



How firms use coordination activities in university–industry collaboration: adjusting to or steering a research center?

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Abstract

University–industry collaboration (UIC) is an important source of knowledge and innovation for firms but is often challenging due to the partners' different goals. Thus, formal research centers have become a key policy instrument to foster stronger UIC whereby strong mutual relationships are created. This study investigates the establishment of a university–industry research center to gain insights into the coordination activities the focal firms used to achieve their goals with UIC. We find that the firms with goals related to specific innovations and technology development took a more active role by using structured coordination activities in the preformation phase of the research center, whereas the firms with goals related to general knowledge development mainly coordinated through unstructured activities when the center began operations. We map the specific coordination activities used in UIC and theorize on how the partners' different organizational goals influenced their use of these activities. Our findings have important implications for how activities in UIC, particularly in research centers, can be designed to strengthen the collaboration between universities and their firm partners to enhance knowledge development and innovation.

Keywords Coordination activities · Firm innovation · Organizational goals · Research centers · University–industry collaboration

1 Introduction

Rapid technological change and globalization have forced firms to accelerate their innovation processes (Burnett & Williams, 2014) and engage in university–industry collaboration (UIC) to enhance technology transfer (Gilsing et al., 2011). While a range of formal and informal UIC linkages that can facilitate knowledge transfer exist (Azagra-Caro

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et al., 2017; Schaeffer et al., 2020), one key linkage is the establishment of formal research centers (Azagra-Caro et al., 2017; Boardman & Gray, 2010; Perkmann & Walsh, 2007). Research centers facilitate formal technology transfer mechanisms through administrative and infrastructural arrangements, such as collaboration contracts and licensing and legal agreements between the partners involved (Azagra-Caro et al., 2017). Research centers also contribute to developing informal technology and knowledge transfer between partners (Ankrah & Al-Tabbaa, 2015; Hayter et al., 2020), for instance through meeting arenas and workshops.

While it is well documented that formal research centers can yield positive firm outcomes (Vega-Jurado et al., 2017), partners often experience challenges that inhibit effective UIC (Ambos et al., 2008; Bruneel et al., 2010; de Wit-de Vries et al., 2018) and technology transfer (Gilsing et al., 2011). These challenges are typically rooted in differences between partners, such as differences in their time and resource allocation, management styles (Morandi, 2013), languages, and goals (Harrison & Klein, 2007; Galán-Muros and Plewa, 2016, Ghauri & Rosendo-Rios, 2016, Holstein et al., 2018). For example, firms often aim to exploit available knowledge to improve their products and processes (Murray and O'Mahony, 2007, Perkmann et al., 2018), whereas university partners aim for scientific novelty (Aghion et al., 2008). When engaging in UIC, firms' goals are often to develop firm-specific knowledge and technologies, while the goals of university partners are related to developing more general knowledge for the public domain (Canhoto et al., 2016; Gilsing et al., 2011).

Prior research has emphasized that firms and university partners often have a diverse set of goals that hamper UIC and technology transfer (e.g. Holstein et al., 2018; Kotlar et al., 2018; Tijssen, 2018). Still, the literature overlooks the behavior and strategies of firms in research centers (Estrada et al., 2016) and how differences in these firms' goals influence the UIC process (de Wit-de Vries et al., 2018). Hence, there is a need to explore how firms' goals influence their decision making and behavior in research centers (Fini et al., 2019).

To explore how firms' goals influence their behavior in research centers, we draw on the organizational goal literature (Gagné, 2018), since goal setting is an important predictor of organizational behavior and decision making (Kotlar et al., 2018). Moreover, we draw on the literature on *coordination mechanisms* which concerns how firms coordinate their actions and behavior in a collaboration with partners (Argote, 1982; Morandi, 2013). By exploring firms' actions and goals during the establishment of a research center, we seek to develop a more comprehensive understanding of *what goals* firms want to achieve in their research partnerships with universities and which strategies they use to achieve these goals. Hence, we ask the following research question: *how do firms' different goals influence their coordination activities in a university–industry research center?*

As establishing goals and coordinating activities are particularly important in the early stages of a research collaboration (Canhoto et al., 2016), we conducted a longitudinal case study of the initial phases of a research center, whereby we followed the coordination activities used by different firm partners with various goals for collaboration. The chosen research center is part of the Norwegian scheme for the Center for Environment-friendly Energy Research (CEER), whose mission is to develop innovations and long-term world-class research related to reducing greenhouse gas emissions (Research Council of Norway, 2016).

Our findings make three key contributions. First, we contribute to the UIC literature by outlining the specific actions firms use to achieve their desired UIC outcomes. We find that the firms that entered the research center with the goal of gaining more specific technological improvements mainly relied on structured coordination activities (e.g., annual meetings

initiated by the center's management), whereas the firms with general goals of research and knowledge development mainly relied on unstructured coordination activities (e.g., ad hoc meetings initiated by the firm partners).

Second, our study in the UIC context provides a unique setting to assess how different firm goals can lead to different firm behavior (Gagné, 2018). By applying organizational goal theory and the literature on coordination mechanisms to the UIC context, we elaborate on how firms with different goals use different strategies to engage in a research center, such as strategies related to steering the research center or adjusting to the research center.

Third, by empirically examining the earliest stages of a research center, our study contributes to the dynamism of the technology transfer literature by providing a novel assessment of the conditions and processes by which formal technology transfer mechanisms may emerge. In sum, our study offers important implications for policy and practice related to the establishment of research centers, indicating that firms' goals for engaging in research centers are an important precondition for what activities these centers should prioritize and how collaboration should be coordinated.

2 Theoretical framework

2.1 University–industry research centers and firms' goals

The overall goal of university–industry research centers is to produce high-quality, long-term research and contribute to the innovativeness and competitiveness of the firms involved (Styhre & Lind, 2010). Although firm and university partners often agree on the overall goals of such centers, translating these goals into specific activities can create conflicts and fluctuating focus between the partners (Ranganathan et al., 2018), which tend to increase when the number of partners is high (Morandi, 2013). Indeed, when entering a research center, firm and university partners often create their own goals and expectations of what they want to achieve (Bruneel et al., 2010), but achieving these different goals simultaneously could be quite challenging (Morandi, 2013).

When entering into UIC, university partners generally have their own goals and expectations (Ranganathan et al., 2018), which mainly relate to scientific novelty (Aghion et al., 2008) and knowledge production for the public domain (Canhoto et al., 2016; Gilsing et al., 2011; Perkmann et al., 2018). However, some university partners focus on goals related to applied research and technological development based on specific firm needs (Tijssen, 2018).

Firms, on the other hand, often enter into UIC with a set of goals related to attaining knowledge and/or advancing innovative efforts (Abramovsky et al., 2009). These sets of goals tend to influence such firms' desired "end state" (Greve, 2008) and are often a combination of "general and long-term" and "concrete and specified" goals (Shah & Kruglanski, 2002). As such, Murray and O'Mahony (2007) found that firms' goals in UIC often relate to attaining specific knowledge related to their internal processes, while Gilsing et al. (2011) found that firms' goals in UIC often focus on appropriating novel technological knowledge that is relevant for their production processes. Other firms may focus on specific technologies (Canhoto et al., 2016) or developing innovations and services (Lam, 2011) by exploiting the knowledge and resources accessible through their university partners (Abramovsky et al., 2009).

Once a firm has decided on its goals (single and/or multiple) for engaging in a research center, it mainly focus its attention and behavior on achieving and steering these goals (Gagné, 2018), which might result in conflicts and misalignments between the firm and its university partners (Ranganathan et al., 2018). Prior literature has devoted much attention to the misalignments between collaborating firm and university partners and how to overcome them (Harrison & Klein, 2007, Galán-Muros and Plewa, 2016, Ghauri & Rosendo-Rios, 2016), for instance, by focusing on research center management (Morandi, 2013), reducing UIC tensions (Steinmo, 2015), and enabling technology and knowledge transfer between the partners (Segarra-Blasco & Arauzo-Carod, 2008). However, this study responds to calls to investigate firms' goals (de Wit-de Vries et al., 2018), the diversity of these goals (Estrada et al., 2016), and the way firms behave when trying to attain these goals (Fini et al., 2019) in UIC by investigating how firms achieve their goals in a research center through coordination activities.

