

Thomas Lauvås and Ola Edvin Vie

Chapter 12

Boundary spanners enabling knowledge integration for sustainable innovations in university–industry research centres

12.1 Introduction

The heightened awareness of societal sustainability challenges highlights the need for an increased effort towards – and better understanding of – developing sustainable innovations. One of the measures taken by governments to foster sustainable innovations is the facilitation of university¹–industry collaboration (UIC). One of the predominant policy responses in the EU and the United States to increase UIC is the establishment of university–industry research centres. These centres are often interdisciplinary in nature, seeking to overcome specific challenges in particular industries (Gulbrandsen, Thune, Borlaug & Hanson, 2015; Villani, Rasmussen & Grimaldi, 2017) or tackling some of the “grand challenges” facing humanity (Hessels, Wardenaar, Boon & Ploeg, 2014).

The research centres promote knowledge and technology transfer and innovation (Boardman & Gray, 2010) and have two main goals: producing academic research and developing innovations (Chai & Shih, 2016; Gulbrandsen et al., 2015; Ponomariov & Boardman, 2010). Partly due to their different knowledge bases, the collaboration process between university and industry partners in research centres is seldom without challenges (Perkmann, 2017). Exploiting external knowledge from universities is far from straightforward due to significant institutional, technological and knowledge boundaries between companies and university partners (Bruneel, D’este & Salter, 2010; Galán-muros & Plewa, 2016). Many companies are therefore unable to integrate the knowledge stemming from the universities’ research findings to develop innovations (Galán-muros & Plewa, 2016), and the literature on UIC offers limited advice on how to handle these challenges (Bruneel et al., 2010).

This chapter examines this challenging process through the concept of knowledge integration, which is the combination of “specialized but complementary knowledge” (Tell, 2011, p. 27). This chapter will examine knowledge integration processes in university–industry research centres on the individual level and assess how strategies frame these processes for sustainable innovation. We focus on two roles: the academic

¹ In line with Perkmann and Walsh (2007), we use the term “university” to include all types of public research organizations, which are research organizations that are predominantly government-funded, i.e. universities, public research laboratories, research institutes, etc.

centre director and the industry partners' contact persons, who are responsible for knowledge integration and facilitating sustainable innovations in the research centre. Hence, we ask: *How do centre directors and industry partners' contact persons contribute to knowledge integration in university–industry research centres?* The research question is examined through a longitudinal study of six Centres for Environment-friendly Energy Research (CEER).² The CEER scheme aims to develop expertise and promote sustainable innovations by focusing on long-term research in selected areas of environmentally friendly energy in close collaboration with prominent universities and industry partners (research Council of Norway, 2008). The research centres were deemed appropriate as cases because their long-term financing makes them suitable for longitudinal studies of knowledge integration.

By adding to the few longitudinal studies of research centres (Lind, Styhre & Aaboen, 2013; Rass, Dumbach, Danzinger, Bullinger & Moeslein, 2013), this chapter makes three distinct contributions. First, it illustrates the organizational dynamics of knowledge integration (Tell, 2011) that underlie UIC (Perkmann & Walsh, 2007). Second, it demonstrates the importance of middle managers as boundary spanners (Nonaka, 1994). Third, these contributions relate to how knowledge integration processes are influenced by the strategies of the research centre and the industry partners and how this is connected to the allocation of resources (von Krogh, Nonaka & Rechsteiner, 2012). These findings have important implications for companies considering UIC, academic researchers leading research centres and policymakers promoting sustainable innovation by supporting such collaborations.

The chapter is structured as follows. In the next section, we present our theoretical framework. Thereafter follows a description of our research methodology and empirical data collection. We then present the empirical case study upon which this chapter is based and submit our analysis and discussion. Conclusions and implications regarding knowledge integration in research centres are proposed in the final section.

12.2 Theoretical framework

In this chapter, we draw on two key, interrelated theoretical concepts – knowledge integration and boundary-spanning – to explore UIC in research centres. We start with an introduction to how knowledge is developed in such centres.

² More details are provided in Section 12.3.2: Case selection. See the description of the scheme at the Research Council of Norway (<http://www.forskningsradet.no/en/Funding/FME/1215006638765>).

12.2.1 Knowledge development in university–industry research centres

In the context of the growing importance of knowledge and innovation for sustainable development, the effort of uniting universities and industry has become a major concern for policymakers (Ranga, Debackere & Tunzelmann, 2003). Since the 1970s, many policymakers have supported more proactive and increased interactions between universities and industry (Cohen, Nelson & Walsh, 2002; Mowery & Sampat, 2005). Following this development, university–industry relationships have been extensively studied in recent years (Bodas Freitas, Geuna & Rossi, 2013; Gulbrandsen, Mowery & Feldman, 2011). Research has emphasized the advancement of higher productivity as one contribution of UIC through facilitating knowledge integration between academia and industry, thus enhancing national innovation performance (Bishop, D’este & Neely, 2011). This is mainly done by giving companies access to fundamental knowledge and the opportunity to conduct high-quality research (Hussler, Picard & Tang, 2010; Laursen & Salter, 2004; Raesfeld, Geurts, Jansen, Boshuizen & Lutge, 2012), two factors that lead to sustainable innovations (Jakobsen, Lauvås & Steinmo, 2019).

Although research centres have existed for decades and have become one of the predominant policy responses to stimulate UIC (Ponomariov & Boardman, 2010; Styhre & Lind, 2010), the understanding of these complex organizations is inconsistent and limited (Gulbrandsen et al., 2015; Ponomariov & Boardman, 2010). Several types of organizations labelled research centres exist, and different categories of research centres have been suggested (Smith, 2012). We follow the definition by Styhre and Lind (2010, p. 910), who defined a research centre as a “joint venture between the university, industry and governmental funding organizations, identifying some domain of research where industry and academy can benefit from collaborating.”

The effort of combining universities and industry partners in research centres is an attempt to connect two distinct and specialized knowledge bases. Yet, incentive structures in universities and industry are contradictory, often ascribed to a dichotomy between the opposing logics between long-term research and the academic publication system and industrial commercialization (Perkmann & Walsh, 2007). Companies and universities are therefore considered to be unnatural collaboration partners (Hasselmo & Mckinnell, 2001), especially since it is difficult to simultaneously leverage academic journal articles and develop sustainable innovations (Ahuja, Lampert & Tandon, 2008; Smith, 2012).

