ACCESSING AND INTEGRATING DISTANT CAPABILITIES IN SMART INDUSTRY PROJECTS

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ABSTRACT

Smart industry initiatives focus on intelligent and interconnected cyber-physical systems. These initiatives develop complex technical architectures that integrate heterogenous technologies, causing significant organizational complexity. Tapping into the digital capabilities of distant partners while capturing profit from such innovation is demanding. Furthermore, firms often need to establish and orchestrate inter-organizational collaborations without prior relations or established trust. As a result, smart industry initiatives bring together disparate organizational forms and institutional environments, distinctive knowledge bases, and geographically dispersed organizations. We conceptualize this organizational capability as 'distant capabilities integration'. This research explores the governance mechanisms that support such integration and their relation to value capture. We analyse 11 IoT case studies organized in three categories (process, product and technologies) of smart industry initiatives. Building on existing literature, we consider different ways to describe distance, including knowledge heterogeneity and organizational, geographical, institutional, cultural and cognitive distance. Finally, we describe the governance mode appropriate for upstream (developing foundational technologies) and downstream (leveraging existing distant technologies) smart industry initiatives.

Keywords: Smart industry; distant capabilities; digital transformation; proximity; ecosystem collaboration; innovation

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INTRODUCTION

Discussions, implementation efforts, and business initiatives on smart industries have intensified over the last decade. Smart industry initiatives involve intelligent and interconnected cyber-physical systems, digitization, and connectivity (Kagermann, Wahlster, & Helbig, 2013). They leverage the Internet of Things (IoT), a powerful suite of technologies and processes that enable tracking and counting, observing and identifying, evaluating and acting, analysing, and predicting in ways not previously possible.

In this chapter, we investigate both upstream and downstream smart industry initiatives. Downstream smart industry initiatives combine the physical with the virtual world by assembling heterogeneous and distant technologies into a technical and business architecture that delivers and captures value. Upstream industry initiatives generate foundational technologies that combine and integrate diverse complementary applications into technical and business architectures.

Smart industry projects leverage technology architectures with significant complexity as they encompass heterogeneous hardware, software and telecommunication capabilities. This technical complexity creates organizational complexity as multiple and diverse organizations need to be effectively and efficiently integrated to generate successful initiatives. External organizational complexity can severely hamper the successful development and exploitation of dynamic capabilities (Teece, 2007) that sense, seize and transform emerging technology opportunities. Furthermore, navigating through such complexity can erode firms' ability to capture value from these initiatives (Teece, 2018). So far, we have a minimal understanding of how organizations integrate heterogeneous technologies to support smart industry initiatives and how they capture value within such a complex and emerging environment.

Smart industry digital capabilities often reside outside the organizational boundaries, and firms need to identify and meld them (Chesbrough & Crowther, 2006; Gualandris, Legenvre, & Kalchschmidt, 2018; Pisano & Verganti, 2008). However, organizations often face geographical and organizational distances in searching for and connecting to those digital capabilities. While the geographical dimension captures the spatial distance between potential partners, the organizational distance is associated with firms' closeness regarding the extent to which they share the same relations space, reference and knowledge space, and institutional environment. Collectively, these dimensions capture the 'proximity' (or 'distance') between partners (Balland, Boschma, & Frenken, 2015; Boschma, 2005).

Tapping into the digital capabilities of distant partners and enabling the learning and innovation required for successful smart industry initiatives is demanding. Firms need to establish and orchestrate inter-organizational collaborations that bring together disparate organizational forms and institutional environments, with distinctive knowledge bases or geographically dispersed, sometimes without prior relations or established trust. We conceptualize such capacity as 'distant capabilities integration'.

While some projects may mobilize relatively simple relationships with familiar suppliers, innovation and value creation are increasingly organized around wider collaborative networks and ecosystems involving unfamiliar and distant partners (Jacobides, Cennamo, & Gawer, 2018). However, research and practice still lack an understanding of how these ecosystems and distinctive collaborative approaches combine heterogeneous and distant capabilities to produce more transformative innovation and value.

We explore the nature and functioning of the inter-organizational governance mechanism underpinning an increasing number of smart industry initiatives. Additionally, we consider the nature and position of the technology within the broader set of technologies and the selected governance mechanisms and their relation to value capture. We analyse various IoT case studies supportive of three major categories of smart industry initiatives. Building on existing literature, we consider different ways to describe distance, including knowledge heterogeneity and organizational, geographical, institutional, cultural and cognitive distance. Some cases focus on downstream initiatives that integrate multiple distant technologies and maximize the value captured from these projects. Other cases consider upstream initiatives that develop enabling technology that is deployed in downstream initiatives.

We organize the remaining chapter as follows. First, we briefly provide the conceptual underpinnings supporting our efforts. Next, we describe the study's methodology. We then report the cases and their analysis and the cross-case analysis. Finally, we synthesize the findings and briefly conclude.

THEORETICAL BACKGROUND

In this section, we lay down the conceptual basis of the study by briefly describing some of the foundational technologies commonly supporting smart industry projects and then briefly discussing the notion of proximity and its dimensions and relating it to knowledge search and governance.

SMART INDUSTRY LAYERS

This section outlines some of the foundational technologies encountered across a wide diversity of smart industry applications while highlighting the complexity of such broad-scale technical artifacts.

Smart industry projects bring together hardware, software, machines and humans. They orchestrate complex interactions, continuous data exchanges and multiple information processing capabilities; they integrate a wide array of technologies within complex architectures. Such architectures define interfaces and prescribe how heterogeneous technologies and distant capabilities interact together. Furthermore, these architectures evolve and expand over time, sometimes incorporating newer technological developments and approaches. Therefore, integration and interoperability are front and centre as they are crucial for full-system effective operations. Finally, different architectures offer different degrees of interoperability, adaptability, manageability and performance.

ARCHITECTURES ARE STRUCTURED AS LAYERS

Multiple 'reference' architectures have described the foundations of smart industries. Many of them come from IoT platform providers. Academia and industry have produced dedicated books and glossaries attempting to organize our understanding of these architectures. In addition, there is an abundance of standards-setting groups offering perspectives on ascertaining interoperability (Cheruvu, Kumar, Smith, & Wheeler, 2020). For example, Sinha, Bernardes, Calderon, and Wuest (2020) refer to the architecture as a multi-layer digital stack. Ancarani, Di Mauro, Legenvre, and Cardella (2019) describe four smart industries layers.

The first layer is the sensing layer, where assets, objects and devices acquire and transform data thanks to sensors, actuators, processors and other hardware. The second layer is the communication layer supporting the transfer of data using diverse network technologies. The third layer is the software layer, where multiple sources of data are stored, combined and transformed. The fourth layer is the application/service layer, housing services and value creation.

Notwithstanding such efforts, describing the architecture and the enabling technologies of smart industry applications remains a challenging exercise with inevitable limitations. Below, we outline some of the foundational technologies commonly found across a wide diversity of smart industry applications. While not an exhaustive list, it provides context for the complexity involved. This outline of technologies includes the following:

- Hardware technologies (e.g., sensors and processors).
- Network technologies (part of the communication layer).
- IoT platforms (within the applications/service layer).
- Edge computing (processing closer to the original data).