2.2 Firms' coordination activities in a research center

The concept of coordination activities is well established in the management and organization literature, mainly through research on intrafirm organizational management (e.g. Argote, 1982; Malone, 1987; Mom et al., 2009). The concept has also been adapted to interorganizational contexts (Nguyen et al., 2018), such as supply-chain management (Cäker, 2008); national and international markets (Koçak et al., 2014; Piazzai, 2018); networks and strategic alliances (Gulati et al., 2012; Oliveria and Lumineau, 2017); and UIC, where Morandi (2013) studied the management of research centers through coordination activities.

We understand the concept of coordination activities as firms' "*activities toward the aim of... cooperative agreement*" (Morandi, 2013, p. 71), which is well suited for investigating firms' actions in a research center for two main reasons. First, this conceptualization is appropriate because research centers involves a range of partners with different goals, and firms need to coordinate research center activities to achieve their own goals (Morandi, 2013). Second, this conceptualization is apt because unexpected developments may arise over the lifespan of a research center, so firms must be able to adjust to and align with these developments (Schilke & Goerzen, 2010).

To coordinate within a research center, firms can engage in structured and unstructured coordination activities (Claggett & Karahanna, 2018) (see Table 1 for an overview). *Structured coordination activities* are predetermined and established prior to the execution of tasks (Fernandes et al., 2018) and include activities like developing contracts (Oliveira and Lumineau, 2017) and engaging in formal partnerships (Argote, 1982; Willem et al., 2006), scheduled meetings, workshops, and projects (Fernandes et al., 2018; Willem et al., 2006). These activities are often formalized by research center management (Fernandes et al., 2018) through long-term and short-term plans (Fernandes et al., 2018; Willem et al., 2006), work procedures, rules, and policies (Hanisch & Wald, 2014). Structured coordination activities are often beneficial when firms need to establish a clear direction for their goals in a research center (Kim et al., 2003) because such activities contribute to aligning decisions and focusing collaboration toward established goals (Morandi, 2013). Structured coordination activities also contribute to formalizing the tasks needed to achieve established goals (Mom et al., 2009). In sum, firms' engagement in structured coordination activities implicitly steers the respective research center's behavior and enables task completion (Dao & Strobl, 2019).

Table 1 Structured and unstructured coordination activities

	Structured coordination activities	Unstructured coordination activities
Type of activities	Predetermined activities and specified relationships	Ad hoc non-institutionalized activities
Examples	Scheduled meetings and workshops, formal action plans and strategies, contract developments and project developments	Meeting arenas with members involved in the organization, such as workshops, visits, and ad hoc resource allocation
Initiated and implemented by	Research center management	Firms that adjust to the actions and activities implemented by management
Goal	Engagement in formal decision making to reach goals and steer the organization	Informal knowledge sharing between members to reach goals and adjust to the organization

Unstructured coordination activities involve ad hoc actions (Argote, 1982), such as unplanned meetings initiated by firm members (Arenas & Ayuso, 2016), unscheduled resource allocation (Geringer & Hebert, 1989), and informal knowledge sharing between actors (Claggett & Karahanna, 2018). Engaging in unstructured coordination activities is often favorable when dealing with uncertainty (Morandi, 2013), such as explorative goals (Dao & Strobl, 2019). Indeed, when dealing with explorative goals, unstructured coordination activities contribute to knowledge creation, which facilitates decision making and goal achievement (Kim et al., 2003). In addition, unstructured coordination activities help align partners by establishing mutual understanding (Koçak et al., 2014) and facilitating mutual adjustments to develop the focal research center (Danese et al., 2004; Dao & Strobl, 2019). In sum, unstructured coordination activities contribute to firms' ability to collaboratively explore and advance new and radical ideas (Dao & Strobl, 2019; Morandi, 2013) by aligning with and adjusting to the focal research center's development (Danese et al., 2004).

Hence, exploring firms' structured and unstructured coordination activities in UIC is particularly valuable, not only because it is important for researchers to gain a more comprehensive understanding of the coordination between partners in UIC (Morandi, 2013), but also because the multiple firm partners involved in these endeavors have diverse goals, so more knowledge is needed on how firms behave in UIC to achieve their goals (Fini et al., 2019).

3 Research method

3.1 Research design, context, and case selection

To increase our understanding of firms' use of coordination activities and the underlying dimensions of firm behavior and actions in UIC, we conducted a qualitative embedded case study of a research center (Eisenhardt, 1989; Yin, 2014). The embedded case study design provides the ability to examine how firms (subunits) adjust to their goals within the context of a research center (the larger unit) and to analyze these firms both separately and in a cross-case manner (Baxter & Jack, 2008).

The research center in our study is part of the Norwegian scheme for CEER. CEER was established to promote innovation and long-term world-class research related to reducing greenhouse gas emissions (Research Council of Norway, 2016). The research center comprises about 40 partners, including 20 firms, and offers a unique context for gaining an in-depth understanding of firm behavior and actions in UIC (Bruneel et al., 2010; Eisenhardt & Graebner, 2007; Okamuro & Nishimura, 2018; Plewa et al., 2013) through its various data sources, such as the CEER application and annual rapports, meeting documents, and interviews with both firm and university partners.

Our interview sample includes informants from different firms within several heavy industrial sectors who could shed light on our research question and could describe and highlight different perspectives on the focal points of this study (Creswell & Poth, 2017). The chosen firms differ in size, ownership, and R&D experience to provide contextual variety (Yin, 2014) and improve the internal validity of the embedded cases (Creswell & Poth, 2017) (see Table 2).

Table 2 Overview of the embedded cases—firm descriptions

Firms	Industry	Ownership	Size	Type of products	R&D experience
Firm 1	Processing industry	Publicly listed	Large	Raw materials	High: Experience with long- and short-term R&D projects with firm and university partners, internal R&D projects, internal R&D department
Firm 2	Infrastructure industry	Private	Medium	End products	Some: Experience with short-term R&D projects with university partners, some R&D contracting projects, no internal R&D department
Firm 3	Processing industry	Private	Medium	Raw materials	Some: Experience with one long-term R&D project with university partners, some R&D projects with other firms, some short-term R&D projects, no internal R&D department
Firm 4	Infrastructure industry	Private	Micro	End products	Low: Experience with some short-term R&D projects with firm partners, a few R&D contracting projects, no internal R&D department
Firm 5	Energy industry	Publicly listed	Large	Raw materials	High: Experience with long- and short-term R&D projects with firm and university partners, multiple R&D contracting projects, large internal R&D department
Firm 6	Processing industry	Publicly listed	Large	Raw materials	Some: Experience with one long-term R&D project with university partners, some short-term R&D projects with firm and university partners, internal R&D department
Firm 7	Energy industry	Publicly listed	Large	End products	High: Experience with long- and short-term R&D projects with university and firm partners, R&D contracting projects, large internal R&D department
Firm 8	Processing industry	Publicly listed	Medium	Raw materials	Low: Experience with short-term R&D projects, R&D contracting projects, no internal R&D department

We use the European Union's categories for firm size: large > 250, medium < 250, and micro < 10 employees

3.2 Data collection

The primary data for the study consists of 28 interviews, including 16 semi-structured interviews with eight firm representatives and 12 semi-structured interviews with six university partners (Eisenhardt, 1989), at two points in time (2017 and 2018) as well as observations during this period. The first round of interviews (eight firm informants and six university researchers) was conducted face to face in early 2017, not long after the research center had officially opened, with the aim to get a retrospective view of how and why the UIC was initiated and why the firms were motivated to get involved in the research center. The research team also participated as observers in research center activities, such as annual consortium meetings, workshops with firms and university partners, and one monthly research manager meeting, to observe how the collaboration unfolded. We used the interviews with the university partners and the fieldnotes from the observations to increase our contextual understanding of how the firm and university partners interacted and to identify and access relevant documents and informants for interviews.

Based on our observations and analysis of how the firms coordinated their activities in the research center, we conducted a second round of interviews with the same firm and university representatives in Autumn 2018. All interviews lasted about one hour and were face to face or by telephone, and the informants were asked to describe the developments of their engagement in the research center. We asked open questions before asking follow-up questions (e.g., “Can you tell us a bit more about that project?” or “How did you experience this activity?”) to obtain a more in-depth understanding of critical events.

To prevent recall bias from retrospective data and to validate our findings of the collaborative process and timeline of critical events, we applied method triangulation (Yin, 2014), whereby interviews from firm informants were supplemented with interviews from university representatives and secondary data sources, such as documents (Denziz and Lincoln, 1994, Denziz, 2012, Yin, 2014). The documents included the application to the CEER program, participation lists from various research center meeting areas and workshops, as well as notes on firm projects and meetings conducted in the research center (see Table 3).