The challenge of integrating diverse knowledge stems from the inherent tension in the division of labour, which is the trade-off between the superior task efficiency of specialization against its inferior coordination and integration properties (Postrel, 2002). In this chapter, we apply the concept of knowledge integration to better understand coordination problems and how differentiated knowledge can be effectively integrated (Grant, 1996).

12.2.2 Knowledge integration and its boundaries

The fact that innovations in general, and sustainable innovations in particular, are created at the boundaries between different disciplines or specializations (Leonard-barton, 1995; De Marchi, 2012) elucidates the importance of managing knowledge across boundaries within and between organizations (Carlile, 2004). Scholars have recognized the value of boundary spanning, where crossing organizational boundaries for knowledge has a higher impact on subsequent technological evolution within and beyond the domain of the firm than exploration within the firm (Rosekopf & Nerkar, 2001). Other scholars have identified the challenges of transferring knowledge across boundaries (e.g. Szulanski, 1996; von Hippel, 1998). This demonstrates that the integration of specialized knowledge is difficult and that integration processes are not always effective (Grant, 1996; Okhuysen & Eisenhardt, 2002). Hence, there are boundaries between organizations and their representatives that both foster and restrain innovation collaboration (Carlile, 2004).

If the collaborative practices are to function well enough to develop sustainable innovations, these boundaries must be overcome (Bruneel et al., 2010; Steinmo & Rasmussen, 2016). One method is using intermediaries in innovation processes. This implies hiring and/or using external institutions to support companies in their innovation activities (Gassmann, Daiber & Enkel, 2011; Howells, 2006). Although we know that the actors involved in the knowledge integration process are important and that more proximate actors may build a more fruitful collaboration (Hansen, 2014; Steinmo & Rasmussen, 2016), few studies have examined the actual collaboration between research centre directors and the firms' contact persons, who operate and mediate between the firm and the universities.

To benefit from UIC, companies should coordinate the knowledge of the individuals that represent the companies in the collaboration (Johansson, Axelson, Enberg & Tell, 2011). In the case of sustainable innovation, this is important to combine expertise from various disciplines. We follow these lines of research on the individual level, exploring how firms, their contact persons and the centre director engage in UIC and overcome challenges to foster sustainable innovations through knowledge integration. The integration process is influenced by existing knowledge integration capabilities within the firm, defined as "the attributes which enable integration to be performed" (Berggren et al., 2011, p. 9). However, it should be noted that these roles also indicate the existence of boundary spanning.

12.2.3 Middle managers as boundary spanners

The role of middle managers is to integrate the top-down and bottom-up approaches into a middle-up-down management (Nonaka, 1994, p. 30). While accepting the right for top management to articulate broad visions and strategies, middle managers

translate these guiding principles into concepts and frameworks that are relevant for frontline workers and lower-level managers. At the same time, middle managers help to formulate the tacit knowledge that workers possess and act as catalysts for knowledge creation for sustainable innovation by being central in sharing and transforming explicit and tacit knowledge throughout the company. Their role is to bring people with specialized knowledge and different team affiliations together to share and develop new knowledge of sustainability. Thus, middle managers act as boundary spanners, defined as “links between a unit and its environment” (Haas, 2015, p. 1034), by connecting people externally and within the organization.

The similar importance of middle managers was also described in a later articulation of leadership in organizational knowledge creation by von Krogh and Nonaka (2012). Their literature review demonstrated a clear tendency to focus on top management, and thus centralized leadership, as opposed to the importance of middle managers and more distributed leadership (von Krogh et al., 2012, pp. 251–252). Second, while distributed leadership activities act as catalysts to developing new knowledge by making tacit knowledge more explicit and connect and encourage participants to share knowledge, centralized leadership provide assets to realize new knowledge; design and implement systems, rules, and procedures; and formulate visions and strategies to connect the existing operation with new knowledge. As demonstrated by Nonaka (1994), different levels in the organization have different roles and responsibilities for developing new knowledge. The lower level of the organization possesses a tremendous amount of tacit knowledge, top management develops explicitly formulated visions and strategies, and middle managers act as boundary spanners and integrators between the other layers.

12.3 Methodology

12.3.1 Research design

We conducted an inductive, longitudinal, qualitative study to gain in-depth insights of how industry and university partners integrate knowledge in university–industry research centres working on sustainability. A multiple-case study of six research centres was used to build a multilevel model of knowledge integration in research centres (Yin, 2009). To obtain a precise account of the specific collaborations, the research centre was the unit of analysis, relying on viewpoints from firm and university partners.

12.3.2 Case selection

The research question was addressed through a dataset of six Norwegian technological CEERs operating from 2009 to 2017. The six centres focused on CO₂ storage, bioenergy, zero-emission buildings, offshore wind energy (two centres), and solar cell technology. Hence, most research centres were based in new, immature industries. The centres had multiple sources for financing, where the Research Council of Norway contributed up to 50% of the annual budget and industry and university partners contributed approximately 25% each. Each centre had an annual budget of approximately 30 million NOK (Research Council of Norway, 2008).

12.3.3 Data collection

The main dataset consisted of 91 interviews with industry and university partners from the 6 research centres, collected in 2 interview rounds (2013 and 2015). Secondary data, including the initial project description, evaluation reports, and annual reports for the research centres, were collected to prepare for the data collection process and to improve the authors' understanding of the context of the study (Alvesson & Sköldbberg, 2009).

The centre directors or centre managers were initially contacted for an interview and permission to study their CEER. After this interview, snowball sampling was conducted by asking for the most involved university and industry representatives, as actively participating actors are the ones who drive the development of research centres (Jarvenpaa & Valikangas, 2016; Mora-valentin, Montoro-sanchez & Guerras-martin, 2004).

The interviews were retrospective and semi-structured, covering themes like the respondents' work background, the initial stages of planning of the centre activities, the rate of involvement and the respondents' expectations at that stage. Further, the interview covered their experiences with the collaboration processes, innovation activities, suggestions for improvements and their views on future collaboration. Through this process, the informants' narrative views were obtained (Gephart, 2004). By considering the different perspectives of the informants, we designed and relied upon two separate interview guides: one for industry employees and one for university scientists. With an emphasis on situational details unfolding over time, we obtained an in-depth description of the collaboration processes (Gephart, 2004). The interviews were always conducted with two or more researchers to minimize interviewer bias.