This heterogeneity of technology and the inherent integration difficulties challenge developers and researchers (Vogel, Dong, Emruli, Davidsson, & Spalazzese, 2020). And within organizations, leaders who need to select solutions or commercialize their technologies face many technological approaches and decisions (Firouzi, Farahani, Weinberger, DePace, & Aliee, 2020). They need to meld these technologies while capturing value successfully.

PROXIMITY, SEARCH, COLLABORATION AND GOVERNANCE

The dynamic capabilities literature suggests that a technical and business architecture's capacity to generate superior value will rely more heavily on the organizational actor's combinative capability (Kogut & Zander, 1992; Teece, Pisano, & Shuen, 1997). Those capabilities manifest when organizations move beyond local search and reconfigure knowledge bases through cross-organizational boundary recombination (Zander & Kogut, 1995). Firms may seek partners inside the local area in some instances and search for partners outside the local area in some other cases (Hanse, 2014). Therefore, knowledge linkages and proximity and distance are essential considerations.

PROXIMITY DIMENSIONS

The proximity between partners' attributes is crucial for coordinating economic activities (Bouba-Olga & Grossetti, 2008; Carrincazeaux et al., 2008). Internal or external collaborative partners' proximity in different dimensions facilitates knowledge creation and transfer, communication of strategic information, resolution of conflict, and, ultimately, successful innovation projects, such as smart industry initiatives (Boschma, Balland, & de Vaan, 2014; Hautala, 2011; Heringa, Horlings, van der Zouwen, van den Besselaar, & van Vierssen, 2014).

Boschma (2005) proposes a framework with five dimensions of proximity and argues that the interplay between them profoundly influences interactive innovation processes. In other words, differences across them characterize inter-organizational collaborations. Proximity along each of these dimensions facilitates interaction and reduces coordination costs, as differences across actors' characteristics can make understanding each other

Table 1. Dimensions of Proximity.

Cognitive proximity	Similarity in knowledge bases, technical domain, or product specialization.
Organizational proximity	Shared ownership, or whether partners belong to the same legal entity or are of the same organizational form or have previously established relationship.
Social proximity	The strength of social ties or personal relations across project teams.
Geographic proximity	Differences in the physical distance between actors.
Institutional proximity	Shared informal (e.g., norms and habits) and formal norms (e.g., rules and laws, culture, institutions, established practices, and routines).

challenging (Nooteboom, Van Haverbeke, Duysters, Gilsing, & Van den Oord, 2007). Table 1 displays the dimensions.

Collectively, these dimensions capture the 'proximity' (or 'distance') between partners (Balland et al., 2015; Boschma, 2005). We conceptualize the capacity to develop and orchestrate inter-organizational collaborations that bring together such disparate organizational forms and institutional environments, sometimes without prior relations, and established trust, with distinctive knowledge bases or being geographically dispersed as 'distant capabilities integration'.

PROXIMITY DIMENSIONS AND KNOWLEDGE SEARCH

Hansen (2014) contributes to the proximity research perspective by seeking to understand partner search criteria along proximity dimensions in collaborative innovation projects. He proposed that different qualities are associated with being proximate or distant that may facilitate or impede collaboration. Hansen further posits that the importance of those qualities may vary depending on the motive for collaborating.

These insights signify that proximity and distance will likely have different significance according to other collaborative reasons, technological layers involved and types of smart industry projects. It becomes essential, then, to analyse the importance of different dimensions of proximity according to different collaborative motives and project scope to identify the types of smart industry initiatives where proximity dimensions are essential and how organizations bridge the difference.

PROXIMITY, COLLABORATION AND GOVERNANCE

Past literature suggests that proximity dimensions drive managerial decisions and affect the success of collaborative approaches to innovation (e.g., Rallet & Torre, 2001). Proximity and distance appear as a frequent feature of decision-makers' partnering decisions, as different motivational contingencies require diverse partners at varying distances. Partner proximity can drive success in complex projects, but not all proximity dimensions will play the same vital role all the time.

For instance, Hansen (2014) remarked that the knowledge that various partners may bring to a project might be highly diverse, resulting in weak cognitive proximity. However, he notes that past research on proximity shows that specific dimensions can substitute for others. Indeed, past studies found that one dimension of proximity could replace another (e.g., Balland, 2012; Ponds, Van Oort, & Frenken, 2007). Thus, proximity along one dimension can help partners avoid or overcome their differences on another dimension.

Table 2. Main Traits of Different Types of Relationships.

Arm's Length	Collaborative Relationships	Strategic Collaborations	Ecosystems Relationships
Buyer–supplier relationships	Buyer–supplier relationships	Complementary partners	Heterogeneous complementary partners
Short-term, low involvement, precise specifications, no sharing of information, no or little trust, few mechanisms to promote joint work, interactions primarily focused on the exchange of purchase orders and invoices	Medium- to long-term projects, selective information sharing, increased trust, ongoing relationship, somewhat precise specifications, little to some shared risk, planning, investment, and reward, standard contracts	Long-term relationship, full information sharing, extensive trust, extensively shared vision, investment, risk, planning, and reward, less clearly specified and more exploratory contract terms, often some exclusivity	Long-term relationships, information and knowledge sharing, shared vision, shared investment, joint development, joint promotion, shared projects and rewards

Additionally, substitution and overlap effects can benefit smart industry collaboration, as the proximity of diverse partners involved can be weaker in some dimensions than others.

Different governance modes can smooth the coordination of activities that exhibit different proximity dimensions. Each proximity dimension has traits that may facilitate or impede success in collaboration and may vary in importance depending on the motives driving the partnership. Besides the proximity aspect in searching for partners, organizations also need to structure the relationship. Table 2 summarizes and adapts the governance and inter-firm relationship literature for our study; we outline how organizations may structure relationships with smart industry initiative partners. If we see these categories as a continuum, as firms move left to the right, they increasingly search for counterparts with whom they can develop a deeper and broader interaction and rely on fewer transactional contracts that contain fewer clearly defined specifications (Cohen & Agrawal, 1996; Fawcett, Ellram, Fugate, Kannan, & Bernardes, 2020).

The first three categories of strategies and ways of structuring relationships with counterparts represented above are traditional and involve identifiable partners in the sense that the focal organization knows who they deal with, as contracts are in place and the work to be done has been specified. However, we have recently witnessed a growing trend towards alternative strategies, such as open-source foundations and technology alliances that can be described as ecosystems (Jacobides et al., 2018). Ecosystems combine heterogeneous but interdependent organizations to combine complementary capabilities aimed at innovation and value proposition realization and delivery.

RESEARCH METHODS

In this section, we describe the procedures and techniques we followed to achieve the study's goals. We present the research approach and context, case selection and data source, and analytical methods.

RESEARCH DESIGN

While smart industry initiatives increasingly pursue innovation and value creation through collaborative networks and ecosystems, research and practice still have an inadequate understanding of how these technological ecosystems and collaborative approaches combine heterogeneous and distant capabilities to produce more transformative innovation and value. In addition, those issues are complex, dynamic and evolving. Therefore, we used an exploratory multicase approach as the research design.

Eisenhardt, Graebner, and Sonenshein (2016) noted the usefulness and crucial role that case studies play in studying innovation processes. As the concept of distant capabilities integration is at very early stages of development, we chose an exploratory multiple case study research design (Yin, 2009), which allows for theory-building through an empirical enquiry of a complex phenomenon (Eisenhardt, 1989; Meredith, 1998). This research design was ideal for understanding the underlying mechanisms that integrate distant capabilities and the nature and functioning of the collaboration governance mechanisms involved in a broad array of smart industry projects.