3.3 Data analysis

As part of the data-analysis process, we recorded and transcribed all interviews shortly after they were completed (Yin, 2014). We then continued our data analysis with an inductive, within-case analysis (Eisenhardt, 1989) to obtain an overview and become familiar with the data. Next, we conducted an inductive data-analysis process inspired by the Gioia method (Gioia et al., 2013), starting with initial coding (Saldaña, 2015) to broadly identify, structure, and label the firms’ goals. This analysis resulted in four second-order themes and two overarching dimensions of the firms’ goals in the research center (see Fig. 1). Next, we undertook initial coding of the firms’ activities. Once we had identified the first-order codes, we used our research question (*How do firms’ different goals influence their coordination activities in a university–industry research center?*) and the coordination activity framework presented in Sect. 2 to structure and label our codes. We used the outputs of this step to analyze how the firm partners engaged in the research center to ensure their goals were attended to, which resulted in four second-order themes related to the firms’ activities, which we then aggregated to overarching concepts (Gioia et al., 2013) (see Fig. 2).

Table 3 Key data sources and interviews

Interviews for analysis	Interviews for method triangulation
Primary data sources	
1.	Research center manager (*)
2.	University project manager (*)
3.	University project manager (*)
4.	University project manager (*)
5.	University project manager (*)
6.	University project manager (*)
7.	University project manager (*)
8.	University project manager (*)
Sum	12
Observations for method triangulation (2017–2018): annual consortium meetings, workshops with the firm and university partners, and a research meeting with research managers. Written fieldnotes from the observations	
Secondary data sources	
<i>Documents for method triangulation</i> : CEER application, firms' letters of intent, annual progress reports, participation lists, project documents, PowerPoint presentations about projects and research center progress	
Sum	16

*Interviewed in both periods: preformation phase (2017) and formation phase (2018)

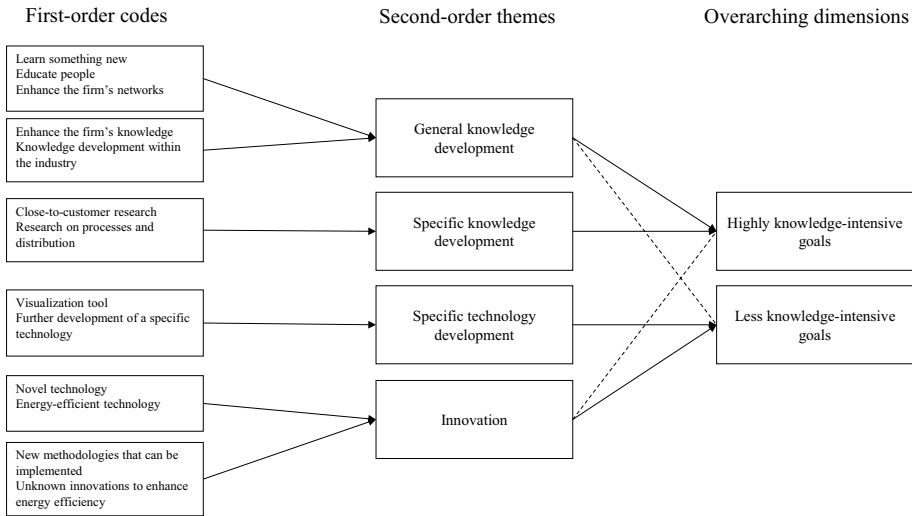


Fig. 1 Overview of the goal structure across the firms

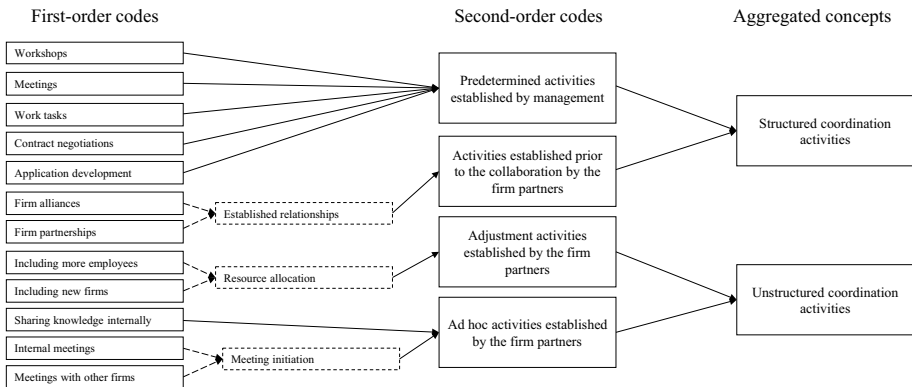


Fig. 2 Overview of the firms' coordination activities to achieve their goals

After identifying the firms' goals and activities, we structured the codes based on two critical phases we noticed in the data: the *preformation* phase (before the research center was operational) and the *formation* phase (the first official year). We also conducted a cross-case comparison of the firms' goals and coordination activities in the observed phases to identify similarities and differences among the firms' goals and their activities over time (Eisenhardt, 1989). From this, we constructed a theoretical model on how firms with different goals adjusted to or steered the research center (Vega-Jurado et al., 2017). Lastly, we derived propositions to clarify our theoretical arguments.

4 Findings

We first present findings regarding the firms' goals in the research center. Then, we present the firms' structured and unstructured coordination activities in the preformation and formation phases of the research center.

4.1 Firms' goals for their research center involvement

We observed that the firms in this study entered the research center with two types of goals: (1) long-term *general goals* (for overall research topics), which were oriented more toward general innovation and knowledge development, and (2) short-term *specific goals* (for specific research topics), which were more firm oriented (Gagné, 2018; Shah & Kruglanski, 2002).

As shown in Table 4, all eight firms in this study had general goals related to innovation (in both the preformation and formation phases), as stated by the representative from Firm 1: "We want to develop methods or technologies that we can implement that will result in a reduction of emission gasses or more energy-efficient production." All of the firms (except Firm 7) also had general goals related to knowledge development, as explained by the informant from Firm 6: "Knowledge and networks that we [the firm] can use in the future." As this statement indicates, firms usually establish multiple general goals to achieve the results they want (Gagné, 2018).

Most of the firms (1–7) also had specific goals related to innovation and knowledge development, which were mostly apparent in the preformation phase. During this phase, three of the firms (5–7) wanted to develop a specific new or improved technology. For example, Firm 6 wanted the research center to develop a technology to monitor the firm's production process, as one representative explained: "Maybe there is some type of sensor or temperature measurements that lets us control [our processes] in a more dynamic way." Moreover, four of the firms (1–4) wanted the research center to focus on specific knowledge development by concentrating on a particular research area, such as "close-to-customer" research: "We are used to researching the large processes, and even though that is important, it is also vital to research the smaller aspects [of processes] that are also central for the firm" (Firm 2).

Hence, we identified a distinction between two groups of firms: (1) firms with highly knowledge-intensive goals that tended to have stronger (specific and general) goals related to knowledge development and (2) firms with less knowledge-intensive goals that tended to be more innovation and technology oriented. Based on this firm distinction, we next explore how the firms' goals influenced the way they coordinated activities within the research center (Ambos et al., 2008; Bruneel et al., 2010; de Wit-de Vries et al., 2018).