12.3.4 Data analysis

A voice recorder was used during the interviews, which made it possible to transcribe the interviews verbatim for further analysis (Alvesson, 2011). Primary or raw interpretations were made before, during and after the interviews and later in the research process. These raw interpretations inspired, developed, and reshaped theoretical ideas during the research process (Alvesson & Sköldbberg, 2009). A qualitative analysis software (NVivo 10) was used to code and categorize the data. The coding began with a careful reading of the interviews line by line, naming and coding the empirical material. We focused on what the university and industry partners experienced as barriers or enablers of knowledge integration in the research centres. During this process, we determined which conditions are necessary for knowledge integration at the individual level in the research centres and how strategies frame these activities. We discussed the coding procedure extensively to increase the rigour of the analytical generalization of the empirical data.

In the coding process, we used inductive codes and followed Gioia et al.'s (2013) method. First, we identified similar codes and clustered them in first-order categories before searching for linkages among the categories (Saldaña, 2013), which led to the development of second-order analytical themes (Nag & Gioia, 2012). Triangulation of the data sources was applied by comparing the interview data with secondary data, including reports, newsletters, press releases and websites. Next, we reviewed the literature once more to identify theoretical concepts that could explain and elaborate upon the findings (Eisenhardt, Graebner & Sonenshein, 2016) to contribute to theory development (Miles, Huberman & Saldaña, 2014). The coding structure for this chapter is provided in Figure 12.1.

12.4 Empirical findings

The findings are presented in three sections. First, we present how the research centres were typically organized. Then, we present the findings regarding knowledge integration activities at the individual level. Finally, the industry partners' involvement in knowledge integration at the strategic level is described.

12.4.1 Organizing the CEER research centres

As part of the CEER scheme, the Norwegian government's Research Council provided clear recommendations for how the research centres should be organized so that they could generate sustainable innovations. This resulted in very similar organizational arrangements among the research centres.

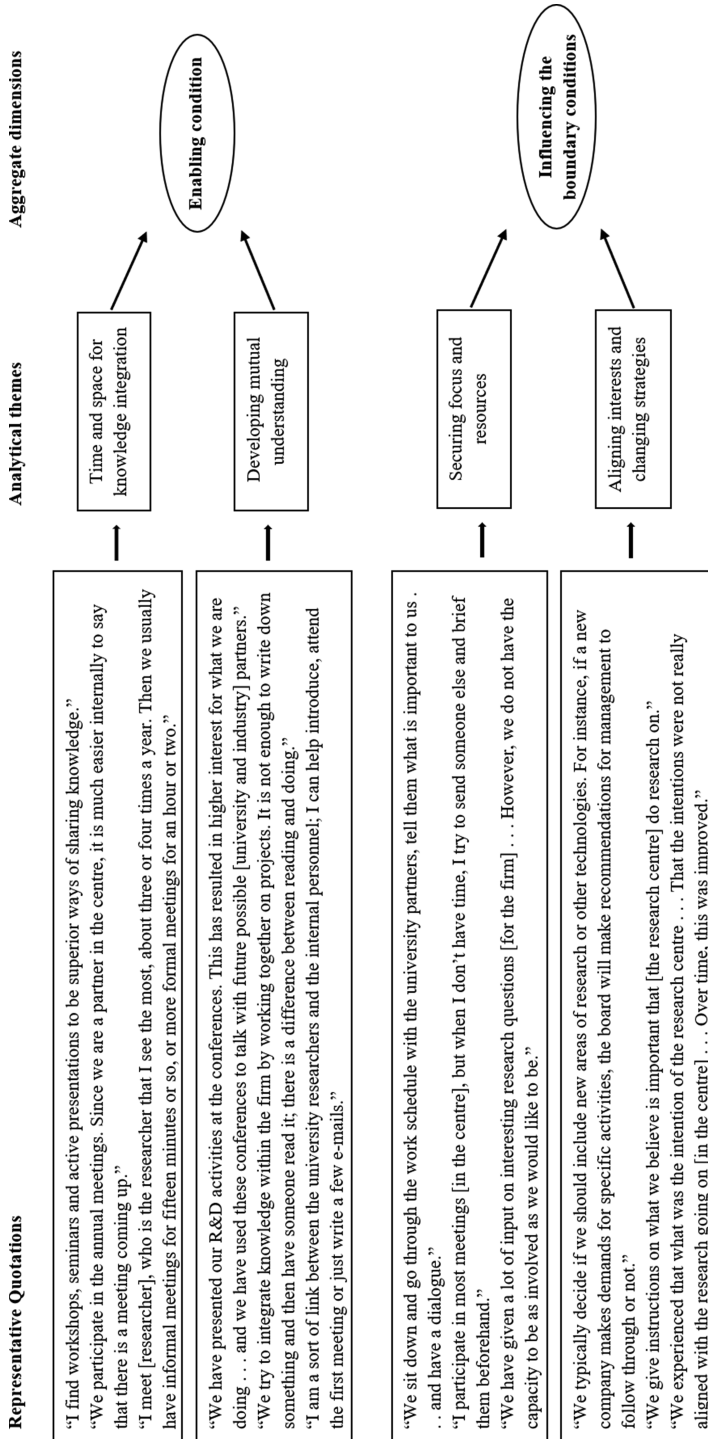


Figure 12.1: The coding structure.
Source: Authors' own elaboration.

The participants came either internally from universities or externally from industry companies or policy organizations (called industry partners). The number of university partners ranged from three to eight, and the number of industry partners ranged from five to twenty. All research and industry partners had representatives in the general assembly, which is the main decision body that meets annually. The general assembly is responsible for approving new partners and deciding on changes to the executive board after the initial agreement drawn up in the consortium agreement. The board is responsible for approving allocation of the budget to the various research activities outlined in the research centre application. It also approves the annual report and all research implementation plans and follows up on the sustainable innovation development process. The industry partners held the majority in the executive boards and typically the chair position as well, meeting at least twice a year.