The multicase exploratory approach enabled the collection of rich data from primary (e.g., interviews and observations) and secondary (e.g., internal reports and press releases) sources. It allowed us to explore similarities and differences across cases, identify patterns and subsequently generate insights (Barratt, Choi, & Li, 2011). We followed established methodological recommendations to ascertain rigour (confirmability, dependability, credibility and transferability) (Gioia, Corley, & Hamilton, 2013; Miles, Huberman, & Saldaña, 2018).

RESEARCH CONTEXT

The purpose of this exploratory multicase study was to advance our understanding of how organizations access and integrate distant capabilities for smart industry initiatives. Examining the link between firms' smart industry initiatives and their governance mode concerning complementary capabilities vis-à-vis value capture is managerially consequential.

Collaboration governance choice pertains to the search for, access of, and coordination of complementary capabilities provided by partners. The existing literature suggests that they can range from straightforward collaboration with familiar and existing suppliers to unfamiliar and distant partnerships with complex ecologies of heterogeneous organizations. Besides, the literature indicates that such initiatives' focus ranges from processes to products to enabling technology development.

According to the phenomenon's nature, the literature has distinguished innovation into two general categories, product innovation or process innovation (Abernathy & Utterback, 1978; Henderson & Clark, 1990). Product innovations are new or improved goods. Process innovations are new thinking about making products and services and can be technological or organizational. Finally, as product or process grow in complexity, architectural innovation defines how foundational technologies can be integrated as a system (Henderson & Clark, 1990).

In this typology, products and technological innovations are material, while the other classes are non-technological and intangible, such as organizational reimagining (Meeus & Edquist, 2006). We focus on material and technological innovations in this study. Thus, we used theoretical sampling (Eisenhardt, 1989; Eisenhardt & Graebner, 2007; Miles & Huberman, 1994) to select cases corresponding to each of those categories: product, process and foundational.

DATA SOURCES

We used several data sources, including semi-structured interviews with focal executives, informal follow-up interviews, and secondary data sources, including archival material. We conducted 32 interviews using a semi-structured protocol, ranging from 60 to 90 minutes with two to four respondents per smart industry initiative. We asked informants about their company's experience with IoT, the IoT project description, technologies project's evolution over time, partners involved and nature of the relationship, challenges to implementation, and outcomes.

We created a summary of each interview and submitted it to the interviewees for accuracy and their thoughts and reactions. Some projects spanned multiple years, so we conducted interviews at different points to understand the initiative's evolution. We used secondary data to triangulate information from the primary data sources.

DATA ANALYSIS

Our unit of analysis was the smart industry initiative in each case study. The investigation involved an iterative approach of systematically combining theoretical concepts with field data (Dubois & Gadde, 2002; Saunders, Lewis, & Thornhill, 2009). Such strategy allows the researcher to cross-fertilize and develop new combinations of constructs through an iterative synthesis of existing theoretical concepts and new concepts emerging from the empirical reality (Kovács & Spens, 2005).

We follow that inductive process to derive insights and our framework. We conducted within-case analyses focusing on the smart industry initiatives' salient characteristics, heterogeneity and distance involved, and inter-organizational governance issues. We prepared case study reports and submitted them for informants' review, a measure recommended to improve credibility and truthfulness in case study research. Next, we carried out a cross-case analysis to identify similarities and differences across the three categories of projects and highlight any emerging patterns.

WITHIN-CASE ANALYSIS

This section summarizes our findings for three categories of smart industry cases, encompassing product, process, and foundation technology. First, we engaged in a sense-making process to identify the initiatives' value capture proposition within each category and its position within the technological architecture. Then, we cross-referenced each project's characteristics and scope with the literature on distance and technological heterogeneity to typify and describe them. Finally, we examined the inter-organizational activities' governance. The within-case analysis produced a concise description of the organizational and technical characteristics of each smart industry project.

SMART INDUSTRY INITIATIVES FOCUSED ON PROCESS

The first category projects encompassed a smart production process, smart maintenance of cranes, smart tracking of waste containers, and smart maintenance of production equipment. Table 3 presents a brief descriptive summary of the cases in this category. While not precisely equal, closeness was the preponderant norm in searching for and selecting a

Table 3. Cases on Smart Industry Initiatives Focused on Process.

Organization	Automotive Supplier	Steel Manufacturer	Waste Management Company	Cosmetic Producer
Project	Smart production process	Smart maintenance of cranes	Tracking waste containers	Smart maintenance of production equipment
Partners involved	Current equipment manufacturer and local specialist supplier	Current equipment manufacturer	A start-up that delivers the hardware	Office of current local telecom solutions provider
Technological integration	Performed by the automotive supplier with the support of the specialist supplier	Performed by the equipment manufacturer	Performed by the start-up	Performed by the telecom supplier

partner for the cases in this category. The focal organizations primarily worked with local suppliers with whom they already had some familiarity and used standard transactional contracts to manage the partnership relation.

The *first application* in this category aims to improve a factory's internal manufacturing process by aggregating different data sources within a central database to highlight production issues. Examples include equipment availability or breakdown and output quality issues. Production equipment generates rich data streams using sensors. The supervisory control and data acquisition (SCADA) systems transmit the data to the central database, where a business intelligence tool is used to perform analysis. The production equipment supplier provided the technology that captures and transmits data. Therefore, the project required developing a database and using software capable of handling the large data volume. An informant's statement captures the need to access external knowledge, its nature, and the decision's rationale:

> Today we need to invest, on top of the database, into a software that can help make things easier to work with the data. We want a low code solution, and we try to limit the number of layers of systems we use. We used a specialist company to work on our choice of database technology, and they also helped us on a specific machine connection to gain some speed.

In this project, the most pressing issue in ascertaining value capture consisted of aligning performance across the different layers, so data are effectively produced, stored and analysed. They used an existing IT supplier through a collaborative partnership to access the required capabilities and technology.

The *second initiative* in this category sought to enhance the maintenance process for cranes used in a steel manufacturing environment. This application sought to increase the efficiency of the equipment and transform fixed cost into a variable cost. Instead of incurring fixed costs by making capital investments in the machine, parts, maintenance programme, etc., the organization started paying per use of the equipment (time the cranes operate and weight they carry). The equipment produces and transmits data to the cranes' manufacturer, which uses it to perform predictive maintenance. The crane's manufacturer has integrated the necessary technologies within the cranes and had already worked on such projects with other organizations. The project led to a change in the pricing model, and the supplier now performs maintenance as a service based on the weight moved, the time required to complete the work, and the energy consumed. The steel manufacturer and the crane's supplier already had an established relationship. The most pressing issue in ascertaining value capture in this project required estimating the decision's financial implications. Access to the necessary capabilities and technology was achieved thanks to a standard collaborative partnership with a very familiar supplier.

The *third application* sought to track the location of thousands of waste containers used by organizational customers such as in construction, mines, harbour, and industrial sites. This application sought to reduce the time spent searching for the containers, prevent losses, and reduce the number of containers purchased. It encompasses a piece of hardware with extended autonomy to signal the container's place, a network layer to transmit the signal information, and a software layer to manage the location. A start-up supplied a complete solution, including the hardware and the software platform.