4.2 Firms' coordination activities within the research center

Both groups of firms (with more and less knowledge-intensive goals) engaged in two types of coordination activities related to the research center: *structured activities*, concerning the firms' engagement in predetermined activities organized by the research center management and themselves during the first years of the collaboration, and *unstructured*

Table 4 The firms' goals before the official start of the research center and during the first year of operation

Innovation development		Knowledge development	
Firm	Specific goals	General goals	Specific goals
1	<p>Both phases</p> <p>Innovation developments: <i>Innovations from research Develop ideas that can lead us forward regarding our work with energy efficiency</i></p>	<p>Both phases</p> <p>Specific research area: <i>We want the research center to manage "near-customer"—research that ena- bles us to make simple improvements in many areas [within the firm]</i></p>	<p>Both phases</p> <p>Learning effects: <i>Our goal is to learn something new It is also very important goal setting for us to get researchers to our firm. We have seen that we get a lot out of it, not just because we then become an attrac- tive collaboration partner in relation to science but also so we can learn things from [the researchers]</i></p>
2	<p>Both phases</p> <p>Concrete innovation outcomes: <i>When I say eight years, that may not be very long from a researcher's per- spective, but with that many resources and expertise, I have to expect that there will be something concrete that will come out of this [the research center]</i></p>	<p>Both phases</p> <p>Technology development: <i>We want to go forward on the technol- ogy side to produce power from heat</i></p>	<p>Both phases</p> <p>Knowledge sharing: <i>We need to share the knowledge; that is one of the fundamentals</i></p> <p>Useful research: <i>We want the research [in the research center] to give results that we can show off</i></p>
3	<p>Both phases</p> <p>Technological improvements in the firm's processes and production: <i>We have some relatively low-hanging fruits [technology related] on the energy side that we could maybe utilize better through participation. I hope that [the research center] can give us some input [on technol- ogy implementation] to make better choices in relation to the road ahead [for the firm]</i></p>	<p>Both phases</p> <p>Useful research: <i>We expect that there will be results that are useful for us</i></p> <p>Access to new customers: <i>We have a lot of surplus heat, and we don't have any customers for that heat. It would be very interesting to get access to energy-demanding industries [in the research center]</i></p>	<p>Both phases</p> <p>Long-term knowledge development: <i>Knowledge and networks that we can utilize in the future</i></p> <p>Knowledge as the basis for decision making: <i>The research [developed in the research center] and the suggestions that come from the relevant research areas in the research center can give us a better foundation</i></p>

Table 4 (continued)

Innovation development		Knowledge development	
Firm	Specific goals	General goals	Specific goals
4	<p>Both phases</p> <p>Technological opportunities: <i>It should be concrete suggestions for technologies [from the research center] and, gladly, things that are already in operations or have been tried at least at a small scale</i></p> <p><i>The safest for us is that it [technology] is something that has been tried out, so we get the information, references, and descriptions about how things [in the technology] work</i></p> <p><i>We want to explore the window of opportunity [in relation to useful technology for the firm]</i></p>	<p>Both phases</p> <p>Technological opportunities: <i>It should be concrete suggestions for technologies [from the research center] and, gladly, things that are already in operations or have been tried at least at a small scale</i></p> <p><i>The safest for us is that it [technology] is something that has been tried out, so we get the information, references, and descriptions about how things [in the technology] work</i></p> <p><i>We want to explore the window of opportunity [in relation to useful technology for the firm]</i></p>	<p>Both phases</p> <p>Specific research area: <i>Everything that focuses on general recovery and utilizing surplus energy and low-tempered energy that is in some way are useful for us</i></p>
5	<p>Preformation phase</p> <p>Specific technology/process improvements: <i>We want to find out what will happen if we take with us [a specific technology] that is already developed and see if it will change our operation costs, operation conditions, and production</i></p> <p>Formation phase</p> <p>New technology to increase efficiency: <i>We want to reduce emissions from heat a given amount. How we do it is not that important</i></p>	<p>Both phases</p> <p>Technology development that benefits the firm: <i>We are only interested in technology that makes things better for us</i></p> <p><i>For us to test something, it must be mature and developed enough to be a case that can give us a dividend</i></p>	<p>Both phases</p> <p>Increase knowledge about the industry: <i>Enhance the understanding of how things are connected and what potential may lie in the areas we are working on in relation to optimizing the digitalization, mathematical modelings, and prediction of both surplus heating access and efficiency of the grid</i></p> <p>Knowledge development relevant to the firm: <i>However, we have an expectation that it [the research center] will be working seriously on the work tasks they have. Also, that the other partners will be active [in the research center]</i></p>
		<p>Both phases</p> <p>Educate personnel: <i>We want to educate people who we can use both directly or indirectly to get candidates we can hire or increase the expertise within this field in research organizations</i></p>	

Table 4 (continued)

Innovation development		Knowledge development	
Firm	Specific goals	General goals	Specific goals
6	<p>Both phases</p> <p>Specific process/technology development:</p> <p><i>We want the research center to develop an innovative way to control the energy flow within our [production processes]</i></p> <p><i>There have been some studies done on this [energy flows in the firms' process] earlier, but maybe they can do it in an even more detailed and structured way so they can confirm what has been found earlier</i></p>	<p>Both phases</p> <p>Technology development that benefits the firm:</p> <p><i>I hope that we will get so far [during the eight years] that there will be suggestions for improvements [within our field/firm] and that some experiments [relevant to our process] can be conducted</i></p>	<p>General goals</p> <p>Both phases</p> <p>Knowledge exchange between partners:</p> <p><i>I hope that we find an opportunity to transfer knowledge and competence [between the partners in the research center]</i></p> <p>Networking:</p> <p><i>I hope that we can get a kind of industrial forum, where we can exchange experiences</i></p>
7	<p>Both phases</p> <p>Specific technology development:</p> <p><i>We want to achieve a supply-chain [technology] from the core process and to the market to ensure energy efficiency through the whole supply chain</i></p> <p>Formation phase</p> <p>Research related to the firm's production process:</p> <p><i>We expect that we will get a project that is directly relevant for our operations</i></p>	<p>Both phases</p> <p>Technological developments/improvements:</p> <p><i>We have expectations that we will get something concrete, so we can get some dividends out of it [the research center]</i></p> <p><i>Energy efficiency in a broader perspective rather than suboptimizing</i></p>	<p>Both phases</p> <p>Knowledge that suits the firm's strategy:</p> <p><i>You get access to pretty much knowledge and resources. It [the research center] fits with our strategy, and we understand the research center as a possible opportunity to study business cases that are specific for our firm</i></p>

Table 4 (continued)

Firm	Innovation development		Knowledge development	
	Specific goals	General goals	Specific goals	General goals
8	<p>Both phases</p> <p>Expect “specific” innovations out-comes:</p> <p><i>We are not very hyped on research for the sake of research, but we have some specific ideas we want to move forward with, but we might take a shortcut and test things rather than research beforehand. We are practically oriented</i></p>	<p>Both phases</p> <p>New technological solutions in several areas:</p> <p><i>New views related to making our processes more effective</i></p> <p><i>We hope that we get closer to solutions that we can implement in our production</i></p>		

activities, involving adjustment activities and ad hoc activities initiated and undertaken by the firms in a way that influenced the collaboration in the research center.

4.2.1 Firms' structured coordination activities

The firms used two types of structured activities in the preformation phase before the research center officially started: *application development*, which concerns the firms' contributions to the research center's application to the CEER program, and *predetermined relationships*, which refer to established alliances and partnerships between the various firm partners before the research center was established. Furthermore, the firms used two activities during both the preformation and formation phases: *meetings and workshops* and *work tasks* (see Table 5).

4.2.1.1 Preformation phase *Application development*. The group of firms with less knowledge-intensive goals (5–8) was highly involved in developing the research center's application to the CEER program. These firms shared their internal challenges and proofread the application: "We went through the application before it was delivered [to the Research Council] and gave feedback on it before it was written [by the universities]" (Firm 5). This group of firms was also more involved in contract negotiations with the university partners: "Everything in [research collaborations] must go through our legal department to handle what [knowledge and results] we can share and not share [with the other partners]" (Firm 7). This involvement implies that these firms made use of the application and contract development to govern their relationships with and the outcomes of the research center (Oliveira and Lumineau, 2017).

The firms with highly knowledge-intensive goals (1–4) were only partially or not at all involved in the application process, as stated by the representative from Firm 4: "I think [the application and the center structure] were already outlined before we came in." Similarly, Firm 1 became more involved only after "the goals of the center were established." This group of firms was also less involved in contract negotiations. For example, the information from Firm 2 noted, "I became involved right after the application had been approved... and [the research center and other firm partners] spent a long time on [contract negotiations] related to the establishment of the research center. It was these legal assessments of the rights." Hence, the firms with highly knowledge-intensive goals seemed more concerned with exploring the full breadth of the research center's knowledge and not with steering the research center toward their firm-specific objectives, unlike the firms with less knowledge-intensive goals (Oliveira and Lumineau, 2017, Vega-Jurado et al., 2017).

Predetermined relationships. Independent of their goals, size, R&D experience, and ownership, all the firms entered the research center with previously established firm alliances and/or partnerships. Some of the firms (3, 6 and 8) were part of an industry alliance with several other firm partners that joined the research center together, as decided by the alliance. Other firms joined the research center together, such as Firms 2 and 4, which had a close partnership prior to their involvement in the research center. These firms had various reasons for joining the research center, as stated by the representative from Firm 4: "We can't be a fully worthy partner in these types of research programs because we don't have the capacity [alone]."