The centre director was usually the most important driving force in the research centres. Normally he/she would be highly involved in the formulation of the research centre application, including the vision, goals, and scope of the research activities. The centre director often had the responsibility of recruiting research and industry partners and managed the day-to-day operationalization in the research centre. The goals and deliveries of the research centre were formulated in the application, where the research activities had been organized in different research areas or work packages (WP), with one researcher serving as the WP leader. Much of the budget was allocated to specialized research groups expected to deliver research on the topics described in the application. These research groups were often so specialized that it would be difficult to move them from one WP to another. Together with the centre director and other administrative centre resources, the WP leaders constituted the centre management team, meeting at least six times a year.

Each industry partner would normally have one individual acting as the contact person. This contact person would usually be informed about the various meetings and activities in the centre. Sometimes the contact person also held a position on the board, but the industry partner could also be represented by another individual from the firm. In some of the research centres, one researcher acted as the research sponsor for an industry partner, with expectations of regular communication with the contact person. In principle, each WP should be filled with active researchers collaborating with the industry partners to achieve the goals set by the various deciding bodies (Lauvås & Steinmo, 2019). However, variations in how well the different WPs functioned, even within the same research centre, were significant.

12.4.2 Enabling knowledge integration at the individual level to achieve sustainable innovation

12.4.2.1 Time and space for knowledge integration

The challenge is if and how the industry partners have the capacity to be integrated [in the research centre]. It is a matter of how we communicate together. – University partner

This quote illustrates that, on the individual level, it can be challenging to achieve effective knowledge integration, as this requires significant time and interaction. University and industry partners explained that they often need 3–4 years to learn how to integrate their knowledge effectively through interaction. As one industry partner stated,

We do not always know what we should ask for; that is why we need to collaborate with someone with top competence [university partners], because we [the industry] does not always understand the questions. We must interact with someone . . . However, if they [the university partners] stay ‘too far’ within their offices with their top competence, we would not call them up, because we do not know how to use them. – Industry partner

It takes time for the industry partners to figure out what they should ask for and what the university partners can deliver knowledge input on, and they need time to interact and work together to solve issues. This is time-consuming and demanding because of the lack of time available to hold meetings within the research centre. Although most of the industry partners emphasized that physical meetings are very important, they struggled to find time to prioritize these meetings. The industry partners further highlighted that physical meetings create better discussions than by using different types of information and communications technologies. The discussion of further use of research results is considered far more effective in person than via phone or email.

12.4.2.2 Developing mutual understanding

A lot of interaction is needed to understand the tacit knowledge of each partner, which is necessary to enable the creation of sustainable innovations. During formal meetings in the research centre, some industry partners discovered knowledge gaps that they had not managed to fully articulate. The university and industry partners in the CEER scheme have, to varying degrees, managed to carry out knowledge integration at the individual level. In some of the research centres, the university partners have primarily been concerned about and focused on conducting research on their own to create academic knowledge disseminated through academic presentations, publications, and reports. All of these documents and publications are available for all parties on an intranet page for each research centre. However, many industry

partners do not refer to this page, and some do not read published materials at all. Consequently, some university partners wondered whether the industry partners have the capacity to be involved. A quote by a university partner elaborates this: We write rather detailed publications, but a lot of partners do not read these. They need to get this knowledge input in another way.

Even though the industry partners generally did not read published works, little was done in some research centres to mend this gap in the first three to four years. This indicates that for some research centres, the transfer processes have not been effective, resulting in little knowledge integration with the industry partners and limited development of sustainable innovations. Some of the research centres adopted the role of research sponsors, with one university researcher being responsible for day-to-day contact with the industry partners. The feedback from the industry partners in these centres was unanimously positive. However, some industry partners managed to take advantage of the published academic work:

The research centre serves as a 'filter' that filtrate research results to us. In this way, we [the industry partner] avoid being the only one that "translate" external research results into manageable and relevant knowledge for the company. The research centre does the first "screening" of academic work, and that has been a big advantage for us. – Industry partner

In other research centres, some university partners felt that industry partners shared to little information, making it difficult to understand and plan for research that meets the industry partners' needs: "Some industry partners have a lot of related research questions and activities, but of which they don't inform or discuss with us . . . that information could create important synergies, important for building a strong knowledge base in the centre."

Such companies were supposedly afraid of exposing trade secrets. Consequently, some university partners did not have enough insight into the industry partner's strategic challenges, which made it difficult to conduct research activities that were strategically important for the industry partners and that could develop sustainable innovations. This created a negative spiral of collaboration, because if the activities were not perceived as strategically important, it was much more difficult to involve industry representatives and get them to show up at meetings and contribute their knowledge. However, in the centres with high levels of industry participation, a more positive atmosphere with higher levels of knowledge integration was observed, as a university partner stated, "I believe the centre meetings has an important role for increased sharing of knowledge in [sustainable energy area] in Norway." An industry partner affirmed this statement: "Seminars, workshops and active discussions are really valuable in increasing the knowledge in the whole industry."

12.4.2.3 Enabling conditions for knowledge integration

Successful knowledge integration involves the combination of industry employees and university scientists collaborating to develop new knowledge for sustainability. As demonstrated, getting the two groups to collaborate was dependent on their mutual understanding of each other's needs and ways of working. This takes time and usually requires face-to-face meetings. Face-to-face meetings could be organized either as a centre-level event like the annual conference, or at a more local-level event with fewer participants organized by different WPs. Both events helped increase the mutual understanding between industry employees and university scientists, at a more overall or specialized field of knowledge respectively.

The centre director could encourage WP meetings to bridge the gap between university and industry employees, and he/she could also help with translating their various needs. Connecting the right people was usually done through a collaboration between the centre director, who has a good overview of the university researchers, and the industry contact person, who knows the employees in his/her organization. The contact person had a similar role in involving the right people from their organization and helping to translate research publications, sometimes jointly with the research sponsor. However, the industry employees usually worked in a day-to-day operationalizing strain in their own organization, making them short on time and in need of prioritizing the most value-adding activities for sustainability.

12.4.3 Enabling knowledge integration at the strategic level to achieve sustainable innovation

12.4.3.1 Securing focus and resources

In the initial phases, most of the industry partners were rather passive, with a “wait-and-see” attitude. Consequently, many industry partners did not influence the research centre application or the first annual research activity implementation plans. This made the initial research activities decoupled from the strategic areas of importance to many of the industry partners. This indicates a mismatch where the type of boundary faced does not match the type of process used (Carlile, 2004). Consequently, some of the industry actors expressed worry that the publication measurement system prevailed, with few incentives for the university partners to interact with the industry. Hence, many of the industry partners were disappointed with the results flowing out from the research centre: “We do not find that much of the publications, and the knowledge produced [in the centre] is relevant, but we also have realised that we need to be more engaged to get more relevant outputs [from the centre].”