The most pressing issue in ascertaining value capture in this project was selecting tracking devices capable of satisfying stringent requirements, including quality, hardware ruggedness, and manufacturing scalability. The following informant's statement describes these aspects:

> The selection of the hardware provider needed to integrate some very stringent requirements in terms of ability to scale and deliver a large volume of defect-free hardware and they also needed to offer a robust piece of hardware that could sustain external shocks and tough environmental conditions.

The firm needed a partner able to deliver devices at a large scale (40,000 units). Besides, the devices must be highly reliable, as even a very low percentage faulty of the 40,000 devices in the field would cause huge logistical issues and costs. Thus, access to the required capabilities and technology was achieved through a collaborative partnership but involved an unfamiliar start-up partner, as no other option existed for the hardware.

Finally, the *fourth application* in this category sought to improve the maintenance of machines designed, produced, and used internally by a manufacturer across 11 global sites. When a piece of equipment in a given location presented problems, the organization needed to dispatch an expert. This project sought to enhance the maintenance process's efficiency, improve equipment availability, and reduce corporate maintenance experts' travel. The solution builds on augmented reality.

The supporting hardware, software and connectivity technologies are all off-the-shelf. The organization developed the solution in partnership with an existing IT provider's local office, which enhanced the software and integrated the different technologies required. One informant described the collaboration's nature as 'we provided clear requirement and scope to them. They could work from the start with the right use case, the right requirements, and to progress through iteration. We had a great cooperation'. Access to the required capabilities and technology was achieved through a standard collaborative partnership with a familiar local IT supplier who developed and integrated the solution.

SMART INDUSTRY INITIATIVE FOCUSED ON PRODUCT

The second category projects encompassed smart metering, smart pump capabilities, data services, and a smart consumer product. Table 4 presents a brief descriptive summary of the cases in this category. Again, while not precisely equal, some distance and heterogeneity were the preponderant norms in searching for and selecting a partner for the cases in this category. The focal organizations worked with one or multiple strategic and often somewhat distant suppliers with whom they could be unfamiliar and used more alliance-based contracts to manage the relationship.

Table 4. Cases on Smart Industry Initiatives Focused on Products.

Organization	Utility Company	Water Infrastructure Company	Motor Vehicle OEM	Tennis Equipment Manufacturer
Project	Smart metering and provision of data services	Better maintenance and provision of data services	Better customer service and provision of new data services	Complementary hardware and new data services
Partners involved	Alliance with two suppliers to setup a market standard	Supplier of a complementary technology to avoid lock-in with the core technology supplier	Collaboration with a university spinoff created for the project to avoid dependency on traditional suppliers	Partnership with a start-up
Technological integration	Performed through an ongoing collaboration encompassing development and commercial activities	Performed through a collaboration with the supplier	Performed as part of the collaboration between the OEM and the spinoff	Performed as part of the collaboration between the manufacturer and the start-up

The *first application* in this category sought to automate and increase the frequency and accuracy of metering data collection and creating additional services. The organization developed the software layer, an existing and familiar telecom provided the network and radio system to transfer the data, and a new supplier provided the meter expertise. The project entailed groundbreaking developments, as no off-the-shelf solution was available.

The idea was to develop an industry standard and new technology to sell in the open market. Access to the required knowledge and capabilities was through a strategic collaboration among the three organizations. The following informant's statement represents such governance outcomes: '*The value created benefits the three partners by creating a new technical standard on the market which led to differentiation*'. The engagement involved a more strategic collaboration and required co-investment, coordinated commercial strategy, periodic technology review and a royalty mechanism.

The *second application* in this category sought to control and maintain water infrastructure. This control system can be sold to the final clients or operated as a service for them. The organization developed the software layer and managed to access data through the supplier of electrical systems. This complementary technology provider allows the organization to bypass the water pump supplier, the core technology provider. The infrastructure moves the wastewater to a water treatment installation.

The most pressing issue in ascertaining value capture in this project was overcoming dependency on the water technology manufacturer, which favoured proprietary solutions that lock in clients. As water technology suppliers compete with their clients to sell installations to the final users, the competitive stakes were significant. The pump manufacturers can bypass their clients (utility companies) and offer an intelligent pump directly to clients with small installations (a large building like a hospital or a jail). So, to avoid dependency on suppliers who increasingly act as a competitor, they decided to capture data from the electric system and not the pump, hence developing a collaboration with the electric equipment supplier.

By implementing a solution where data are accessed from the electric system rather than from the water system, the organization could protect its competitive position. One informant described such dynamics in the following terms: 'It was important for our company to eliminate this dependency, to gain a better commercial position and some differentiation with the new solution'. The organization achieved that goal by strategically collaborating with the electrical system provider interested in generating more value out of this market.

The *third application* in this category sought to enhance customer service and provide additional data services for motor vehicle owners. The solution encompasses software and hardware on top of connectivity technologies. The organization's R&D expertise was in mechanical technology; it had a limited understanding of the project's diverse digital technologies. Initially, the organization co-developed a system with a supplier. However, the organization concluded that they would not secure exclusivity and the solution would become available to competitors. Therefore, it became necessary to ensure access to an alternative to ascertain value capture.

Developing the solution involved creating a spinoff organization from an academic institution to access the technology building blocks software, hardware and service. This strategic collaborative solution also allowed the organization to gain access to ongoing exploratory capabilities that provide a competitive advantage. The following informant's statement is indicative of the solution's outcome and the concerns with ascertaining value capture: 'We realized that working with them would be a great way to avoid supplier lock-in, to access solid technical expertise and funding opportunities for further research'.

The *fourth application* in this category sought to develop complementary wearable technology and online services that supplement tennis equipment. The hardware includes a sensor with a trained AI technology to interpret the sport's motion, and Bluetooth technology transmits data to the application layer. The project's outcomes allow players to observe their performance in real-time, monitor their evolution, and compare their performance to others.

The organization developed the solution through a strategic collaboration with a start-up, which was already developing connectivity solutions for other sports equipment manufacturers with exclusivity clauses in each sport. One informant described the value of complementarities, stating that 'as a company specializes in connected devices, you have an opportunity to build on complementary capabilities and to co-brand the connected device'. The start-up developed and integrated the technologies that were co-branded and sold by the tennis equipment manufacturer.

SMART INDUSTRY PROJECT FOCUSED ON FOUNDATIONAL TECHNOLOGY

The third category projects encompassed developing a low-power wide-area network (LPWAN), an open radio access network (RAN), and an open architecture for microprocessors. Table 5 presents a brief descriptive summary of the cases in this category. Distance, heterogeneity, and often scale were the prevailing norms in searching for and selecting needed partners for the cases in this category. As a result, there were often multiple organizations involved in an ecosystem sourcing relationship.

The first project in this category sought to provide technological foundations for multiple IoT applications across various sectors. This project is a connectivity solution that enables lower power consumption. Two organizations, one hardware and one software specialist, alongside a telecom partner representative, initiated an open, non-profit technology alliance (the LoRa Alliance) to standardize LPWAN, attracting over 500 members. The coalition supports and promotes the global adoption of the LoRaWAN standard by

Table 5. Cases on Smart Industry Initiatives Focused on Foundational Technologies.

