alignment with the framework's recommendations was consistent with successful project outcomes. A brief overview of each company follows.

Analysis of Company A revealed a misalignment in all categories between the actual relationship and the recommendations in the NIUR framework. For example, in the category of *organizational culture orientation*, the industry participant commented on issues related to the general nature of the exploration and emphasized "the need to apply [research] narrowly and directly to a specific product" providing evidence of a solutions-oriented cultural orientation. The university participant, on the other hand, was concerned that the industry participant was too focused on finding "incremental solutions" and did not recognize the necessity of the R&D process suggesting a research-oriented cultural orientation. Misalignment of key factors identified in the framework would suggest unsuccessful outcomes. This was in fact the case with both parties feeling the relationship was of limited success.

Analysis of Company C shows an alignment in all four categories between the actual relationship and the recommendations in NIUR framework. For example, based on the NIUR framework, a research services relationship was most appropriate. Analysis shows such a research services approach was indeed taken. The university participant clearly identified the need of the industry participant as well as the importance of keeping costs and timeframes at a minimum. Wording such as "required," "proactive," and "matching industry needs to University capabilities" was included. This ability to recognize and adapt to industry needs as well as align cultural orientation and processes to those needs was likely a key factor in the success of project outcomes. Alignment with the NIUR framework in this case helps to explain why outcomes were seen as successful by all participants.

Finally, results for Company B were not as straightforward. Analysis of Company B showed an alignment in relationship suitability, a mixed alignment in the categories of organizational culture orientation and absorptive capacity, and no alignment in procedural/contractual factors. Interestingly, the outcomes of the relationship were also somewhat mixed with university participants feeling the project was on target and industry participants expressing concerns.

DISCUSSION AND LIMITATIONS

As the application of data from the three companies shows, the NIUR framework helps explain success factors for industry-university relationships based on industry need. In should be noted we are not suggesting universities can easily change their processes or revamp their organizational cultures. Instead, the framework is intended to provide guidance to university researchers on key success factors that help to identify relationships that may be most fruitful. The hope is these guidelines help university researchers best position themselves and their research facilities for success. By focusing on the need of the industry participant and using the framework guide rails to assess critical success factors, university researchers can make more informed decisions regarding potential industry-university relationships.

Taking a proactive approach to understanding what type of relationship is best suited to industry need before entering into a relationship may help to reduce frustration and increase successful outcomes for both industry and universities. By evaluating industry participants before entering into relationships, the university can define key areas that may create barriers to successful outcomes and proactively address each area. University partners may decide there is a misalignment between university needs and industry needs and decline to enter into a relationship, or they can make adjustments to help improve the likelihood of success outcomes for all.

While these three companies represent a limited data set, the results suggest the NIUR guidelines may indeed map closely with successful project outcomes. Testing this framework with more robust data sets is certainly warranted. To better ascertain the usefulness of this framework, specific interview questions guided by the defined coding categories should be created. This will allow for a deeper exploration of the underlying characteristics that make up each category.

Because research was NSF-funded this may have also created different motivations and dynamics than if companies had self funded the research. Analysis of data from industry-university relationships that are funded by industry should also be conducted. Finally, this analysis focused on data from SMEs. Future research should examine the applicability of this framework to both SMEs and large enterprises to determine if size of the organization may play a role in identifying categories that may be most closely tied to positive outcomes.

CONCLUSION

The speed at which innovation is required combined with the rising costs associated with developing new product innovations is driving companies to reevaluate their innovation practices. In doing so, more and more companies of all sizes are looking to reduce their innovation gap by turning to sources of knowledge outside their corporate walls. Open innovation initiatives by industry that leverage university knowledge for innovation will be especially important as legacy industrial regions move into the knowledge-intensive economy. Increasing the number of successful industry-university relationships will have positive economic impacts for industry, universities, and the U.S. as a whole. Additionally, successful relationships will increase the impact of both public and private research funding.

The integrative theoretical NIUR framework presented here has been applied to a study of knowledge exchange between university and industry partners in order to show its applicability in identifying success factors within open innovation initiatives. By bringing together literature related to key factors that are associated with successful outcomes of industry-university relationships for innovation, it makes a contribution to both practice and theory. With respect to practice, the framework provides guidance to both industry and university participants in evaluating and structuring open innovation initiatives. The application of this framework can facilitate the creation of more successful relationships by understanding the key factors that impact positive outcomes based on the need of the industry participant. With respect to theory, taking an integrative approach to evaluating underlying independent constructs related to success allows for a deeper understanding of the interrelationship between these constructs. As such, researchers can begin to explore how these factors interact and under which conditions they may be predictive of successful outcomes in open innovation initiatives between industry and universities. Finally, by better understanding underlying success factors based on industry need, we may be better able to match appropriate collaborative technologies to the task at hand.

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