The most prominent reason for the lack of involvement was a lack of resources and/or time. It should also be noted that in the more successful cases, more than one person from the industry partner worked towards the research centre. The contact person received a lot of information and invitations to activities in the research centre, but if he/she did not have the time or resources to involve others, many opportunities were missed. This quote from an industry partner provides an example: “We had no time; we had just invested [a large amount of money] in our factory. The investment seized all our organisational resources.” Many informants acknowledged that their own effort and time was needed to gain the necessary benefits from the collaboration. For some industry partners, the internal strategic objectives could also be very challenging: “I struggle to manage a very operative organisation, and at the same time keeping a focus on research activities.”

However, not all industry partners were passive at the start or experienced dissatisfaction with the collaboration and the results flowing out from the research centre. Companies with their own research divisions and well-defined research strategies were able to influence the research areas and targets. One industry partner actually left the research centre due to shortcomings in their own research strategy, but after an extensive internal process that led to a reformulated strategy, they re-joined the centre. Another industry partner was deeply involved from day 1: We joined the research centre because it is of strategic importance for us. . . and we discussed with the centre management . . . what we saw as important research areas . . . and the centre has produced a lot of knowledge . . . of which some are implemented into our [firm] operations.

12.4.3.2 Aligning interests and changing strategies

As the process continued, most of the companies recognized the possibilities inherent in the research centres. With that understanding, some industry partners proposed research areas of strategic importance for their firms’ sustainability. The limitations of the research centres’ structure then emerged, as the research activities and WPs were largely fixed to uttered dissatisfaction for some industry partners: “The research centre was established five to six years ago, and the research focus was set. However, since then, the environment that we [the industry] operates in has changed completely. . . Therefore, the research focus could have been more flexible.”

The industry partners could influence the research activities at two levels. First, the board could prioritize the research activities and other strategic directions. Although the overall research focus was already defined in the research centre application, there was some room to include new areas of research if the budget resources were available. However, there was a considerable degree of variation in the flexibility of the strategic research focus between the different research centres, as indicated by an industry partner: “If a firm requests or demands specific research

activities, the centre board would discuss, and recommend if the centre management should carry this out or not.”

Second, industry partners could influence the research activities at the WP level through more informal communication with university researchers at an individual or group level. Defining a relevant research activity for the industry partner usually started with communication between the contact person from the industry partner and the centre director, often when they were recruited as partners but also on a more ongoing basis. Sometimes it was straightforward: “In the process of enrolling the research centre, we discussed our research needs with the centre manager, and he thought it would be doable.” Sometimes it was a lengthier process:

After we enrolled [the research centre] . . . we attended the annual conference. After that, we had some discussions with the centre director, before attending other events, such as WP meetings . . . Over time, we understood what kind and type of research that were taking place in the centre . . . At a seminar, we presented our firm, and the centre management grasped what was important to us. Next, together with the centre director, we looked into how the existing research activities could be altered to increase the relevance for us. – Industry partner

Central in these processes was the centre director, who was responsible for the formalities in the research centre, such as the budget, annual reporting to the research council, and calling meetings for the general assembly, the board and the research management team. Often, the centre director had the best overview of the active researchers in the centre as well as the greatest general understanding of the needs and challenges facing the various industry partners. The centre director, together with contact persons from the industry partners, was highly involved in the formulation of the overall research activities and the formal strategic discussion in the board but also connected the industry partners with the right university scientists. However, there was a need for the centre director to find a balance of attuning the different needs between the university partners and industry partners: “There is quite a lot of feedback on what the industry want us to focus on. Then the case is if this is something the university partners actually have competence on, and if they want to focus on this issue. This is an interactive . . . and dynamic process.”

12.4.3.3 Influencing the boundary conditions

There were some obstacles to initiating the collaboration. Because the research centre and the university scientists are measured by the number of articles they publish, they are not inclined to spend much time on activities that are not relevant to the publication process or activities defined in the research plan, like being a research sponsor or producing summaries for policymakers. The centre director could advocate for the university scientists to be more engaged with the industry partners. Site visits, meetings, serving as a research sponsor and doing more hands-on technological development

work were common in the research centres. However, the latter is dependent on the flexibility in the research activities in the research centre. It was not uncommon for all funding to be distributed to the different university partners without having much room for moving resources.

Additionally, some industry partners were satisfied with just donating money for research without draining too much of the time resources of their employees. The industry partner would give permission to spend more time if the activity was within their strategic focus and in line with the strategic research focus of the research centre. Many of the contact persons were part of the boards of the research centres or were at least present at the annual general assembly. Part of the formal structure and responsibility of the board was to give advice on the planned research activities. These activities were mainly decided by the research focus chosen in the research centre application and organized in different WPs led by university scientists. However, we observed that some research centres were flexible enough to adapt their research plans after discussions with the board and the centre director.

12.5 The important role of boundary spanners enabling knowledge integration and sustainable innovations

Based on these data, we highlight a few key elements. In Figure 12.2, we have placed the university partners on the left and the industry partners on the right. We have highlighted the academic centre director and the different contact persons from the industry partners.

Successful knowledge integration at the individual level between university scientists and industry employees, which is necessary to develop sustainable innovations, depends on an enabling context with mutual understanding and sufficient time to work together (Lauvås & Steinmo, 2019). The centre director and the contact persons can facilitate the collaboration, but both depend on securing the necessary resources. The centre director should remind scientists to broaden their focus to more than just publications, while the contact persons need acceptance from the top management in their firm to engage employees to work towards the research centre.

In cases where the strategy of the industry partner does not fit the strategy of the research centre, the academic centre director together with the board would come up with suggestions and make necessary changes to make the research relevant for the industry partner. Failing to adjust could result in a dissatisfied industry partner who is more reluctant to spend their resources on the collaboration, which may eventually lead to firms dropping out of the research centre (Gray, Lindblad & Rudolph, 2001).