Thus, Firm 2 involved Firm 4 to enhance the resources it brought to the research center, as the Firm 2 informant explained: "First, [we included] Firm 4 because the firm representative [in Firm 4] is an important resource [for Firm 2 in the research center]. He has

Table 5 The firms' structured coordination activities in the research center—Activities determined by the research center's plans and programs and predetermined relationships

Preformation phase		Preformation and formation phases	
Firm	Participation in developing the research center's application to CEER (including contract negotiations)	Engaged in predetermined relationships	Participation in meetings and workshops
1	<p>Partially involved:</p> <p><i>We contributed to developing the application [after the goals were established</i></p> <p>Discussed the use of in-kind contributions in contract negotiations:</p> <p><i>Half of it [the cash contribution] is in-kind, which can be used on meetings and things like that</i></p>	<p>Involved in a partnership with a firm in the research center:</p> <p><i>In these kinds of large projects, we collaborate with a firm partner</i></p>	<p>Both phases</p> <p>Partially involved:</p> <p><i>We participate in relevant [for the firm] workshops and meetings</i></p> <p>Preformation phase</p> <p>Minimally involved:</p> <p><i>We haven't done that [influencing the research topics] yet</i></p> <p>Formation phase</p> <p>Partially involved:</p> <p><i>When we participated at the opening of the center, we found three to four themes that were relevant. However, we have to pay attention. There can be other areas that can develop in a direction that is relevant to us</i></p>
2	<p>Minimally involved:</p> <p><i>We became involved pretty early in the research center, but I can't remember if we discussed the [research center's] objective. It was probably made very early in the application process toward the Research Council</i></p> <p>Did not participate in contract negotiations:</p> <p><i>The other firm partners' lawyers have worked a lot with technology rights. We haven't worried that much about that and have thought that somebody else will deal with that</i></p>	<p>Involved in a partnership with Firm 4, which they engaged in the research center in the preformation phase:</p> <p><i>I understand that they [Firm 4] are engaged through us</i></p>	<p>Preformation phase</p> <p>Partially involved:</p> <p><i>I have represented the firm in meetings, and on Monday, I will go to participate in a workshop</i></p> <p>Formation phase</p> <p>Highly involved:</p> <p><i>There have been meetings with the different work task researchers</i></p> <p>Preformation phase</p> <p>Minimally involved:</p> <p><i>I am not sure that we were contacted beforehand, but those who have written it [the work tasks] have done a good job</i></p> <p>Formation phase</p> <p>Partially involved:</p> <p><i>We have studied the work tasks in the research center and chosen those that seem most relevant to us</i></p>

Table 5 (continued)

Preformation phase		Preformation and formation phases		
Firm	Participation in developing the research center's application to CEER (including contract negotiations)	Engaged in predetermined relationships	Participation in meetings and workshops	
3	Minimally involved: We on the [industry alliance] board chose three to four people to contribute [to the application], but I was not a part of that	Involved in an industry alliance: After a board meeting with [industry alliance], we agreed that it was reasonable to join [the research center], and we, the firm, became a partner	Both phases Minimally involved: I haven't participated in all of them [meetings], but I have been at three or four	Preformation phase Partially involved: We have been involved in the workshops that lay the foundation for the work tasks Formation phase Partially involved: [Participated in one of the work-tasks] I don't remember the number of work tasks, but it is the one that is most relevant for our industry
4	Minimally involved: We haven't had so much to do with the application	In a partnership with Firm 2 and a research firm: It [the initiative to join the research center] was proposed by Firm 2. They wanted me to represent them	Both phases Partially involved: I have had a bit of an irregular role in the meetings	Preformation: Minimally involved: [The firm's] role will not be very large or very active. That will be difficult Formation phase Partially involved: I and Firm 2 are the ones who were most active [in the center] until the research subcontractor became engaged as our project manager

Table 5 (continued)

Preformation phase		Preformation and formation phases	
Firm	Participation in developing the research center's application to CEER (including contract negotiations)	Engaged in predetermined relationships	Participation in meetings and workshops
5	<p>Highly involved: We joined in the preformation phase, where we told about our challenges, and have partly participated in developing the details for it [the application]</p> <p>Participated in contract negotiations: During the contract negotiation, we discussed publication rights</p>	<p>In a partnership with Firm 7: We have specified collaborations with Firm 7</p>	<p>Both phases Highly involved: [Talks about the firm's involvement in developing the work tasks] The universities took account of the general challenges in the industry and wrote down some technologies and methods</p>
6	<p>Highly involved: I was in the writing group for the application</p> <p>Discussed the results from the contract negotiation process: We must pay a given sum. That's the least we shall do. In addition, we will contribute with other things</p>	<p>Involved in an industry alliance: The firm is involved in the research center through the industry alliance</p>	<p>Both phases Highly involved: We have partaken in meetings and workshops that have been arranged [so far]</p> <p>Preformation phase Partially involved: There has been limited contact with those who do the job [researchers], so we currently have only participated in these large workshops</p> <p>Formation phase Highly involved: I think the meetings have been well organized</p>

Table 5 (continued)

Preformation phase		Preformation and formation phases	
Firm	Engaged in predetermined relationships	Participation in meetings and workshops	Development of and participation in work tasks
7	<p>Minimally involved: <i>There were some drafts in the beginning. With the possibility to comment, but I must admit, I don't remember to what degree we engaged in that process</i></p> <p>Detailed the results from the contract negotiation process: <i>We were aware when we signed the deal with the research center regarding what lies within confidentiality and publishing</i></p>	<p>In a partnership with Firm 5: <i>We have a close dialogue with Firm 5, and we expect to agree upon the things that are proposed and that we stick together about the things we want the research center to focus on. We already discussed this before entering the research center</i></p> <p>Preformation phase Partially involved: <i>I have participated in the kick-off, and my colleague participated in a workshop</i></p> <p>Formation phase Minimally involved: <i>I have had a more administrative role, and he [the other employee] has contributed mostly because I have had some challenges with my calendar and their [the research centers] meetings</i></p>	<p>Both phases Partially involved: <i>We have contributed through Firm 5</i></p>
8*	<p>Minimally involved: <i>We [the firm] were not so involved in the application process, but we were invited as a partner by those who manage the research center</i></p>	<p>Preformation phase Involved in an industry alliance: <i>I'm on the executive board of the [industry alliance]</i></p> <p>Both phases Minimally involved: <i>They [the research center] have annual and semiannual meetings, but we haven't been very active</i></p>	<p>Both phases Minimally involved: <i>I wasn't very involved in that process [developing the work tasks]</i></p>

*This firm left the industry alliance in the formation phase: *We were a partner in the industry alliance until this year, but now we have left it*

contributed in many of the meetings toward the research center.” Hence, one of the main reasons the firms joined the research center together and brought their previously established relationships was to coordinate their actions in the center to reap common benefits. This motivation was explained by the representative from Firm 7, which, along with its customer, had specific goals related to innovation development in the early stages of the collaboration: “As of now, we are backing [Firm 5] in a project [in the research center] because we can learn something in relation to our projects. The priorities have been sensible, but in the next eight years, we expect a specific work project related to our supply chain.”

4.2.1.2 Preformation and formation phases *Meetings and workshops.* Several of the firms with less knowledge-intensive goals were highly involved in the meetings and workshops established by the research center in the preformation phase: “We have participated in almost every [meeting] so far” (Firm 5). As the firms entered the formation phase of the research center, they continued to be highly involved in the research center’s meetings and workshops, and Firm 6 even increased its involvement in these activities in the formation phase. Conversely, the firms with more knowledge-intensive goals were only partially involved in the research center’s meetings and workshops in both phases: “We choose some of [the meetings and workshops] because the research center is so large, and much that happens there is not interesting for us. It isn’t valuable for us” (Firm 1). Only two of these firms (2 and 4) became more involved in meetings and workshops during the formation phase: “We have been present in the large workshops with two or three participants” (Firm 2).

Work tasks. The firms with less knowledge-intensive goals were more involved in influencing the research center’s work tasks and projects during both phases. For example, the representative from Firm 7 described how his firm had influenced such tasks and projects: “[We] have been in a dialogue with the research center about various work tasks, and have actually landed one ... we have also evaluated other work tasks, which have been discussed [with the university partners].” The group of firms with highly knowledge-intensive goals, on the other hand, was less involved in influencing work tasks and projects during both phases: “Our engagement will be passive in the beginning” (Firm 4).

