Balancing learning and knowledge protection in university-industry collaborations

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ABSTRACT

Purpose: The purpose of this study is to examine the tension between learning and protection in university-industry relationships (UIRs) and, in particular, to identify practices that facilitate ways of coping with this tension.

Methodology: The empirical work for the study is based on a qualitative comparative case analysis of six successful, long-term relationships between industrial technology firms and university research groups in Finland.

Findings: The findings of the study reveal that the development of mutual trust, based on personal-level relationships, adaptation and reaching a consensus about the utilization of research results represent the key processes that enable partners to balance learning and protection, as well as lower the informational barriers within the collaboration.

Research limitations: The case data have been collected from IT industry, in which the need for knowledge is changing rapidly and the need for learning is typically high. However, generalization of the results may need additional case studies including from other industrial areas.

Practical implications: The results highlight a rich set of practices that can support both industrial actors and academics in improving their engagement in collaboration and to facilitate successful knowledge creation and utilization in UIRs.

Originality/value: This study extends the existing literature on UIR learning by presenting organizational practices, which help UIR actors to balance learning and protection in their collaboration. Along with mutual trust and adaptation achieved in long-term personal relationships, these practices allow partners to overcome organizational barriers that result from different orientations, attitudes and incentives.

1. INTRODUCTION

The growing interest in university-industry relationships (UIRs) among high-technology firms is based on the view that collaborative research between academia and industry can be a powerful source of innovation (Perkmann et al., 2013; Ankrah and Al-tabbaa, 2015). During recent years, the aspects of joint knowledge creation and learning in UIRs have received growing attention among scholars (Weckowska, 2015; Kunttu, 2017). Previous research has shown that knowledge sharing and transfer taking place in UIRs enable industrial firms to absorb knowledge that may be critical to their future innovations and new product development, as well as for solving technological problems and gaining access to critical human resources and new competencies (Siegel et al., 2004; Lee, 2011). However, the UIRs are usually mediated by relatively high organizational and cultural barriers. One of the core barriers to knowledge transfer and creation between universities and industry involves different institutional norms concerning private and public knowledge and information (Bruneel et al., 2010). In universities, the creation and development of public and open knowledge are central principles (Lee, 2011), whereas the economic value of knowledge, which can be assessed according to the potential competitive advantages that it facilitates, represents a key factor affecting industry actors' attitudes to knowledge and the openness shown towards it in private companies (Geuna and Nesta, 2006). For this reason, the actors working in UIRs are increasingly facing the dilemma of how to enable learning and access to scientific knowledge provided by the UIRs whilst simultaneously protecting their own valuable knowledge resources, which may have strategic value in terms of competitive advantage. In this manner, the competing demands between learning and protecting in the relationship have caused a challenging task of managing the balance between "trying to learn and trying to protect" (Kale et al., 2000).

As most of the existing research on UIR learning is quantitative in nature, concentrating on, for example, the determinants of innovation performance, barriers to collaboration (Bruneel et al., 2010), development of mutual trust (Bstieler et al., 2017), or relationship governance, the existing

research falls short in its analysis of the practices of learning in dyadic university-industry collaborations. Moreover, previous research provides minimal information about the practices and mechanisms behind learning processes that occur in the research-based interactions between universities and industry. Indeed, Weckowska (2015) has studied UIR learning mechanisms and Bruneel et al. (2010) have examined the practices that may lower the organizational and informational barriers in UIRs, but research on relational practices facilitating UIR learning remains absent. Coping with the competing demands between learning and protection, in particular, seems to be neglected topic in the existing UIR research, despite the partners' attitudes towards knowledge sharing and openness of the knowledge may cause a real informational barrier to UIR learning Bruneel et al. (2010).

To fill this gap, this study intends to answer the following research question: what practices help industrial firms to achieve a balance between learning and knowledge protection in university-industry relationships? To address this question, our aim is to study the tension between learning and protection in UIRs and, in particular, to identify the practices that facilitate coping with this tension. Thus, our objective is to find organizational mechanisms and practices that help the actors in UIRs to facilitate effective relationship learning and joint knowledge creation processes while simultaneously maintaining the confidentiality of that knowledge. This study makes an empirical contribution to the existing, mainly quantitative, literature on UIR learning by examining the relational level practices in terms of a qualitative multiple case analysis. The study also extends the existing literature concerning informational barriers to learning in UIRs by presenting relational practices, which may significantly lower these barriers to collaboration. These findings may have also significant managerial interest, given that most high-technology companies utilize

collaborative university partnerships for their innovation and product development work, and thus face the challenge of learning and protection.