Organization	IoT Platform Provider	Telecommunication Technology Provider	Electronic Firm
Project	Develop technologies supporting low-power wide-area networks	Develop an open radio access network	Develop a processor's instruction set architecture
Partners involved	Initiated by a hardware provider and an integrator and then supported by a technology alliance	A multi-firm collaboration conducted the pilot. The solutions were standardized and promoted through multiple ecosystems	Initiated by an academic institution turning into multiple ecosystems established around specific firms and foundations
Technological integration	A technology alliance addresses interoperability issues. Individual companies as an ecosystem of partners and suppliers contribute to integrate specific technologies for specific projects	A standard's body defined some standard interfaces. Integrators emerging from early adopters integrate specific implementations	One foundation ensures the integrity of the ISA and provides verification tools. Other ecosystems provide complementary technology or offer development platforms

ensuring all LoRaWAN products' and technologies' interoperability. Organizations now have their respective ecosystems of partners who provide multiple technologies needed to create specific IoT applications. We see extensive ecosystem sourcing collaborations taking place and characterizing this project.

The LORA alliance serves as a neutral, open ecosystem that brings together all companies interested in the technology. The following informant's statement captures the benefits of such governance:

> If we take the example of a smart city, instead of having one network for waste management activities, one for smart meters, one for the traffic light system, here you have only one. It started by attracting international players like Cisco and Schneider Electric, and then it allowed creating more local alliances for regional markets. This scheme is a great way to identify and integrate new partners.

Each solution encompasses heterogeneous sets of technologies delivered by the ecosystem partners. The hardware company ascertained value capture through proprietary technology, while the software partner contributed through a first-mover advantage in offering a complete LPWAN IoT platform.

The *second project* in this category sought to provide a technological foundation for 5G applications that enable smart industry initiatives. A network of organizations, including Facebook, telecommunications companies, start-ups, and technology suppliers, jointly piloted projects to deploy the first Open Radio Area Network (Open RAN) in areas where limited connectivity existed. This solution allows them to disaggregate the network and to mix and match different components from various suppliers. This organization creates more competitive solutions by reducing dependencies on an integrator.

The Telecom Infra Project (TIP), a foundation that brings together hundreds of companies to design, build and test advanced connectivity solutions, led the pilots. A more traditional industry-standard group, the O-RAN alliance, complemented the TIP ecosystem to establish Open RAN as a solid market contender. The Open RAN coalition is a lobby group that promotes policies favouring the adoption of Open RAN. The most pressing issue in terms of value capture was bringing together the various telecoms, hardware, and software vendors to design and promote the adoption of this new architecture. The following informant's statement captures the complexities and challenges involved: 'This was not a new problem within the telecommunication sector. We needed to create a new value chain with plug and play elements and to facilitate the introduction of new vendors that bring innovation and lower costs'.

The solution involved the establishment of complementary ecosystems with different goals over time. Again, a preponderance of ecosystem collaborations characterizes this project.

The *third project* in this category supports the design of processors dedicated to IoT applications. RISC-V is an open Instruction Set Architecture (ISA). Its openness and modularity allow the creation of domain-specific processors. Andes Technology's Chief Technology Officer describes how RISC-V allows integrating Artificial intelligence in IoT applications:

> For AIoT SoC development, RISC-V offers the advantage of a standard ISA that allows designers to create custom instructions for Domain-Specific Acceleration. This proposition provides a competitive advantage, product differentiation, and cost and power savings over alternative ISAs on the market.

A university started RISC-V and donated it to the RISC-V foundation, which brings together hundreds of companies who promote and advance the use of RISC-V.

Going from an ISA to a processor requires a broad array of heterogeneous capabilities to support the design, customization, testing and manufacturing of a processor based on the project. The following informant's statement captures the value creation benefits of such organization governance:

> If you just really wanted something off-the-shelf, then, of course, using something proprietary makes sense. But for innovative innovation developments, you are going to be able to collaborate more effectively. You are going to advance more quickly. The total cost of doing that will for sure lower.

The RISC-V foundations and complementary initiatives centred on RISC-V foster the development of those required capabilities.

CROSS-CASE ANALYSIS

In the cross-case analysis, we attempted to identify patterns across the various categories of initiatives. We outlined a set of factors and characteristics linked to smart industry projects during the within-case investigation. During the cross-case analysis, we organized those factors and features across the categories of smart industry initiatives. We transferred each element we identified for each project category from the original data displays to displays focused on a single construct.

This exercise allowed us to reposition the data from a case-by-case arrangement to a construct-by-construct scheme. Table 6 summarizes this information. We performed multiple iterations in the process of moving the data from case-based displays to construct-based displays. During this phase of the analysis, we sought out common patterns to draw insights and formulate conclusions.

We incorporated literature at this stage to compare and contrast our findings, essentially using the literature as an additional source of validation as advised by Eisenhardt (1989) and Kaufmann and Denk (2011). Comparing the projects reveals predominant patterns common across five dominant themes and case categories. These themes are the goals driving partner search, the organizational distance between partners, technological heterogeneity, partner selection decision criteria, and governance/coordination structuring partner relationships. While the specifics are not precisely equal for each category within

Table 6. Cross-Case Patterns Summary.

	Predominant				
Project Focus	Partner Search Goal	Distance between Firms	Technological Heterogeneity	Partner Decision Criteria	Governance/ Coordination
Process	A partner who can integrate all required technologies most efficiently	Two close firms	Low	A close partner to minimize risks	Partnership
Product	A partner who can assist in integrating all required technologies and contribute towards the desired differentiation	Two or three distant firms	Low/medium	A partner, even if distant, that allows to control differentiation factors	Collaborative strategic development with close interaction and monitoring of the distant partner
Foundational technology	Partners who offer complementary technologies and market access	Multiple firms with heterogenous degrees of distance	Very high	Partners with complementary capabilities and access to market	Ecosystem collaboration involving promotion of a standard and interoperability

cases, they are congruent and would cluster around the same region on a potential continuum. Table 6 summarizes the patterns across the project categories and themes.

Partner Search Goal. The projects we sampled varied in the goals driving partner search considerably according to the project's focus.

Process-oriented smart industry projects present a relatively limited range in terms of value scope, mostly bounded internally, exploiting available technology, pursuing improvements, and ultimately improving efficiency. For instance, the third application in this category sought to reduce the time spent searching for containers, prevent losses, and reduce the number of boxes acquired. This application reveals a focus on reducing costs, improving operations, and increasing efficiencies in general. Correspondingly, our analysis shows that the goals driving partner search for this category mainly focused on identifying one able to integrate all required technology for the focal firm at the lowest price. This finding was familiar to the other cases in our sample in this category.

Product-focused smart industry initiatives exhibit a more ample reach than the previous class and some knowledge exploration activity – the focus shift towards the market to sell intelligent products. For instance, the fourth application in this category pursued developing a wristband, complementary hardware to the existing product, and additional online data services. Correspondingly, our analysis shows that the goals driving partner search for this category focused on finding a partner who could help the focal organization integrate all required technologies and contribute towards the desired product differentiation. Such a pattern was typical for the other cases in this category.