4.2.2 Firms’ unstructured coordination activities

Our analysis revealed that both groups of firms were involved in three types of unstructured coordination activities in the preformation and formation phases of the research center: *resource allocation*, which relates to how the firms allocated their resources in the research center; *knowledge integration/transfer*, which concerns how the firms integrated knowledge from the center; and *meeting initiation*, which refers to how the firms called meetings with other firms and university partners involved in the research center (see Tables 6 and 7).

4.2.2.1 Preformation phase The firms had limited involvement in unstructured coordination activities in the preformation phase.

Resource allocation. During this phase, many of the firms dedicated a few selected employees to engage with the research center before its official start. If necessary, the firms drew on internal expertise to contribute in the research collaboration: “I am the contact person from our R&D department [who works with] the research center, but I have the

Table 6 The firms' use of unstructured coordination activities in the preformation phase—Adjustment activities and ad hoc activities established by the firm partners

Firm	Resource allocation (in kind)	Knowledge integration within the firm	Meeting initiation internally and with other firms
1	Engaged a couple of people to work with the research center and plan to engage more: <i>We try to engage a larger professional environment in the firm. As of now, there are two people who have been involved, but it might be four or five or maybe six who contribute from us</i>	Limited knowledge integration: <i>My expectation is that the [research center] is open for various solutions. That there are many ways to have contact. The research center often has meetings in [specific city] with presentations, but [the firm] thinks it is useful to have workshops at the firm's [location]. We have good experience with researchers coming to us because then we can reach more widely internally</i>	Partially involved: <i>[Employees join internal meetings] to follow up [with the research center's activities] and that type of thing</i>
2	Involved another firm and an internal resource to contribute to the research center: <i>He [the firm representative] from Firm 4 and another one from our energy department [work with the research center]</i>	Limited knowledge integration: <i>We haven't decided on anything yet—not the time we will use on this or other things</i>	Highly involved: <i>[The firm has] internal meetings where we [the firm] prepare what is going to happen</i>
3	Contributed internal resources when doing so was seen as profitable: <i>It will depend on what the results from the work projects are. That we value as expedient</i>	Limited knowledge integration internally; the firm had not decided to facilitate knowledge integration internally: <i>It will depend on what [knowledge] is produced [in the research center] and how easy it is to integrate [the knowledge] related to what we want to focus on</i>	Minimally involved: <i>Even though the industry alliance isn't a formal partner, it may be that we engage through it and that it chooses which member firms will engage here or there and that we do our part though the alliance. It will be the firm that engages, but it is the alliance that makes the decision that our industry will engage</i>
4	Limited resources to allocate toward the research center: <i>The research center is larger and a heavier boost than anything we have ever been involved in, and therefore, we can't be very involved. We are not able to be very deeply involved in something like this because we have limited resources</i>	Limited knowledge integration; the firm partners were not very focused on knowledge integration: <i>We don't have enough time or people to focus a lot on the R&D</i>	Highly involved: <i>We don't have any formal agreement between us [the firm and Firm 2] about the activity engagement. It is divided between us</i>

Table 6 (continued)

Firm	Resource allocation (in kind)	Knowledge integration within the firm	Meeting initiation internally and with other firms
5	Allocated resources based on need: <i>There is a different degree of involvement. When we are discussing work tasks, many employees are involved. In the daily work, it's me and one other</i>	Limited focus on knowledge integration: <i>In the relevant work projects, it will be important [to integrate the knowledge internally] because it will have a value for us. If not, then we will get nothing for [the knowledge]</i>	Partially involved; the firm sometimes initiated internal meetings with employees: <i>We don't want general research center presentations held by the research center [when the research center visits the firm]. Those are things we'd rather do internally</i>
6	Let employees be involved if they want to: <i>Those who are interested have been invited to work-shops, and if they want to go, they can</i>	Limited knowledge integration: <i>They [other employees] are involved in getting the information [about the research center] and supporting me to ensure I do a good job by communicating their wishes</i>	Minimally involved: <i>I have discussed with those responsible for the work tasks that we are interested, but as of now, there hasn't been specific work meetings</i>
7	Allocated resources based on need: <i>[If we get a specific work project] then we will typically connect more people to the project. We have a technical support group. They have been somewhat involved but only sporadically. We use them to discuss projects and come up with suggestions for projects</i>	Limited knowledge integration: <i>We have in-kind resources to follow up with the research center. But this year, it is only some thousands. This is because we are just starting and haven't contributed yet. It [knowledge integration] will depend on what type of activities are initiated in the center. How relevant it is for us</i>	Minimally involved: <i>I haven't had the opportunity to discuss with my colleague the workshop he participated in</i>
8	Struggled with resource allocation to the research center: <i>The biggest challenge is to come up with resources. Both cash contributions and in-kind contributions, contributions from the firm and the employees</i>	Limited knowledge integration: <i>[Talks about their focus on knowledge integration] We are kind of a small organization, and we don't have so many to play ball with. I was chosen as the formal contact person, so I try to be updated, but sometimes, I have to send somebody else to participate</i>	Minimally involved: <i>As of now, no [initiating meetings with researchers], but it may be relevant later if we have some questions or need to clarify something</i>

Table 7 The firms' use of unstructured coordination activities in the formation phase—Adjustment activities and ad hoc activities established by the firm partners

Firm	Resource allocation (in kind)	Knowledge integration within the firm	Meeting initiation internally and with other firms
1	Engaged another employee to work specifically on the project: <i>It's not practical to be only one person. It becomes so non-robust. We need to engage as many as we can. Our goal is to engage even more people</i>	Partial knowledge integration: <i>We have begun inviting researchers to us and offer ourselves as a research facility to get more people involved</i>	Highly involved by coordinating with their firm partner: <i>We have had meetings with the firm partner, where it was only us. It was easier because then we made the decisions together with the firm partner</i>
2	Included another firm in the research center: <i>Maybe six months ago, we applied and got a research organization approved as our subcontractor</i> Engaged people internally: <i>We have about five people who are engaged [in the research center]</i>	High knowledge integration: <i>We try to tell the employees what we are doing. It is usually a topic at our assemblies. [We are] telling them what we are engaged in within the research center</i>	Highly involved: <i>[In internal meetings with partner firms] We decide on what we will focus on now in relation to the workplan for next year</i>
3	Experienced internal challenges with resource allocation: <i>We have struggled to find the organizational form internally this first year</i>	Limited knowledge integration: <i>Yes, some, a bit at least. Some I would say. I must admit, [knowledge transfer from the center to the firm] is not our highest priority. But we use some of our time on it</i>	Minimally involved: <i>We have someone in the industry alliance who does the main communication with the research center, and I have not been one of them</i>
4	Allocated resources based on need: <i>We use a technical employee, who gets the raw data, and discuss technical issues</i>	High knowledge integration: <i>During the lunches, we discuss what is going on [in the research center]</i>	Highly involved: <i>We have discussions where we discuss the program for the next year. We contribute with ideas and try to make things relevant for us and for Firm 2</i>
5	Use of employees: <i>Two to four people—depends on how you look at it—but they are not involved full time</i>	Limited knowledge integration; the firm representative reported the research center's activity internally: <i>Let's say we give a sum each year to this project [the research center]. I have to defend it internally each year. If we don't get anything. The money will stop</i>	Partially involved: <i>We have [some] discussions with firms, for example, Firm 4</i>

Table 7 (continued)

Firm Resource allocation (in kind)	Knowledge integration within the firm	Meeting initiation internally and with other firms
<p>6 The firm had two people working with the research center: <i>In practice, it is my coworker, who focuses on one work task, and I, who work toward a project. That's our hours</i></p>	<p>Limited knowledge integration: <i>We try to get others from the firm who work in the energy field to contribute on workshops or do some of the work. However, since there are currently so few activities that are of direct interest for us, it is quite difficult to get any involvement from the other people in the firm</i></p>	<p>Highly involved: <i>We [the firm] have invited the researchers to meetings with the industry alliance, where they showed up and were willing to discuss and ensure progress</i></p>
<p>7 Involved one extra employee in the research center: <i>In practice, it is mostly my coworker that follows up the activities. I have mostly an administrative role toward the research center</i></p>	<p>Limited knowledge integration; a coworker gave summaries to the firm representative after participating in the research center <i>[The coworker] has given summaries to me after [participating]</i></p>	<p>Minimally involved; the firm followed up with activities in the research center but did not initiate meetings: <i>[The employee] follows up, is positive, and believes that we will get the case [project task] when it is suitable</i></p>
<p>8 Engaged engineers when support is needed: <i>We have some senior engineers that have participated</i></p>	<p>Limited knowledge integration: <i>Now, the last half a year, it has been quiet. Maybe the whole last year. There hasn't been anything concrete</i></p>	<p>Limited involved: <i>We haven't been that active, more that we have been pulled into some ideas</i></p>

coordination role. We engage people from, for example, the process department, who work as our experts” (Firm 7).