2. THEORETICAL FRAMEWORK

Organizing raises multiple tensions that are often contradictory in nature. Whereas the more conventional contingency theory relies on either-or decisions by finding the most suitable fit for each situation and prioritizing competing tensions, the more recent paradox theories suggest a "both-and" approach, which could foster novelty, creativity and long-term sustainability (Lewis, 2000). Thus, a paradox perspective argues that long-term sustainability requires the organization to undertake continuous efforts in order to meet multiple and divergent demands simultaneously (Smith and Lewis, 2011). In this "both-and" thinking, the organizational actors develop practices and mechanisms through which they can cope with the conflicting demands, and find a balance between them (Jay, 2013). The collaborative relationships between industrial firms and universities can be seen as learning alliances, in which the partners strive to learn or internalize critical information or capabilities from each other (Kale et al., 2000). In these kinds of relationships, the firms continuously face competing demands about sharing critical knowledge with the research partner in order to facilitate the research process, while, on the other hand, managing the risk of losing knowledge that may be commercially sensitive (Geuna and Nesta, 2006). To find a balance between these conflicting demands about learning and protecting knowledge in a UIR collaboration, the partners have to develop the practices of their mutual learning process in order to facilitate effective learning process and simultaneously take care of protecting commercially sensitive information.

This research studies the learning practices that may help the UIR collaborators cope with the competing demands by overcoming the barriers to collaboration. The learning process is analysed using the theoretical framework of relationship learning (Selnes and Sallis, 2003). The work of Selnes and Sallis (2003, p. 80) defines relationship learning as a joint activity between a supplier and customer where two

parties share information, which is then jointly interpreted and integrated into a shared relationship-domain-specific memory that changes the range or likelihood of potential relationship-domain-specific behaviour. The first phase, knowledge sharing, refers to knowledge transfer in terms of formal and informal interaction within the relationship. The main knowledge-based obstacles in effective knowledge transfer in UIRs include the sharing of commercially sensitive industrial information with the academic partner (Bruneel et al., 2010). Sharing industrial information may be critical for the academic partner to properly accomplish the research task but, at the same time, this information may be commercially sensitive for the industrial partner. For this reason, finding the balance between knowledge sharing needs and the need to protect the sensitive information (Kale et al., 2000) is central for the UIR actors (Geuna and Nesta, 2006). The second phase of the relationship learning process is related to joint knowledge creation through the process of joint sense-making (Selnes and Sallis, 2003). In this phase, the partners jointly create new, experience-based tacit knowledge that is difficult to imitate or transfer outside of the relationship, as well as combining their own previous knowledge resources and experience. One of the major obstacles to joint sense-making in UIRs is a consequence of the differing orientations of industry and universities (Siegel et al., 2004), which are visible in the motives, attitudes and organizational cultures of these institutions. Whereas the main motive of industrial actors is to create and develop private knowledge that should remain hidden within the firm or disclosed in a limited way through patenting (Geuna and Nesta, 2006), the main motive among academics is to create reliable, public knowledge. Thus, conflicting attitudes and motives concerning the joint knowledge creation process have a particular impact on the joint learning process, whereby the partners must find ways to cope with this tension in UIR collaborations. In the third phase of the learning process, the organizations develop relationship-specific memory structures within which they jointly develop relationship-specific knowledge that can be stored and integrated. In this phase, the partners may implement the results of their joint development and learning as concrete outcomes that can be utilized in industrial commercialization processes or as

academic outcomes. In UIRs, the industrial partners have a clear need to protect the results of the co-creation, as they may be sensitive in terms of competitive advantage. On the other hand, academics have an interest in publishing the results from their joint actions on industrial projects since establishing a good reputation through publications and other academic credentials is critical to career success and sustainability in universities (Bruneel et al., 2010); in other words, there is a need for a process that makes the jointly created knowledge accessible to academic audiences.