Foundational technology-focused initiatives display the farthest reach in terms of potential value capture, involving the development of enabling ground-laying technology potentially deployable in numerous applications as part of the solution. For instance, this category's first project has allowed users to assemble and sell the technological foundations

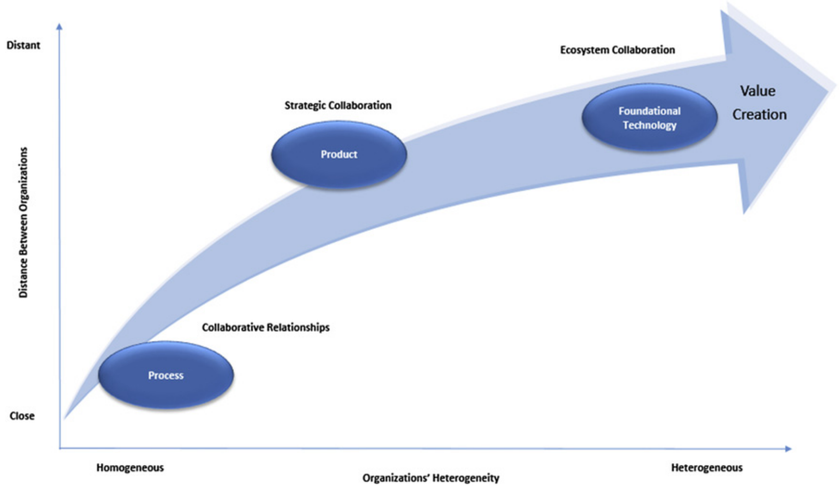

Fig. 1. Accessing and Integrating Capabilities in Smart Industry Initiatives.

for multiple tracking and monitoring solutions across various sectors. Our findings reveal that the goals driving partner search for this category focused on identifying those with complementary technologies and enabling market access. Table 6's second column shows the variation across the projects' bundles. Fig. 1 synthesizes the findings, and Figs. 2–5 provide additional details.

Distance (or Dimensions of Proximity). Here also, the projects we sampled exhibit a dominant pattern conforming to the project's focus. In general, *process-oriented* smart industry initiatives presented mostly limited knowledge distance, with projects predominantly exploiting or leveraging existing knowledge bases and exploiting technological competencies of the involved parts or those relatively easy to acquire on the market. For instance, this category's second project involved a supplier with experience implementing such projects with other clients and leveraging the focal organization's existing competencies. Furthermore, this category of projects also displayed a predominantly close organizational and institutional distance. The companies involved mainly showed the same corporate form or the same legal entity and operated under mostly similar norms. Finally, the physical distance among the participants was relatively close, involving mostly local or geographically proximate partners.

Product-focused smart Industry initiatives, in general, exhibited more distance regarding the knowledge, organizational and institutional dimensions, and sense of exploration. When knowledge and institutional distance were high, organizations tended to work with local or proximate partners. This distance relates to the company that contributes to integrating all required technologies for the project. For instance, the third case organization in this category focused its knowledge base and competence on mechanical technology. It had a limited understanding of the aspects encompassing user experience in a digital environment and little AI and software knowledge. The organization cooperated strategically with an academic institution (more distant organizational form) to advance the project and eventually created a spinoff. Similarly, the organization in the fourth application in this category cooperated with a start-up (more distant organizational and institutional form) to obtain multiple competencies.

Foundational technology-focused initiatives displayed the most significant distance as related to all dimensions. And this applies to relations across an assortment of partners who all contribute to developing solutions encompassing foundational technologies. For instance, the first application in this category required the combination of exceedingly heterogeneous knowledge bases and technologies and involved multiple technology providers, partners located across different countries, and numerous ecosystems. Table 6's fourth column shows the variation across the bundles of projects.

Technological heterogeneity. The projects we sampled exhibit a considerable amount of technological heterogeneity across the project's focus. In general, *process-oriented* smart industry initiatives presented less technical complexity than other initiatives. Organizations were accessing different technical competencies and skills restricted to engaging partners from diverse technological backgrounds to supply mostly packaged or off-the-shell existing solutions. Leveraging their existing knowledge base and infrastructure constituted a significant component of the implementation.

As organizations needed complementary technology unavailable in other parts of the organization to complete the solution's development and implementation, they usually sought partners with low cognitive proximity. However, those partners mainly were existing or familiar relations, close geographically. The range of technological layers addressed within the project was narrow. For instance, this category's first case leveraged the current SCADA system and the factory communication infrastructure and databases. The second case involved a partner already experienced in implementing the solution.

Product-focused smart industry initiatives exhibited scant to mostly medium technological heterogeneity. This category's projects required integrating and deploying existing components available either internally or through immediate partners, increasing the cognitive distance. For instance, partners' capabilities in the third and fourth cases enabled developing specialized software or hardware for specific needs and context.

Foundational technology-focused initiatives displayed high heterogeneity. They typically encompassed many layers, technologies, and applications that need to operate effectively together. They also involved the continuous development of new knowledge and solutions. For instance, this category's fourth case required the ongoing combination of knowledge bases and technology coming from organizations of very different sizes, geographic locations, and technical backgrounds. The result of those requirements is greater cognitive distance and technological heterogeneity.

Partner Decision Criteria. The projects we sampled exhibit a clear pattern in terms of the criteria for partner selection. *Process-oriented* smart industry initiatives are geared towards an integrated solution in a specific sector or geography and adopted by the organization that undertook the project. For instance, the fourth application in this category sought to improve the maintenance of machines designed and manufactured internally for their own use across global sites. We found that this category involved primarily identifying a close partner to minimize risks as the primary decision-making criteria.

Product-focused smart industry exhibits a similar integrated solution pattern still bounded to a specific sector or geography and sold to the organization's client who undertook the project. The first application in this category illustrates this pattern in the water-infrastructure control system market. Our findings indicate that this category mainly involved finding a partner, even a distant one when needed, which would allow maintaining control of factors contributing to differentiation as the primary decision-making criterion. The underlying motivation was ascertaining exclusivity.

The *foundational technology-focused* projects display a broader span by shifting towards applications across multiple sectors and geographies. Our analysis shows that partner decision-making criteria in this category are driven by identifying complementary capabilities that can form a complete solution and allow access to the market. Table 6's third column shows the variation across the bundles of projects.

Governance/Coordination. Finally, we also observed projects we sampled exhibit clear patterns in how they structured the relationships with partners conforming to the project's focus. In general, *process-oriented* smart industry initiatives tended towards partnership, where the organizational proximity enable trust. The leading firms seemed to typically reach out to local organizations already known to them before starting the project. For instance, the organization in the third case in this category engaged the local office of their telecom provider, which developed the necessary software and performed the technological integration. The other cases in this category displayed similar patterns.

Product-focused smart Industry projects tended towards strategic collaboration with more distant organizations, more structured cooperation agreements, and a deeper coordination level than the previous category. For instance, this category's first case involved a formal cooperation agreement encompassing co-investment, cost and profit-sharing mechanism, coordinated strategy royalty agreement, and periodic technological review. The following informant's statement captures the issue:

> When you go to, say a traditional supplier, it was more bargaining situation. It's a bit more complex, and then some suppliers are strong in hardware, but they are not as strong in software. Suppliers who were approaching maybe haven't shared completely the same vision we have.