Knowledge integration/transfer. In the preformation phase, most of the firms did not engage the other firms and did not use resources to integrate knowledge from the center. However, they were aware that integrating such knowledge into their own operations could be important. For example, during this phase, Firm 3 (with highly knowledge-intensive goals) was aware of knowledge outputs from the research center that eventually needed to be transferred to the firm: “We have to ensure that [the knowledge outputs] which are relevant [for us] are implemented and distributed internally.”

Meeting initiation. Almost none of the firms facilitated internal meetings or meetings with other firm or university partners during the preformation phase, except for Firm 2 (with highly knowledge-intensive goals), which had meetings both internally and with other firms in the research center (see Table 4). Firm 2 arranged internal meetings to “discuss what is important to us [in the research center],” which were likely needed because this firm had limited involvement in developing the center’s application and needed to coordinate more internally to achieve its goals. Firm 4, which was also not involved in the center’s application development, initiated some internal meetings with its firm partner (i.e., the firm it had a prior relationship with) to coordinate activities in the research center to attain results that could benefit their industry overall rather than the firm individually: “As of now, everything is decided through Firm 2.”

In sum, both groups of firms were minimally involved in unstructured coordination activities in the preformation phase; however, some firms with highly knowledge-intensive goals were slightly more engaged during this phase.

4.2.2.2 Formation phase As shown in Table 7, during the first official year of the research center, several of the firms became more involved in the research center through unstructured coordination activities.

Resource allocation. Firms with highly knowledge-intensive goals dedicated more firm resources to the research center during the formation phase. For example, Firm 2 involved a researcher (subcontractor): “He comes from a research organization. He has a prior relationship with the researchers [in the research center]. He seeks them out, makes contact, and follows up with the activities [in the research center]. It has worked for us.” The new research subcontractor contributed to the firm’s understanding of the research center and bridged the gap between the firms and university (Al-Tabbaa & Ankrah, 2018). Firm 1 also increased the resources it allocated toward the research center by hiring people to work directly with the research center: “[A particular employee] is engaged in the research center activities.” Firms with less knowledge-intensive goals, however, were less involved in resource-allocation activities during the research center’s first year, as explained by a representative from Firm 7: “In regard to resources, it’s only one person that follows up [with the research center], in addition to me on the administrative side.”

Knowledge integration/transfer. Some of the firms with highly knowledge-intensive goals started to internally integrate the knowledge provided by the research center among several of their employees: “We try to tell the employees what we are doing [in the research center]” (Firm 2). Firm 4 also started to discuss research center activities during informal meetings, considering, for example, “What kind of possibilities [the research center] can give us.” The firms with less knowledge-intensive goals were less engaged in integrating knowledge in their firms, except for a few that reported the research center’s progress to a small group of firm employees for evaluation reasons. For example, Firm 5 reported

this progress to an evaluation committee: “[The firm representative in the research center] receives evaluations from others within the firm on [research and results] that have come from the research center.”

Meeting initiation. Several of the firms with highly knowledge-intensive goals continued to facilitate internal meetings in which they involved another firm to coordinate together toward the research center: “We [the firm] have coordination meetings with [a firm partner] where we agree upon what is important and what we should follow up with in the research center” (Firm 1). However, only a few firms with less knowledge-intensive goals started to facilitate internal meetings with other firms and university partners during the formation phase. For instance, Firm 6 initiated meetings with the university partners: “We had an initiative [for the research center] to get [research and results] that were more in line with our expectations. We have had meetings with particular researchers, but we are not yet exactly in line with what we want.”

5 Discussion and propositions

In this section, we discuss the key findings and develop propositions regarding how different types of firms use coordination activities to achieve their goals within the research centers.

5.1 Firms’ goals for their research center involvement

The firm and university partners translated the overall goals of the research center into more specific outcomes. This potentially created goal conflicts and fluctuating focus between the firm and university partners in the research center (Ranganathan et al., 2018). While firms’ multiple goals have largely been overlooked in the UIC literature (Ankrah & Al-Tabbaa, 2015; Fini et al., 2019; Steinmo, 2015), we found that the firms in our sample established both general and more specific goals that jointly influenced their desired outcomes. The notion of firms having multiple goals is well established in the literature on organizational goals (Gagné, 2018; Shah & Kruglanski, 2002). In our context, we found that the firms had multiple goals that were more or less related to knowledge development. While some firms had *highly* knowledge-intensive goals that focused mostly on developing and exploring new knowledge, other firms had goals that were *less* knowledge intensive and focused more on developing specific innovation solutions.

5.2 How firms coordinate through structured activities

All the firms in our study, regardless of their goals, size, ownership, and R&D experience, had established partnerships and alliances with other firms in the research center. These alliances and partnerships usually enabled the firms to sustain a cooperative advantage and enhance their resources relative to the other firm partners and the research center in general (Lorenzoni & Lipparini, 1999). We suggest that the firms used their relationships with other firms as a coordination activity to enhance their position within the research center. We also found that the firms that maintained their involvement in alliances and firm

partnerships were more engaged in the research center and participated in research center activities and internal activities related to the research center to a greater extent, while the firms that left such alliances and firm partnerships became less engaged with the research center over time (see Tables 6 and 7). Thus, we suggest that when firms enter a research center together with other firms, they find it easier to coordinate with the research center because of their combined resources.

The firms with less knowledge-intensive goals were generally more involved in the pre-planned and predetermined activities established by the research center in both the pre-formation and formation phases, such as *application development, meetings, workshops, and work tasks* (Mom et al., 2009). When firms establish goals, they usually focus their behavior on achieving those goals (Gagné, 2018; Shah & Kruglanski, 2002). Hence, the firms with less knowledge-intensive goals wanted the research center to produce specific solutions for their problems and may have engaged in structured coordination activities to include these problems in the research center's contracts and application, with the ultimate goal of ensuring the research center would attend to their goals (Oliveira and Lumineau, 2017, Vangen, 2017; Vega-Jurado et al., 2017).

Furthermore, we suggest that the firms engaged in these types of activities to enhance their interactions with the university partners such that these partners would focus on the firms' goals and ultimately incorporate the firms' goals into the research center's overall goals (Perkmann & Walsh, 2007). By doing this, the firms managed to keep the focus on their goals and therefore steer the research center's activities (Mom et al., 2009). Hence, the firms with highly knowledge-intensive goals were less involved in predetermined activities as these firms were more explorative and did not expect specific problems to be solved. Indeed, the development of novel knowledge usually follows a more unpredictable path and is continuously adjusted during the lifespan of a research center. Thus, the firms with highly knowledge-intensive goals were less involved in these types of structured activities because their goal attainment did not depend on steering the research center (Vega-Jurado et al., 2017). Thus, we propose the following:

Proposition 1 *Firms with less knowledge-intensive goals use structured activities to coordinate their participation in a research center more than firms with highly knowledge-intensive goals.*

5.3 How firms coordinate through unstructured activities

The firms with highly knowledge-intensive goals became more engaged in unstructured coordination activities during the first official year (formation phase) of the research center. These firms allocated resources to the research center, integrated the center's knowledge within their own firms, and initiated internal meetings with other firm partners. Our findings illustrate that when firms' goals were rather unspecific and relate to a high degree of knowledge development, the firms adjusted to the development and progress of the focal research center through unstructured coordination activities (Geringer & Hebert, 1989; Morandi, 2013).