3. METHODOLOGY

In this study, an explorative qualitative in-depth case study approach is used to examine six UIRs in Finland. The case study approach has been found to be particularly useful when studying complex and evolving relationships and network interactions in real-life contexts (Easton, 2010), and therefore the case study approach was selected for the research method in this paper. The cases represented UIRs in the field of the information technology (IT) industry (electronics, mobile communications and software). Knowledge creation and application are seen as important in high-technology sectors, and the need for learning is typically particularly high in the IT industry, in which knowledge changes quickly. According to Yin (2009), multiple sources of evidence should be used in qualitative data collection. Therefore, the case data collected include interviews, as well as secondary data, such as corporate brochures and archives, Internet information, publications and descriptions of the partnership. The cases for the study were selected purposively, rather than randomly drawing on the concept of the information-rich case (Welsh et al., 2008). To select cases and recruit interview participants for our semi-structured case interviews, we used different network platforms and personal contacts to identify cases, in which a long-term and close

collaborative UIR has yielded to successful results in terms of practical value for the industrial partner.

The data used in this case study were collected over a period of seven months. The researchers put significant effort into accessing those industrial managers who had the best possible long-term experience from collaboration with their university partner in the selected cases. For the case interviews, a semi-structured interview template was designed. The template focused on the major parts of relationship learning: knowledge sharing, joint sensemaking and storing the knowledge within the relationship-specific memory in the context of UIRs. In each of the three parts, the template included questions on the practices and factors related to the joint learning process, such as: *How would you describe the information sharing within your relationship?* or *Based on your experience, which factors may facilitate open discussion and information sharing between you and your partner in your relationship?* The template also included several questions concentrating on learning protection of knowledge, such as: *Do you see that the partners' different motives concerning the utilization of the jointly created research results cause conflicts in the relationship?* The interview questions were designed in a way that encouraged the interviewees to relate their own experiences about how they had coped with the competing tensions of learning and protection: *Do you think that confidentiality of company-specific information has been an obstacle in your collaboration and can you tell examples on these kinds of situations?* Each of the case interviews involved an interviewee on both sides of each case relationship to involve relevant interviewees from both sides of the relationship to validate the analysis. The interviewed industrial managers named their key collaborators on the university side, who were usually the leaders of research groups. Interviews, which generally lasted between 60 and 90 minutes, were recorded and transcribed. To maintain confidentiality of the interview data,

the analysis presented in this paper identifies the interviewees only by position (university=UNIV; industry=IND). Given that the collected interview data reflected the interviewees' own personal views on the relationships studied, the researchers actively monitored and discussed issues raised during the interview process by comparing the answers from both sides of the relationship and asking additional questions. The researchers also cross-checked each other's independent interpretations after every interview.

4. CASE ANALYSIS

In this section, the data collected from the case-specific interviews is analysed in order to identify differences and similarities in the data. Relationship learning related to UIRs is analyzed in terms of knowledge sharing, joint sensemaking and the integration of knowledge into relation-specific memory.

5.1. Practices of knowledge sharing

In the literature on organizational knowledge flows, knowledge accessibility is regarded as a driver of innovation in the relationships between organizations (Tsai, 2001). As described earlier, one of the main barriers to knowledge transfer in UIRs is related to the conflicting norms concerning private and public knowledge and information (Bruneel et al., 2010). The industrial interviewees had very coherent views on the protection of the commercially sensitive information:

> *The university actors have to understand that the great part of the knowledge we are sharing is commercially sensitive. (IND F)*

> *It is a rule that all the collaboration is made under a non-disclosure agreement, and if there is some information that can be openly published, it is always reviewed by us. (IND B)*

However, when the industrial actors were asked how they cope with the conflicting demands of information sharing and protection, they usually talked about long-term collaboration, personal relationships and the building of trust. Interorganizational learning is typically based on close personal-level relationships, in which substantial knowledge exchange, and hence effective learning activities, can occur and be sustained between partners (Fang et al., 2011; Bäck and Kohtamäki, 2016) in order to move knowledge from academia to industry, which is a process that requires engagement from both parties (Perkmann et al., 2013). Our interview data were consistent with this statement, as practically all the interviewees suggested that long-term personal relationships are the key enablers of efficient knowledge transfer:

> *As our collaboration has lasted several years, we know each other very well, and we speak the same language. Hence, our university partner knows our problem area as well as our technical limitations. This way, it is easy to go directly to the issues to be solved. (IND C)*

> *I feel that long-term personal relationships between the industrial partner's R&D staff and our researchers represent one of the most critical facilitators of close collaboration and open communication in this relationship. (UNIV D)*