The *foundational technology-focused* initiatives tended towards more sophisticated and non-traditional collaboration, ecosystems collaboration, which bring together distant partners and typically involve large scales. For instance, the third case on this category encompasses multiple ecosystems that interact, complement and support the original project. Start-ups that provide processor development services have their own ecosystems of partners for intellectual property, extensions and production. An ecosystem structured around a not-for-profit foundation offers global education and verification services. A group of companies orchestrates the development of complementary open technologies, and other ecosystems support the development of processor design capabilities in diverse countries. These ecosystems interact, and the assets and relationships criss-cross them. They illustrate the complexity and sophistication of the governance characteristic of this category. The multiplicity of ecosystems and the type of governance adopted enable the integration of a highly diverse set of organizations who have different agendas while sharing some common goals.

ANALYSIS AND DISCUSSION

Our analyses suggest that the scope of value creation and the partnership structure (search and selection criteria) needed to capture value correlate with organizational distance, technological heterogeneity and project focus. Distance and heterogeneity vary following the project focus, as do the goal for partner search and the criteria for selecting partners. As Fig. 1 summarizes, heterogeneity and distance increase as we move from process-focused projects to foundational technology-focused projects. Besides, heterogeneous sets of technologies correlate with the distance between the organizations and require more complex and sophisticated forms of governance and coordination. According to the smart industry project's focus, we can have more collaborative ties, strategic collaboration and development between relatively close and distant partners, or collaboration between heterogeneous partners within ecosystems. We next suggest the reasoning.

Process-oriented smart industry initiatives drive firms to find the most efficient way of gaining access and integrating a combination of new technologies. They do not seek exclusivity and true novelty. On the contrary, they tend to look for a reliable mix of available technology to deliver the expected outcome. Therefore, they go to the closest partner with the relevant capabilities to handle the technology heterogeneity. They can implement such an approach by selecting a company with which they have worked before and with which they share knowledge bases, social ties, norms, and even physical distance. On the other hand, suppose they search for partners with low levels of the various dimensions of proximity. In that case, they risk facing difficulties they will not be well placed to solve without investing significant time and energy in the relationship and the project itself.

Based on these findings, we conclude that if leadership teams are looking to exploit technology to improve the firm's processes and make them more efficient, this will likely be primarily an internally focused endeavour that involves partners as close as possible to them. Leaders do not have to seek access to distant capabilities systematically and, for the most part, do not need to worry about property rights or sophisticated coordination mechanisms. As suggested in Fig. 2, the decision should focus on partnership with local or known organizations to compensate for any cognitive distance required to bring in complementary knowledge bases and technology. Here, organizations can access needed knowledge through typical market mechanisms and look for the availability of familiar and proximate organizations to perform the integration, keeping the project as simple as possible.

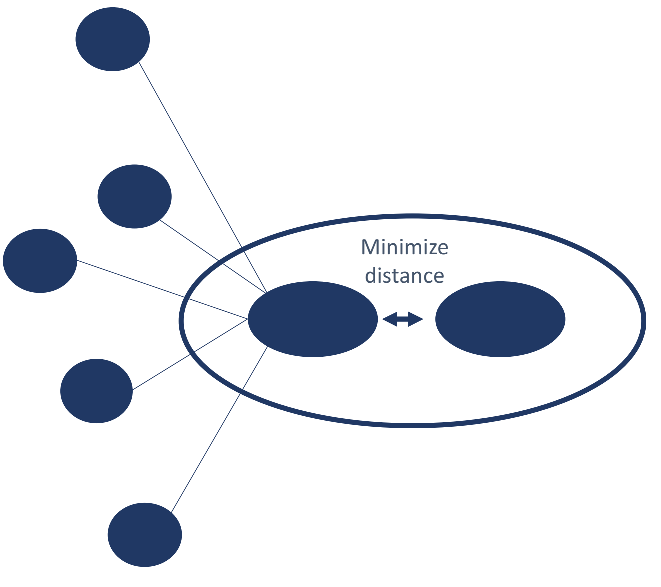

Fig. 2. Accessing and Integrating Capabilities in Process-Focused Smart Industry Initiatives.

Product-oriented smart industry initiatives face the challenge of producing something distinctive, not yet available in the market through competitors so that the organization can capture value from the initiative as a first mover. However, because the organization needs to design something distinctive to capture value through the market and some explorative capabilities, the decision will likely involve searching for a more distant partner, possibly an upstream player – see Fig. 5. Such effort will likely require managing a more structured and strategic collaboration with perhaps a single more distant organization. Formal development agreements will ascertain control of any intellectual property and the corresponding market benefits.

Firms need to ensure that they can derive a competitive advantage out of their offering. They need to ensure access to rare, hard to imitate, hard to substitute resources. This need explains why they establish partnerships with more distant partners. They need exclusive access to a combination of technologies that can help them deliver differentiation. Suppose they go to a close industry partner. In that case, it will be difficult for them to gain this exclusivity from a supplier that wants to serve the whole market and capture a large amount of value through proprietary solutions. A more distant partner can also allow access to emerging new technologies that can deliver a temporary advantage compared to the competition. The distance at stake here is knowledge (latest technology) and institutional distance (e.g., spinoff, start-up). However, the companies we studied sometimes tried to counterbalance these types of distance by establishing partnerships with geographically close partners.

Suppose the organization aspires to build a new digital service that needs to integrate new technologies. In that case, leaders should search for more distant partners when it gives the organization an advantage in building a competitive market offering and capturing its value. Indeed, keeping control becomes an important issue. The partner might be a start-up or might be unfamiliar with the industry. A crucial takeaway is that, while the contractual agreements may differ only slightly from the previous category of projects in some cases, the essential distinctive issue is the investment in social capital that

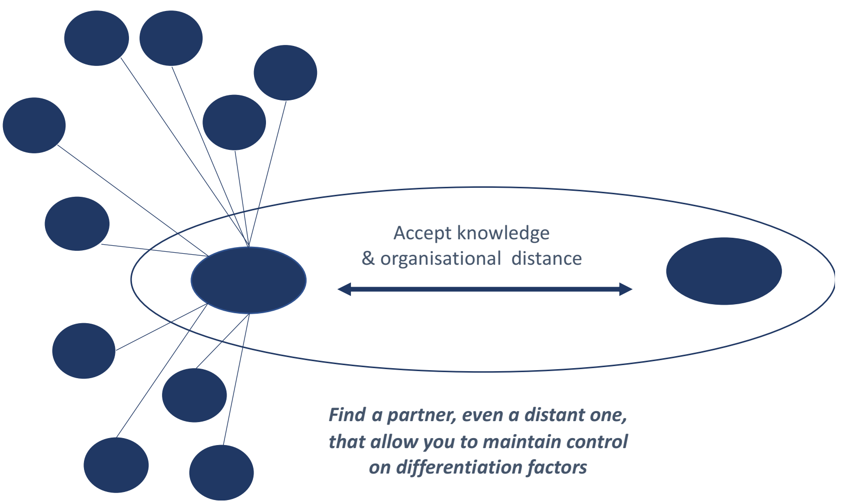

Fig. 3. Accessing and Integrating Capabilities in Product-Focused Smart Industry Initiatives.

starts from the very early stages of the project – and again, structuring the relation to ascertain control.