Furthermore, the firms with highly knowledge-intensive goals left room for unexpected changes during the research center's lifespan and reacted to events that occurred in the research center (Morandi, 2013). We argue that these firms focused more on exploring new

tacit knowledge and taking advantage of the full breadth of the research centers’ and the university partners’ knowledge. Hence, the firms engaged in unstructured activities to follow up on unforeseeable changes (Vega-Jurado et al., 2017) and enhance their development of new knowledge. Moreover, by integrating knowledge from the university partners and the research center, the firms enhanced their possibility of developing new ideas and exploring new possibilities that may contribute to achieving their goals (Dao & Strobl, 2019; Spee et al., 2016). However, firms with less knowledge-intensive goals were more focused on attaining their specific goals and did not explore new possibilities to the same degree. Thus, we propose the following:

Proposition 2 *Firms with highly knowledge-intensive goals use unstructured activities to coordinate their participation in a research center more than firms with less knowledge-intensive goals.*

5.4 How firms’ goals affect their behavior

While prior literature has focused on goal divergence between firms and university partners as a single entity (Ankrah & Al-Tabbaa, 2015; Steinmo, 2015), our study shows that firms enter a research center with a set of multiple goals (Gagné, 2018). As shown in Fig. 3, we found that some firms had goals that were highly knowledge intensive and were oriented toward knowledge development (Styhre & Lind, 2010); these firms aimed to achieve outcomes that involved exploring novel knowledge (Vega-Jurado et al., 2017). However, the other firms had goals that were less knowledge intensive and more oriented toward innovation development (Styhre & Lind, 2010), and they aimed to attain specific technological solutions for predetermined problems (Vega-Jurado et al., 2017). Thus, our analysis further confirms that firms’ goals affect their behavior (Gagné, 2018; Shah & Kruglanski, 2002), as shown in Fig. 3.

As such, we suggest that the firms’ different behavior toward the research center can be explained by their attempts to attain their goals for research center involvement. The firms with highly knowledge-intensive goals focused on exploring the different possibilities within the research center to a larger degree (Vega-Jurado et al., 2017), which means that they mainly tried to adjust to the development of the research center. In contrast, the firms with less knowledge-intensive goals focused on attaining their specific goals for research

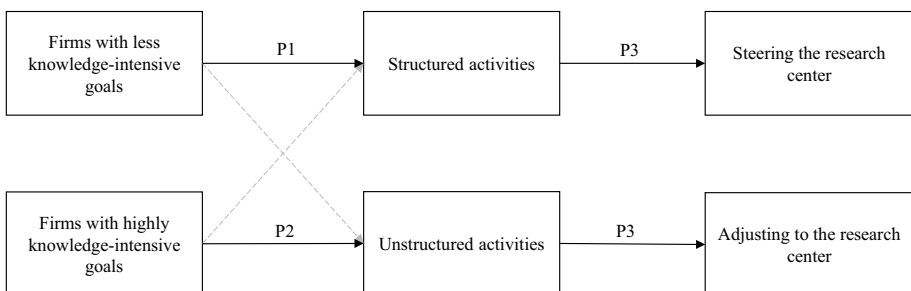


Fig. 3 How firms’ goals affect their behavior toward a research center

center involvement to a larger degree, which means that they tried to steer the development of the research center. Thus, we propose the following:

Proposition 3 *Firms with highly knowledge-intensive goals are more willing to adjust to the development of a research center compared to firms with less knowledge-intensive goals, which are more interested in actively steering the development of a research center based on their own needs.*

6 Conclusion and implications

By investigating the collaborative relationships between firms and a research center from its establishment, we contribute to a more in-depth understanding and dynamic perspective of technology transfer in UIC, particularly in relation to the scarcely investigated creation phase of new UIC (Skute et al., 2019, pp. 934–935) in the context of research centers (Skute et al., 2019, p. 918). By following eight firms during the preformation and formation phases of a research center, we showed how different firms coordinated their activities to achieve their goals in the research center.

Overall, we found that the firms with highly knowledge-intensive goals and the firms with less knowledge-intensive goals used different coordination activities to attain their goals in the research center. While previous UIC research has focused on the distance between firms' and universities' goals, our study contributes with new insights by highlighting the diversity in firms and their goals for research center involvement (Ankrah & Al-Tabbaa, 2015; Steinmo, 2015). Hence, we extend the UIC literature by showing that firms within a research center likely have multiple goals, which are more or less focused on knowledge development or innovation development. Moreover, by drawing on the coordination mechanisms literature, we outlined the various coordination activities firms with different goals engaged in during the preformation and formation phases of a research center (Asmussen et al., 2016; Larsen et al., 2013). We showed how the firms with less knowledge-intensive goals adopted a more active role by engaging in predetermined research center activities, while the firms with highly knowledge-intensive goals engaged more in unstructured coordination activities that were ad hoc and determined by the firms.

Drawing on organizational goal theory and the coordination literature, we outlined how the firms' goals and coordination activities enabled them to steer or adjust to the research center (Oliveira and Lumineau, 2017). We found that the firms with less knowledge-intensive goals coordinated through structured activities to a larger degree, ultimately steering the research center toward their own goals. The firms with highly knowledge-intensive goals, on the other hand, coordinated through unstructured activities to a larger degree, which ultimately caused these firms to adjust to the research center. Thus, this study demonstrates how firms use different types of specific structured and unstructured coordination activities to achieve their goals in research centers.

6.1 Implications

Our findings have important implications for organizations that are structured around the production and exchange of knowledge (Weick, 1976), such as research centers and related firms, as well as for policymakers who support such collaborations.

Firms with highly knowledge-intensive goals and firms with less knowledge-intensive goals use different coordination activities to attain their goals for research center involvement. Consequently, research centers should use different strategies to get these different types of firms involved and committed to their endeavors. As such, when trying to engage firms with highly knowledge-intensive goals, research centers can use an explorative strategy focusing more on the development of novel knowledge. However, when working with firms with less knowledge-intensive goals, research centers can focus on attaining the firms' specific goals to a larger degree. These different strategies may contribute to the more successful management of research centers, which can be organizationally complex and have weak linkages between their different components (Weick, 1976). For policymakers and research center managers, this finding indicates that the structure of research centers should include better tools to incorporate various firm goals as part of overall center goals by establishing subgoals. These subgoals should cover both knowledge-intensive and more innovation-intensive goals, which—in combination—are important to achieve the overall long-term goals of knowledge and innovation development. Importantly, firms should be heavily involved in the development of these goals early in UIC to secure their engagement and commitment in the research center.

Lastly, our findings suggest that firms should dedicate resources to become involved in both structured and unstructured coordination activities in research centers to reap the potential (short- and long-term) benefits of knowledge and innovation development. Moreover, as our findings show that firms with too specific goals may experience difficulties in taking advantage of the full breadth of research center activities (Vega-Jurado et al., 2017), we echo Spee et al. (2016) and suggest that firms should use more explorative strategies in research centers to enhance their chances of developing new ideas and exploring new possibilities that may contribute to their innovativeness.

6.2 Limitations and further research

While our study provides several new insights into UIC, it has some limitations that may limit the generalizability of our findings, and/or open new avenues for research. First, research centers in different fields might experience other types of mismatches between firms' goals and coordination activities. Our findings may be restricted to research centers involving firms in technology-based heavy industries, such as energy, processing, and infrastructure, while centers in more science-based industries, such as biotechnology, may have firm partners with more developed links to universities (Gilsing et al., 2011). Studying only one research center may also be a limitation because comparative studies are often recommended to ensure the transferability of findings (Eisenhardt, 1989). Hence, future research could perform case studies in several research centers in different fields to obtain a more comprehensive understanding of how firms coordinate within a research center to achieve their goals.

Moreover, while our analysis did not reveal direct relationships between firm heterogeneity (e.g., in R&D experience, size, ownership) and the use of coordination activities in the research center, our findings hinted that small and medium-sized firms with lower

R&D experience had challenges engaging in both structured and unstructured coordination activities unless they were involved in prior firm alliances and/or partnerships (e.g., Firm 4 and 8). Thus, we suggest that future studies look more closely at the use of prior relationships as a coordination activity and whether these relationships influence how firms of different sizes and with different R&D experience engage in and use coordination activities in a research center.

In addition, our findings show that the firms' goals in the preformation and formation phases of the research center were more or less constant. Thus, future studies should specifically focus on how the development of a research center influences the firms' goals in later phases, to explore whether firms' engagement in various research center activities affect their goals over time. Lastly, our findings suggest that some of the firms' goals were rather specific, which further opens up questions related to what strategies firms use after their specific goals have been achieved, and whether firms with mostly general goals develop more specific goals during the collaboration.

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