Thus, in long-term collaboration, both parties learn from experience and, together, develop richer and more refined ways to engage with their research partners (Bruneel et al., 2010). Collaborative experience especially plays a critical role, as research institutes, which already have experience of industrial collaboration, tend to be called on by their industry partners in the future (Perkmann et al., 2013):

> *We have had a research collaboration with this partner for several years. This is of remarkable benefit in terms of information sharing. (UNIV C)*

Mutual trust between partners is essential in facilitating UIRs (Santoro and Saparito, 2003) because the firms often need to share commercially sensitive information and tacit knowledge with their university partners. Thus, high levels of trust between university and firm stimulate rich

information exchange and the sharing of valuable knowledge and information (Santoro and Saparito, 2003; Inkpen and Tsang, 2005). Moreover, since it is often very difficult to specify the actual results and implications of research, the research process between firm and university is beset with many unknowns (Bruneel et al., 2010), as well as possible fears of opportunistic behavior on the part of the other party. A high level of trust in the relationship, however, is able to reduce this fear and also resolve any problems that may arise in the relationship (Inkpen and Tsang, 2005), given that mutual trust allows partners to be confident that the other party is treating them fairly and in a consistent manner (Bruneel et al., 2010).

> *Knowing the university partners at a personal level and the long-term experience of working with them help us to trust them. (IND D)*
>
> *We have provided the university with a lot of our internal R&D tools and knowledge. This was necessary to enable efficient and fruitful research. Of course, this was somewhat risky for us in the beginning, but there was no other way to proceed than to trust them if we wanted good results. So we had to open our doors to the university. Everything has gone well and the trust is now at a very high level. (IND F)*
>
> *I have a high level of personal trust for our university partners. However, due to our corporate policy and rules, I cannot disclose as much information to them as I would like to. This is a pity, since I know that the researchers would be more motivated if they did not need to work "in the dark". (IND C)*

Thus, high-level trust enables partners to work efficiently and collaboratively in order to solve problems, which in turn lowers the barriers to knowledge transfer (Siegel et al., 2004; Bruneel et al., 2010).

5.2 Practices of knowledge creation in joint sensemaking

The process of searching for a common understanding and for the joint interpretation of the information and knowledge created in the course of joint action between partners is called joint

sense-making (Selnes and Sallis, 2010). As such, it can be regarded as a link between information and its meanings (Fang et al., 2011). As described earlier, one of the major barriers to advancing joint activities and knowledge transfer in UIRs is the difference in the orientations of industry and universities. These differing orientations can be seen in motives, attitudes and organizational cultures, all of which have a particular effect on the interaction in UIRs (Siegel et al., 2004). Again, the academic priorities conflict with the industrial priorities, especially in terms of the openness of knowledge:

> *Based on my experience, some research groups are not eager to collaborate with industry even if their research areas might have potential for commercialization – they feel that it is more important to concentrate on publishing in high-quality journals. (IND D)*

> *It is true that universities usually encourage their researchers to publish at a high level, and this does not necessarily fit well with practical research collaborations with industry. (UNIV A)*

Great differences in the views on the openness of knowledge may indicate weak attitudinal alignment in the collaboration among academics (Bruneel et al., 2010), since their possibilities to publish the research results may be limited in the industrial projects. This, in turn, may impair the process of joint learning and knowledge creation. Moreover, collaboration partners in firm-university collaboration have totally different incentive systems (Bruneel et al., 2010; Lee, 2011), since the academics are typically rewarded based on their publication records whereas the industrial actors' incentives are mainly dependent on product development outcomes. These differences can make the search for a common understanding and setting common targets very difficult. However, our data reveal that the partners can also carry out concrete actions to develop the incentive policies in a ways that encourage the actors to UIR collaboration:

In the very early stage of our collaboration with our university partner, we made a decision that we would extend our internal R&D incentive system to also cover the university researchers working on our joint projects. (IND F)

The fact that the company covers our researchers with its incentive system is an honor to us and motivated our research staff to develop and report inventions in the project, even if the researchers cannot improve our publication records in this industrial project. (UNIV F)

In case F, the industrial partner decided that the university researchers working in the collaborative projects with the company were granted the same incentives for inventions and patents that the company grants to its own R&D staff. Therefore, the company encouraged the university research staff to make inventions and report for them in the same manner as the company internal staff. According to the interview data, this kind of setting facilitates joint efforts in knowledge creation and learning, which also yield concrete industrial outcomes in the research projects. In the same manner, the university partner may also develop their own incentive policy to encourage the research staff to industrial collaboration, as described in case A:

In addition to the traditional publication record-based incentive system, our university also rewards those researchers who take an active role in establishing and running projects with industry. (UNIV A)

The interview data also emphasized the fact that industrial managers who have a background in university research are open to collaboration with universities and often steer such collaborative projects:

It is usual that our R&D managers are graduates of the university that is our research partner. For this reason, they have close relationships with university people and they are very open towards collaboration. (IND E)

I have been studying and also working in the past in the university with whom we now collaborate. Also many of my colleagues come from there. Therefore the link with them is quite natural. (IND C)

Thus, the data highlight the importance of boundary actors, who operate across organizational boundaries between university and industry, and also demonstrate an important practice related to boundary spanning activities (Siegel et al., 2004; Kunttu, Huttu and Neuvo, 2018), in which the industrial partner recruits former university research staff who have previous experience of industrial collaboration.

> *Before I joined this company, I worked for several years as a university researcher and completed my PhD in the same area as I am now working in industry. Therefore, I understand how researchers work in universities and what kinds of task are beneficial to give them as research projects. I also have good relationships with several research groups working in my field. (IND B)*

The movement of staff also occurs in the opposite direction:

> *Even though I have a background in research, I worked for several years in industry before returning to my current position in the university. I feel that this is a very good experience in terms of helping me better manage our industrial relations. (UNIV A)*

5.3. Practices of knowledge integration

The third part of a relationship learning process involves the integration of jointly developed knowledge in relationship specific memory (Selnes and Sallis, 2003). This part is often referred as knowledge implementation or institutionalization. In this process of implementation of the jointly created knowledge, the partners face conflicting demands of the disclosure the research results. It is very important for the industrial partner that it is able to utilize the results obtained in the collaboration with external research partners within its own organization, and develop them towards commercialization. In this process, they must be able to show concrete results:

> *A new innovative method developed with the university never ends up in the productization pipeline unless we can show that it really works. For this, we must build some kind of proof of concept, which can be used when I show the results to decision makers in our organization. (IND B)*

The interview data showed that the academics are able to support the industrial partner in this process by developing prototypes or demonstrations together with industrial developers:

> *We usually make a pilot project using real circumstances. My experience has shown that a working pilot opens many doors in the company. (UNIV A)*

The industrial integration and utilization of experience-based tacit knowledge, obtained and accumulated in joint action between academic research and industrial R&D, typically require personal efforts on the part of all the key stakeholders in the projects. In practice, this means that the persons who have created the knowledge also need to take an active role in its integration and utilization (Bäck and Kohtamäki, 2016). The industrial managers emphasized this and indicated that, by employing university researchers in parts of their internal R&D organization, the industrial partner is able to fully utilize the results of the joint research.

> *After finalizing their doctoral degree, we have employed most of the researchers working on our joint projects. They have then continued their development work as part of our R&D organization. (IND F)*

> *It is quite typical that a person who has first worked as a researcher has then continued his or her work as a part of our internal R&D staff. (IND B)*

> *During the years of collaboration, several members of our research staff have been employed by the company. (UNIV C)*

Thus, the importance of the boundary spanning activities in the relationship between scientists and industry (Siegel et al., 2004) is again emphasized, but this time in the context of the implementation of jointly created knowledge.

For universities, publishing the research results is an essential outcome of the research projects, and in many cases the academics need to engage in "status competitions" with their peers and colleagues, based on their publication records and other institutional affiliations (Geuna and Nesta,

2006; Bruneel et al., 2010), which are critical for their success and career sustainability in the academic world. On the other hand, the companies may often wish to keep research results secret in order to ensure a potential competitive advantage facilitated by this new knowledge. Again, working with universities requires that the firms have the ability to collaborate with partners with a different incentive system(Siegel et al., 2004; Bruneel, D'Este and Salter, 2010). In the same way, universities have to understand the importance of intellectual property (IP) for industry. For example, establishing expectations concerning what aspects of and when the results of the joint projects can be published by the university researchers may be controversial (Bruneel et al., 2010). Our interview data concerning knowledge integration revealed that academics and industrial actors are able to find a consensus regarding the publication policy:

> *We try to focus our joint research in such a way that at least part of the results can be published by the university researchers. In many cases, we have patented the new idea first and allowed the researcher publish it after that. (IND F)*