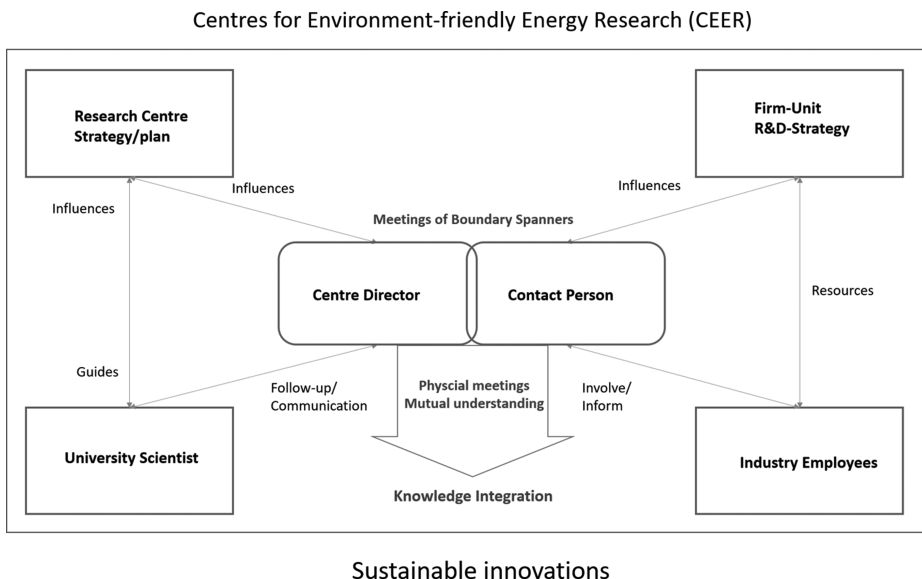


Figure 12.2: Boundary spanners enabling knowledge integration and sustainable innovation.
Source: Authors' own elaboration

The central boundary spanners are the centre director and the firms' contact persons, who connect people and strategies through formal and informal meetings. Their main task is to influence the boundary conditions to align different interests and secure resources to enable knowledge integration at the individual level. The empirical material we have presented highlights the role of the centre director and the contact persons as boundary spanners within the context of UIC for sustainable innovation. The existing literature on knowledge integration has mainly focused on the integration of knowledge held by individuals (Berggren, Bergek, Bengtsson & Söderlund, 2011) without considering how strategies frame and influence the opportunities for knowledge integration. We have therefore referred to the works by Nonaka (1994) and von Krogh et al. (2012), which emphasize how strategies formulated by top management contribute to securing resources for developing new knowledge.

Based on the research of Nonaka (1994) and von Krogh et al. (2012), we can recognize the dual function of the academic centre director and the contact persons as offering both centralized and distributed leadership. The latter is visible when they assist with the knowledge creation process by making tacit knowledge explicit, and the former is apparent when they adapt formulated strategies and secure resources for knowledge collaboration. Our findings support the importance of middle managers in knowledge integration and creation and their role of integrating people and strategies to enable knowledge integration for sustainable innovations.

This chapter is an initial answer to the call for in-depth case studies and inductive analyses of knowledge integration and sustainable innovation as a collaborative effort (Tell, 2011). Figure 12.2 shows many of the elements that are necessary for knowledge integration in UIC and depicts many of the underlying processes and activities that are necessary to accomplish knowledge integration and sustainable innovations. The figure can also be read as an illustration of the difficulties in achieving valuable collaborations, the necessary interplay with actors at several levels and the need for interaction and communication that facilitate knowledge integration (Okhuysen & Eisenhardt, 2002).

Hence, our study adds to the few longitudinal studies of research centres (Lind et al., 2013; Rass et al., 2013) by illustrating the organizational dynamics of knowledge integration (Tell, 2011) underlying UIC (Perkmann & Walsh, 2007). Figure 12.2 expands existing research in knowledge integration literature by illustrating the knowledge integration process as a multilevel phenomenon in the specific context of technology-based innovation (Berggren et al., 2011) aimed at achieving sustainability.

12.6 Conclusion

Sustainable innovation often depends on getting specialists from different fields to work together to integrate and create knowledge (De Marchi, 2012). This chapter shows some of the obstacles that such collaboration raises and some of the elements that connect the obstacles. We have emphasized the role of the centre director and the contact persons as boundary spanners who integrate people and strategies.

As demonstrated in the literature review, the links between university–industry and innovations have been extensively studied. However, our study contributes to a growing need to understand the organizational dynamics underlying these relationships and how to better utilize UIC (Perkmann & Walsh, 2007) to develop sustainable innovations. Although attempts have been made to develop frameworks that resolve the challenges of knowledge integration in UIC, a more detailed understanding of how problems with collaboration and coordination can be improved is needed (Johansson et al., 2011).

Our chapter extends prior research on UIC and knowledge integration in research centres by clarifying several elements that either help or hinder the integration of diverse knowledge in research centres. We show that knowledge integration is a multilevel phenomenon conducted by individuals (Berggren et al., 2011) but dependent on the strategies of both the research centre and the industry partners. In particular, we provide valuable insights of how academic centre directors and firms' contact persons can collaborate to secure favourable conditions and necessary resources for more successful knowledge integration between university and industry that may lead to sustainable innovations.

12.6.1 Implications

Although participating in research centres may be rewarding for the development of sustainable innovations, it is often challenging for industry partners to take full advantage of the knowledge created in the research centres, particularly if the new knowledge is diverse from the companies' well-established knowledge bases (Howells, Ramlogan & Cheng, 2012). Companies' ability to integrate knowledge within the firm, as well as between the firm and external actors such as universities, has a major influence on companies' innovative capability (Lazonick, 2005). Our findings indicate that to fully take advantage of the knowledge developed within the research centres and to increase the potential for sustainable innovations, companies should focus on knowledge integration at the strategic and individual levels. Without a strategy that fits the research centre, it is more difficult to secure the necessary resources to actively participate in the collaboration. Choosing a contact person with the right competence, networks, and time to be the catalyst for knowledge integration is essential, especially since many firms often involve only one person to work with the centre, as indicated by Santoro and Chakrabarti (2002).