Foundation technology-oriented smart industry initiatives integrate ground-laying technologies in complex, multi-layered solutions. Selling technologies as part of more comprehensive solutions across multiple geographies and verticals generates value. These initiatives, therefore, involve high technological heterogeneity and distance across numerous dimensions. The solution is technologically advanced and innovative, so, as suggested by Fig. 4, the seller of foundational technologies must integrate a network of distant partners and possibly one or more complementary ecosystems to increase its ability to generate revenue.

These networks involve social structures that support the concurrent emergence and development of complex solutions and organizations. These ecosystems are developed around open standards, open architectures and open-source technologies. On the one hand, this increases the solutions' adoption and expands their potential markets. On the other hand, this can challenge the ability to capture value from foundational technologies that become more standard and open. As such, progress and value capture become dependent on the alignment and successful relationship and contribution among many participating organizations within the ecosystem. The development of such healthy and growing ecosystems enables adopting the foundational technologies in different sectors and geographies.

Out of the three initiative categories, heterogeneity mainly impacts the governance of foundational technologies. To develop a specific application, a company favours a partnership with a single or a small number of partners who have the necessary infrastructure to integrate the required foundation technologies. In contrast, an ecosystem is the best-suited governance form to handle foundational technologies diversity and complexity. Indeed, the ecosystem brings together a large group of firms that can perform joint development, ensure technology interoperability, and follow a standard. They also

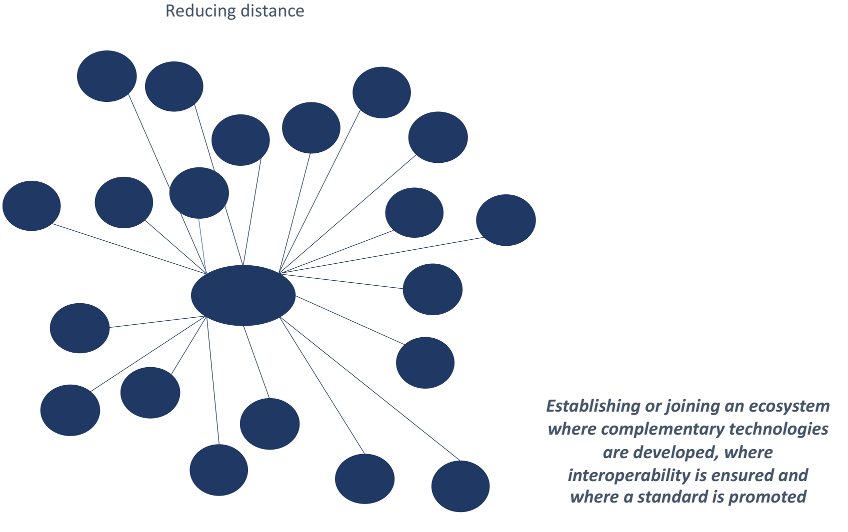

Fig. 4. Accessing and Integrating Capabilities in Foundation-Focused Smart Industry Initiatives.

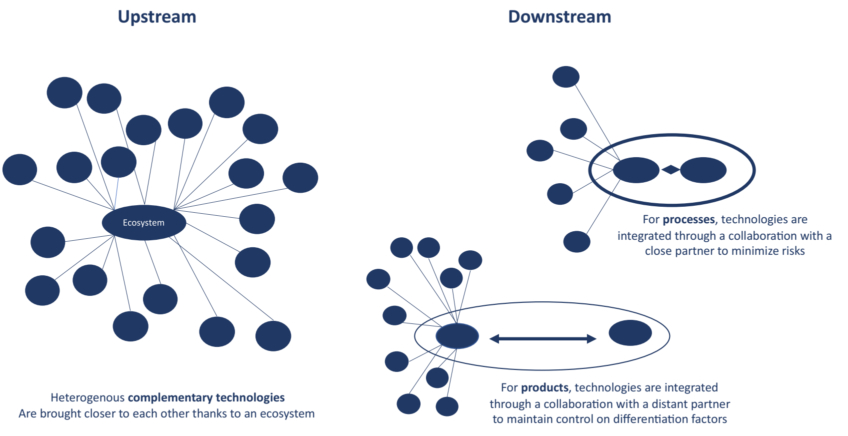

Fig. 5. Accessing and Integrating Capabilities Upstream and Downstream.

promote the technology they have coalesced around (IoT protocol or processor architecture we have mentioned) and their offerings. These dynamics create a sense of community; they reinforce relationships and bring these companies closer together. The ecosystem, therefore, enables complementary technologies to meet but also to mix and match easily. Moreover, active participation in the ecosystem reduces relationship distances; this turns diversity into an advantage as specific offerings can be integrated later within solutions that match the particular requirement. Fundamentally, the ecosystem creates proximity (cognitive, social and geographic, at least temporarily and to some degree).

Suppose we consider firms downstream as integrating multiple distant technologies and maximize the value captured from these projects and upstream as those developing enabling technology and need to find market access across numerous intermediaries, applications, sectors and geographies. Then, as suggested by Fig. 5, from a downstream perspective, smart industry initiatives combine the physical with the virtual world by assembling heterogeneous and distant technologies into a technical and business architecture that delivers and captures value. From an upstream perspective, smart industry initiatives generate foundational technologies that combine with diverse complementary technologies and integrate them into technical and business architectures.

CONCLUSIONS

When a company wants to build or sell an intelligent system, it will face various heterogeneity and distance levels. It will need to structure the relations and integrate the solution into some form of governance to capture value. Our study's outcomes suggest that the smart industry initiative's scope informs the degree of technological heterogeneity involved, which tells the needed distance (familiar versus unfamiliar, similar or distinctive knowledge basis, etc.) and appropriate governance to ascertain value capture. As initiatives move from process towards foundational technology, value creation potential increases tremendously, but so do the complexity and challenges of capturing a portion of that value. To ascertain control and value capture, leaders may need to access required knowledge through distant partners (low organizational proximity), such as academic institutions and start-ups. Geographic, cognitive, social and institutional distances also tend to increase.

The case analyses highlight that innovative industry initiatives can be resource-intensive regarding the technologies and knowledge bases required, their integration, and the organization needed to capture value. Collaboration with different external organizations, including traditional suppliers and non-traditional ones such as start-ups and research organizations, brings in the necessary knowledge and technological expertise. However, organizations need to skillfully interact with those external actors, combine the different knowledge bases, select the appropriate distance, and strategically structure the relations according to the heterogeneity of technologies involved to capture value from such initiatives.

We call that ability distant 'capabilities integration' and propose it as a dynamic capability. Dynamic capability is the organization's ability to integrate, build and reconfigure internal and external resources to address and shape changing business environments (Eisenhardt & Martin, 2000; Teece, 2018; Teece & Pisano, 2003; Teece et al., 1997; Winter, 2003). We see that these activities encompass all the initiatives we studied in this research to at least some degree. We put forward theory that distant capabilities integration will drive smart industry initiatives' success. Organizations with superior distant capabilities integration should not only produce innovative outcomes but also capture value from them.

In contrast, organizations unable to diagnose the required collaboration distance and corresponding relationship structure according to the initiative's heterogeneity and scope, while successfully interacting with external actors and integrating their knowledge bases into a coherent technological solution, will, at best, capture less value or, at worse, fail. We hope that our exploratory research helps decision-makers embark on smart industry initiatives and opens up a fruitful avenue for future research.

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