> *Usually, we have found a way to publish the results as soon as the IP issues have been agreed with the company partner. However, this has sometimes not been possible, which is of course very demotivating for the researcher, but we have to accept this with industrial projects. (UNIV F)*

> *We always negotiate with our partner about what can be published and usually we have together found areas of research that can be published. (UNIV B)*

The interview data revealed an interesting opportunity in terms of overcoming the potential conflicts concerning the publication of the jointly developed research results by authoring the publications together:

> *We know that it is important to our university partner to publish the results, but it is not always possible. On many joint projects, we have decided together what can be published and how, and then we have written the papers together. (IND B)*

I feel that the joint authoring of scientific papers also really helps the industry people to deeply understand the methods and technologies that we are developing together from a scientific perspective. They also seem to appreciate the opportunity to co-author the publications. (UNIV D)

Working together on a research paper helps the company's R&D staff to understand academic research and our way of working. It also makes our collaboration closer, since the writing process is often a quite demanding part of the project. (UNIV B)

Thus, joint scientific publications (D'Este and Patel, 2007) can be an important way of deepening the relationship between university and industry actors, as well as facilitating joint knowledge creation in the relationship and bringing the partners closer to each other.

5. DISCUSSION AND CONCLUSIONS

The present study extends the existing literature on UIR learning by presenting a qualitative case study on organizational learning practices in university-industry relationships. This is an important research setting, given that UIR relationships tend to vary in terms of their learning capabilities, with some relationships performing better and producing more highly innovative outcomes than others, because they have been able to develop appropriate learning mechanisms. By identifying relationship learning practices, this study makes three important contributions. First, the study extends the existing, mainly qualitative literature on interorganizational learning (Selnes and Sallis, 2003; Fang et al., 2011) by providing qualitative evidence on the practices on how partners in long-term UIRs deepen and develop their learning. Second, the results of the study propose a number of mechanisms and practices that help the UIR actors to cope with competing demands between learning and protection (Kale, Singh and Perlmutter, 2000b) – a topic widely neglected in the existing UIR literature (Siegel et al., 2004; Bruneel, D'Este and Salter, 2010; Perkmann et al., 2013). Third, the study contributes to the research on UIR collaborations by demonstrating

how the identified learning practices also help actors to lower the barriers to effective relationship learning. These barriers caused by different institutional norms concerning the openness of knowledge as well as different motivations, attitudes and organizational cultures have been recognized as a major obstacle for effective learning in UIRs (Bruneel, D'Este and Salter, 2010). This study is one of the few providing qualitative evidence on real-life practices to lower these barriers.

The study has examined learning practices in three phases of relationship learning (Selnes and Sallis, 2003), as summarized in Figure 1. Knowledge transfer is the first phase in this process. One of the main barriers to efficient knowledge transfer in UIRs is the level of openness concerning commercially sensitive industrial knowledge, with our data having emphasized the role of mutual trust between partners, which can stimulate rich information exchange and the sharing of valuable knowledge. High levels of trust in the relationship enable the industrial partner to disclose sensitive information, which may be commercially advantageous, but is necessary for research partners to carry out the relevant research. The observations revealed that long-term and close personal-level interactions between key stakeholders in the relationships are the most important factors facilitating the creation of mutual trust, which also facilitates commitment between partners. Commitment, in turn, positively impacts on the partners' adaptation to each other's processes and way of working.

In the joint knowledge creation through the process of sensemaking the main organizational barriers are related to different motives, attitudes and organizational cultures between partners. As the actors involved have totally different incentive systems, they have to find ways to make their collaboration motivating on both sides. The data suggested that industrial partners can carry out concrete actions to motivate collaboration by extending their own incentive systems to cover

university staff working on joint projects. In the similar manner, universities may provide incentives for the researchers for participating the industrial projects. The role of boundary actors' engagement in university collaborations was found to be particularly important for the relationship learning process, and therefore the industrial collaborators must be active in encouraging their staff for crossing the boundary between industry and academia. In the same manner, in order to facilitate and motivate academic involvement in industrial collaboration, academics have to be business-oriented and understand the industrial way of working if they are to adapt to their partners' processes. In this way, the experience of collaboration may enable academics and their industrial collaborators to converge in terms of attitudes and arrive at a mutual understanding about the research process and collaboration practices.