University scientists should consider the centrality of the academic centre director in uniting the interests of all partners. The centre director should thus have excellent scientific knowledge, including a good overview of the field, but also be well attuned to the needs of the industry partners. Allocating sufficient funds to arranging physical meetings at both the centre level, like annual conferences, and shorter and more focused events at the WP levels to promote mutual understanding is also important. When establishing the research centre, it is vital that the board be capable of handling continuously shifting strategic needs, securing room for flexibility in budget allocation and efficiently utilizing university scientists as resources. Recognizing the importance of the industry partners' strategies early in the process should be prioritized because industry partners will be reluctant to spend more resources if there is not a good fit. Hence, contact should be made with industry partner management, representing both distributed and centralized leadership (von Krogh et al., 2012) to secure the necessary resources for performing the actual knowledge integration.

12.6.2 Final remark

We would like to emphasize that industry partners can benefit from participating in UIC, even without having all the components in place. It is possible to achieve some knowledge integration through collaborative research activities that occur daily on the individual level without having aligned strategic interests, without flexible research plans in the research centre, without a centre director with good overview, without an active contact person, without mutual understanding, without someone

to translate scientific publications and without having much time to collaborate, but it will be more challenging to do so. Knowledge integration is a complex process in UIC, but it is eased with key persons acting as boundary spanners to promote favourable boundary conditions through doing both centralized and distributed leadership. Together with mutual understanding, these favourable boundary conditions align different interests and secure resources to enable knowledge integration contributing to sustainable innovations.

References

- Ahuja, G., Lampert, C. M. & Tandon, V. (2008). Moving Beyond Schumpeter: Management Research on the Determinants of Technological Innovation. *The Academy of Management Annals*, 2, 1–98.
- Alvesson, M. (2011). *Interpreting interviews*. London: Sage.
- Alvesson, M. & Skoldberg, K. (2009). *Reflexive methodology: New vistas for qualitative research*. London: Sage.
- Berggren, C., Bergek, A., Bengtsson, L. & Söderlund, J. (2011). Exploring knowledge integration and innovation. In Berggren, C., Bergek, A., Bengtsson, L., Hobday, M. & Söderlund, J. (eds.), *Knowledge integration & innovation: Critical challenges facing international technology-based firms*, 3–19. Oxford: Oxford University Press.
- Bishop, K., D’este, P. & Neely, A. (2011). Gaining from interactions with universities: Multiple methods for nurturing absorptive capacity. *Research Policy*, 40, 30–40.
- Boardman, P. C. & Gray, D. (2010). The new science and engineering management: Cooperative research centers as government policies, industry strategies, and organizations. *The Journal of Technology Transfer*, 35, 445–459.
- Bodas Freitas, I. M., Geuna, A. & Rossi, F. (2013). Finding the right partners: Institutional and personal modes of governance of university–industry interactions. *Research Policy*, 42, 50–62.
- Brunel, J., D’este, P. & Salter, A. (2010). Investigating the factors that diminish the barriers to university–industry collaboration. *Research Policy*, 39, 858–868.
- Carlile, P. R. (2004). Transferring, Translating, and Transforming: An Integrative Framework for Managing Knowledge across Boundaries. *Organization Science*, 15, 555–568.
- Chai, S. & Shih, W. (2016). Bridging science and technology through academic–industry partnerships. *Research Policy*, 45, 148–158.
- Cohen, W. M., Nelson, R. R. & Walsh, J. P. (2002). Links and impacts: The influence of public research on industrial R&D. *Management Science*, 48, 1–23.
- Eisenhardt, K. M., Graebner, M. E. & Sonenshein, S. (2016). Grand challenges and inductive methods: Rigor without rigor mortis. *Academy of Management Journal*, 59, 1113–1123.
- Galán-muros, V. & Plewa, C. (2016). What drives and inhibits university-business cooperation in Europe? A comprehensive assessment. *R&D Management*, 46, 369–382.
- Gassmann, O., Daiber, M. & Enkel, E. (2011). The role of intermediaries in cross-industry innovation processes. *R&D Management*, 41, 457–469.
- Gephart, R. P. (2004). Qualitative research and the academy of management journal. *Academy of Management Journal*, 47, 454–462.
- Gioia, D. A., Corley, K. G. & Hamilton, A. L. (2013). Seeking qualitative rigor in inductive research: Notes on the gioia methodology. *Organizational Research Methods*, 16, 15–31.

- Grant, R. M. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal*, 17, 109–122.
- Gray, D. O., Lindblad, M. & Rudolph, J. (2001). Industry–university research centers: A multivariate analysis of member retention. *The Journal of Technology Transfer*, 26, 247–254.
- Gulbrandsen, M., Mowery, D. & Feldman, M. (2011). Introduction to the special section: Heterogeneity and university–industry relations. *Research Policy*, 40, 1–5.
- Gulbrandsen, M., Thune, T., Borlaug, S. B. & Hanson, J. (2015). Emerging hybrid practices in public–private research centres. *Public Administration*, 93, 363–379.
- Haas, A. (2015). Crowding at the frontier: Boundary spanners, gatekeepers and knowledge brokers. *Journal of Knowledge Management*, 19, 1029–1047.
- Hansen, T. (2014). Juggling with proximity and distance: Collaborative innovation projects in the danish cleantech industry. *Economic Geography*, 90, 375–402.
- Hasselmo, N. & Mckinnell, H. (2001). *Working together, creating knowledge: The university-industry research collaborative initiative*. Washington, DC: Business-Higher Education Forum.
- Hessels, L. K., Wardenaar, T., Boon, W. P. C. & Ploeg, M. (2014). The role of knowledge users in public–private research programs: An evaluation challenge. *Research Evaluation*, 23, 103–116.
- Howells, J. (2006). Intermediation and the role of intermediaries in innovation. *Research Policy*, 35, 715–728.
- Howells, J., Ramlogan, R. & Cheng, S.-L. (2012). Innovation and university collaboration: Paradox and complexity within the knowledge economy. *Cambridge Journal of Economics*, 36, 703–721.
- Hussler, C., Picard, F. & Tang, M. F. (2010). Taking the ivory from the tower to coat the economic world: Regional strategies to make science useful. *Technovation*, 30, 508–518.
- Jakobsen, S., Lauvås, T. A. & Steinmo, M. (2019). Collaborative dynamics in environmental R&D alliances. *Journal of Cleaner Production*, 212, 950–959.
- Jarvenpaa, S. L. & Valikangas, L. (2016). From governance void to interactive governing behaviors in new research networks. *Academy of Management Discoveries*, 2, 226–246.
- Johansson, M., Axelson, M., Enberg, C. & Tell, F. (2011). Knowledge integration in inter-firm R&D relationships: How do firms balance problems of coordination with problems of cooperation?. In Bergek, A., Hobday, M., Berggren, C., Bengtsson, L. & Sö Derlund, J. (Eds.), *Knowledge integration and innovation: Critical challenges facing international technology-based firms*, 148–169. Oxford University Press, Oxford.
- Laurson, K. & Salter, A. (2004). Searching high and low: What types of firms use universities as a source of innovation?. *Research Policy*, 33, 1201–1215.
- Lauvås, T. & Steinmo, M. (2019). The role of proximity dimensions and mutual commitment in shaping the performance of university-industry research centres. In *Innovation* (pp. 1–27).
- Lazonick, W. 2005. The innovative firm. In: J. Fagerberg, Mowery, D. C. & Nelson, R. R. (eds.) *The Oxford Handbook of Innovation*, 29–55. Oxford: Oxford University Press.
- Leonard-barton, D. (1995). *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Boston: Harvard Business School Press.
- Lind, F., Styhre, A. & Aaboen, L. (2013). Exploring university-industry collaboration in research centres. *Innovation*, 23, 182–208. <https://www.tandfonline.com/doi/abs/10.1080/14479338.2019.1662725>
- Marchi, D. E. (2012). Environmental innovation and R&D cooperation: Empirical evidence from Spanish manufacturing firms. *Research Policy*, 41, 614–623.
- Miles, M. B., Huberman, A. M. & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook*. Los Angeles: Sage.
- Mora-valentin, E. M., Montoro-sanchez, A. & Guerras-martin, L. A. (2004). Determining factors in the success of R&D cooperative agreements between firms and research organizations. *Research Policy*, 33, 17–40.

- Mowery, D. C. & Sampat, B. N. (2005). Universities in national innovation systems. In Fagerberg, J., Mowery, D. C. & Nelson, R. R. (eds.), *The oxford handbook on innovation*, 209–232. Oxford: Oxford University Press.
- Nag, R. & Gioia, D. A. (2012). From common to uncommon knowledge: Foundations of firm-specific use of knowledge as a resource. *The Academy of Management Journal*, 55, 421–457.
- Nonaka, I. (1994). A dynamic theory of organizational knowledge creation. *Organization Science*, 5, 14–37.
- Okhuysen, G. A. & Eisenhardt, K. M. (2002). Integrating Knowledge in groups: How formal interventions enable flexibility. *Organization Science*, 13, 370–386.
- Perkmann, M. (2017). How Boundary Organizations Facilitate Collaboration across Diverse Communities. In Tell, F., Berggren, C., Brusoni, S. & van de Ven, A. (eds.), *Managing knowledge integration across boundaries*, 155–170. Oxford: Oxford University Press.
- Perkmann, M. & Walsh, K. (2007). University–industry relationships and open innovation: Towards a research agenda. *International Journal of Management Reviews*, 9, 259–280.
- Ponomariov, B. L. & Boardman, P. C. (2010). Influencing scientists' collaboration and productivity patterns through new institutions: University research centers and scientific and technical human capital. *Research Policy*, 39, 613–624.
- Postrel, S. (2002). Islands of Shared Knowledge: Specialization and Mutual Understanding in Problem-Solving Teams. *Organization Science*, 13, 303–320.
- Raesfeld, A. V., Geurts, P., Jansen, M., Boshuizen, J. & Luttge, R. (2012). Influence of partner diversity on collaborative public R&D project outcomes: A study of application and commercialization of nanotechnologies in the Netherlands. *Technovation*, 32, 227–233.
- Ranga, L., Debackere, K. & Tunzelmann, N. (2003). Entrepreneurial universities and the dynamics of academic knowledge production: A case study of basic vs. applied research in Belgium. *Scientometrics*, 58, 301–320.
- Rass, M., Dumbach, M., Danzinger, F., Bullinger, A. C. & Moeslein, K. M. (2013). Open innovation and firm performance: The mediating role of social capital. *Creativity and Innovation Management*, 22, 177–194.
- Research Council of Norway. (2008). *Centres for Environment-friendly Energy Research (CEER). Description of the CEER scheme* [Online]. Oslo. [Accessed 15.07.2017].
- Rosenkopf, L. & Nerkar, A. (2001). Beyond local search: Boundary-spanning, exploration, and impact in the optical disk industry. *Strategic Management Journal*, 22, 287–306.
- Saldaña, J. (2013). *The coding manual for qualitative researchers*. Los Angeles: Sage.
- Santoro, M. D. & Chakrabarti, A. K. (2002). Firm size and technology centrality in industry–university interactions. *Research Policy*, 31, 1163–1180.
- Smith, P. (2012). Where is practice in inter-organizational R&D research? A literature review. *Management Research*, 10, 43–63.
- Steinmo, M. & Rasmussen, E. (2016). How firms collaborate with public research organizations: The evolution of proximity dimensions in successful innovation projects. *Journal of Business Research*, 69, 1250–1259.
- Styhre, A. & Lind, F. (2010). Balancing centripetal and centrifugal forces in the entrepreneurial university: A study of 10 research centres in a technical university. *Technology Analysis & Strategic Management*, 22, 909–924.
- Szulanski, G. (1996). Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, 17, 27–43.
- Tell, F. (2011). Knowledge integration and innovation: A survey of the field. In Berggren, C., Bergek, A., Bengtsson, L., Hobday, M. & Söderlund, J. (eds.), *Knowledge integration & innovation: Critical challenges facing international technology-based firms*, 20–58. Oxford: Oxford University Press.

- Villani, E., Rasmussen, E. & Grimaldi, R. (2017). How intermediary organizations facilitate university–industry technology transfer: A proximity approach. *Technological Forecasting and Social Change*, 114, 86–102.
- von Hippel, E. (1998). Economics of product development by users: The impact of “sticky” local information. *Management Science*, 44, 629–644.
- von Krogh, G., Nonaka, I. & Rechsteiner, L. (2012). Leadership in organizational knowledge creation: A review and framework. *Journal of Management Studies*, 49, 240–277.
- Yin, R. K. (2009). *Case study research – design and methods*. Thousand Oaks, California: Sage Publications.