The third phase, integration of knowledge with relationship-specific shared memory, refers to the implementation of the knowledge accumulated in the relationship. Conflicting interests related to the openness of research results may often yield to conflicts between partners over attitudes towards the timing and format of the publication of the research results. This is because companies wish to keep the results secret from their competitors, while academics, on the other hand, wish to facilitate open knowledge, such that their ideas may be acknowledged by their peers. However, the data revealed that partners are able to find a consensus in this regard through negotiation and by understanding the interests of the other party. In addition, publishing the results together with the industrial partner provides academics with an interesting way of creating publications with real-world applications, as well as deepens the relationship with the industrial partner.

In conclusion, establishing a successful learning relationship between industry and academia requires the long-term investment, understanding and adaptation on the part of both parties at several organizational levels. This study presents several relational practices that facilitate knowledge sharing, creation and integration by aligning attitudes and ways of working on both sides of the relationship. The study also

highlights the meaning of interorganizational trust facilitated by overlapping personal and professional relationships and close interactions – processes necessary to create the right atmosphere, in which partners can jointly create and utilize knowledge and overcome barriers caused by different orientations, attitudes and incentives.

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Table 1. Case descriptions for the studied relationships between universities and industrial partners

	Relationship A	Relationship B	Relationship C	Relationship D	Relationship E	Relationship F
Number of employees in R&D unit	90	120	50	80	200	150
Main products/services of the customer company	Electronic and electrical systems	Mobile devices	Software products	Software for mobile devices	Hardware platforms and embedded software	Power electronics products
RELATIONSHIP						
Duration of the relationship	Four years	Five years	Four years	Five years	Five years	13 years
Area of the joint development project(s)	Process development for R&D function	Software and algorithm development	Software and algorithm development	Algorithm development	Software development	Hardware and related embedded software development
Key facilitators of the relational learning process (as evaluated by the customer)	Very close collaboration with and the university partner's good understanding of the industry facilitate learning in the relationship	The university partner has been developing new technologies for the industrial partner; the partner actively proposes new ideas in joint projects	The university partner acquires new knowledge and shares it actively with the industrial partner; it also proactively prototypes new ideas for the customer	The university partner has strong competences and experience in the relevant field, which also makes it competent in terms of solving complicated technological problems in collaboration with company R&D staff	The university partner has very strong competences in the relevant field, as well as being able to put forward good proposals that could improve the quality and competitiveness of the customer's products	The university partner has considerable experience of the customer's technology area; close personal relationships between researchers and the company's internal R&D staff help the developers to develop new ideas together
Key industrial results of the joint research projects	New processes and tools for the development of the R&D organization	New software algorithms commercialized as new features in customer products	New software algorithms developed together, some of which have been commercialized	New software algorithms developed together	New software algorithms developed together, part of which are now in the process of commercialization	The results of several joint projects have been commercialized in the customer's products
Key academic results of the joint research projects	Scientific articles, educational collaboration	Several scientific articles (also jointly authored) and Master's theses; jointly organized education.	Scientific articles	Several scientific articles and Master's theses; jointly organized education.	Scientific articles	Several PhD and Master's theses, as well as scientific articles
Participants in the case interview (company)	R&D Director	Research Manager	Project Manager	Technology Manager	R&D Manager	Senior Director, Global Innovation
Participants in the case interview (university)	Assistant Professor (responsible researcher)	Professor (leader of research group)	Professor (leader of research group)	Professor (leader of research group)	Professor (leader of research group)	Professor (leader of research group)

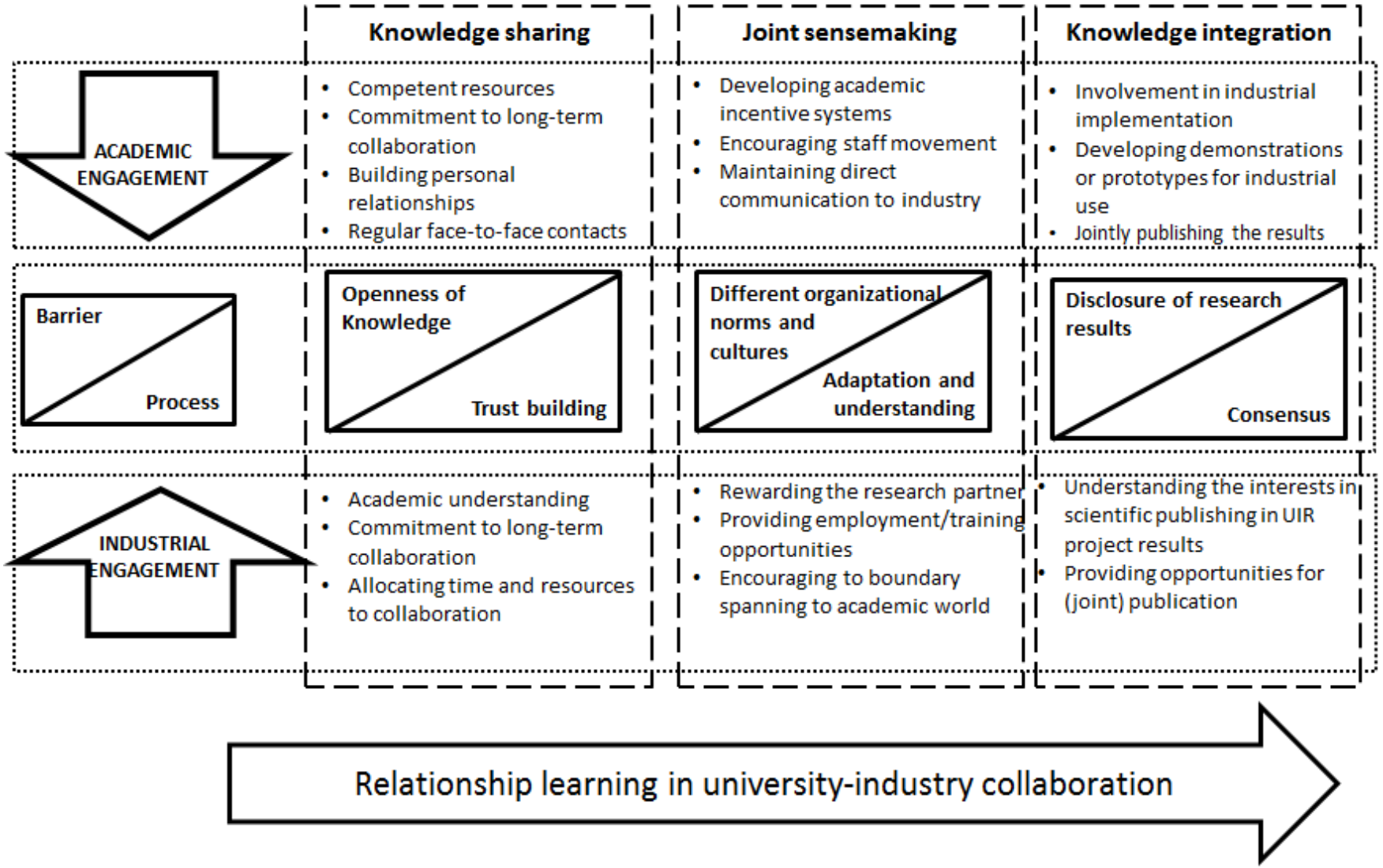

Figure 1. A summary of central practices, which facilitate the lowering of barriers in the relationship learning process within university-industry collaboration

Appendix 1. List of questions used in the interviews

Information sharing

1. How would you describe the information sharing within your relationship? Has there been problems and how have you been able to overcome them?
2. Based on you experience, which factors may facilitate open discussion and information sharing between you and your partner in your relationship?
3. Could you tell examples on situations in which information sharing has been effective or ineffective in your relationship?
4. Do you think that confidentiality of company-specific information is an obstacle in your collaboration, can you tell examples on these kinds of situations? How have you been able to overcome these obstacles?

Joint sensemaking

1. How do you see that partners' organizational cultures, attitudes or motives differ between universities and industry? Can you tell examples on this? Have you faced challenges in aligning the motivational factors and how have you solved them?
2. Which factors do you see important in finding common understanding in the U-I relationship?
3. Which factors or practices do you see as the most important in reaching open atmosphere and good mindset for co-creation between the U-I partners? Please share your experiences
4. Has there been any conflicts regarding publishing of the research results? How have you been able to solve them?

Knowledge integration

1. In your relationship, have you been able to utilize the results in the best possible manner? Why? Have both university researchers and industrial actors had equal possibilities to utilize the results?
2. Based on your experience, how the partners in the U-I relationship may facilitate the utilization of the results of the joint co-creation? What kinds of actions are required from the parties?
3. Do you see that the partners' different motives concerning the utilization of the jointly created research results cause conflicts in the relationship? How they could be solved?
4. Can you tell examples of successful/unsuccessful utilization of the research results in the U-I relationship?