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Svante Schriber
Stockholm University

Jan Löwstedt
Stockholm University

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Tangible resources and the development of organizational capabilities

Svante Schriber [a,b,*], Jan Löwstedt [b,1]

[a] Stockholm School of Economics, 113 83 Stockholm, Sweden
[b] Stockholm Business School, Stockholm University, 106 91 Stockholm, Sweden

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Summary Capabilities theory concerned with how firms develop organizational capabilities to improve firm competitiveness prioritizes intangible resources as antecedents of capabilities. This theory takes organizational capabilities to consist of routines that evolve over time by being enacted in their organizational contexts. Extant theory has largely left tangible resources as antecedents unstudied, thereby neglecting potentially important insight into how capabilities develop. This paper uses an explorative approach and qualitative data from product development in two world-leading Nordic firms to study tangible antecedents of organizational capabilities development. Our findings contribute to research by expanding the scope of antecedents to organizational capabilities, with implications for explaining the competitiveness of firms.

Introduction

More than three decades ago, Nelson and Winter (1982) ignited new research attention in the area of heterogeneously dispersed capabilities to explain differences in firm performance (Amit & Schoemaker, 1993; Protogerou, Caloghirou, & Lioukas, 2012). Capabilities are central in explaining how firms manage the development of innovative products and services (Kotha, Zheng, & George, 2011), strategic alliances (Capaldo & Messeni Petruzzelli, 2011), and integrate acquisitions (Heimeriks, Schijven, & Gates, 2012). More broadly, its ambition to explain how firms perform in relation to their competitive environment (Helfat et al., 2007) has made capability research one of the dominating schools of strategic management research (Barreto, 2010).

The importance of capabilities for firm performance has made the development of organizational capabilities a topic of much study (Arikan & McGahan, 2010; Narayanan, Colwell, & Douglas, 2009). In line with its origins in evolutionary economics (Nelson & Winter, 1982), this research generally regards capabilities as consisting of routines (Teece, Pisano, & Shuen, 1997) and has revealed several resources that influence these routines, thereby acting as antecedents of capabilities. Until now, research attention has been focused almost exclusively on certain types of (intangible) resources as antecedents of capabilities simply by virtue of their being intangible. Intangible resources are understood to be a more

* Corresponding author. Tel.: +46 8 73 69 000; fax: +46 8 31 81 86.
E-mail addresses: svante.schriber@hhs.se (S. Schriber), jan.lowstedt@fek.su.se (J. Löwstedt).
[1] Tel.: +46 8 6747438; fax: +46 8 1620 00.

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likely source of sustainable competitive advantage since they are typically more difficult to imitate (Barney, 1991; Dierickx & Cool, 1989). As a result, research has emphasized the important influence from different knowledge resources (Dosi, Faillo, & Marengo, 2008; Easterby-Smith & Prieto, 2008; Prieto, Revilla, & Rodríguez-Prado, 2009), as well as that of networks (Rothaermel & Hess, 2007) and organizational cultures (Macher & Mowery, 2009), as antecedents to organizational capabilities.

However, this focus on intangible resources implies a bracketing of resources typically labeled as "tangible" (Grant, 1996; Teece et al., 1997). Since tangible resources are recognized as indispensable aspects of the context in which organizational activities take place (Reed, 2005), neglecting these resources means bypassing a potentially important factor when accounting for how routines develop (D'Adderio, 2011). Consequently, there is a risk that this may restrict our theoretical understanding of how capabilities develop, and in turn of firm performance, thereby contradicting the espoused ambition of the capabilities field. A more inclusive approach to organizational capabilities development, e.g. by including tangible resources like physical artifacts as antecedents to this development, thereby offers the possibility of filling this gap in capabilities theory.

The aim of this paper is to contribute to capabilities theory by studying tangible resources as antecedents of organizational capabilities development. We take our point of departure in capabilities research that views capabilities as routines (Felin & Foss, 2009; Schreyögg & Kliesch-Eberl, 2007) that develop iteratively (Zollo & Winter, 2002) when used in their context of both intangible and tangible resources. Given the lack of attention to tangible resources as antecedents to capability development in particular, we apply an explorative, inductive approach. From an empirical standpoint, our study focuses on capabilities in product development that are central to the competitiveness of the two multinational firms studied, identifying categories of tangible resources as significant in relation to four distinct organizational routines.

The paper is organized as follows. We begin with a review of the existing research on antecedents of organizational capabilities. We then describe our methods — from gathering data to the analysis of the longitudinal qualitative data — followed by a presentation of our inductive findings of how tangible resources act as antecedents to a set of organizational routines central to product development. These findings are then discussed in relation to existing research on how capabilities develop, before we move on to draw our conclusions and present the implications for capabilities research.

Antecedents of organizational capabilities

At the heart of capabilities research is the search for explanations of how firms perform in competitive markets. Working from the evolutionary economics (Nelson & Winter, 1982) and resource-based traditions (Barney, 1991; Wernerfelt, 1984), capabilities research looks at organizational capabilities in an attempt to explain a firm's organizational ability to continuously renew itself through improved ways of operating (Amit & Schoemaker, 1993). Organizational capabilities derive their strategic importance from the ability to alter, change, reconfigure (Eisenhardt & Martin, 2000; Teece et al., 1997), combine (Kogut & Zander, 1992) and integrate (Grant, 1996) the resources controlled by a firm. Some capabilities are general and robust organizational processes, others elaborate and highly specific (Eisenhardt & Martin, 2000). Capabilities explain a wide set of a firm's abilities, including handling exogenous change (Drnevich & Kriauciunas, 2011), producing corporate entrepreneurship (Newey & Zahra, 2009), adapting to shifting markets (Rindova & Kotha, 2001), initiating and the benefit from strategic alliances (Kale & Singh, 2007), and continuously producing innovative products and services (Capaldo & Messeni Petruzzelli, 2011).

Capabilities can range from basic and common capabilities, to advanced, scarce, and more strategically important ones. Research has typically described the development of capabilities as a gradual process (Arikan & McGahan, 2010; Marsh & Stock, 2006; Zott, 2003) as routines are enacted in their organizational context (Levinthal & Myatt, 1994; Narayanan et al., 2009; Romme, Georges, Zollo, & Berends, 2010). Zollo and Winter (2002) describe this as a cycle whereby behavior is incrementally altered and retained, iterated in interaction with the assets controlled by the firm. Thus, rather than being created, capabilities develop as existing capabilities are used in interaction with a firm's resources (Amit & Schoemaker, 1993; Zahra, Sapienza, & Davidsson, 2006).

More specifically, and in line with its evolutionary economics origins (Nelson & Winter, 1982), capabilities research views capabilities as consisting of routines: purposeful and ongoing collective, conscious or unconscious processes and ways of working (Ambrosini, Bowman, & Collier, 2009; Becker, 2004; Rerup & Feldman, 2011; Schreyögg & Kliesch-Eberl, 2007; Teece, 2007; Winter, 2003). These routines develop through formal and intentional efforts as well as informal and unreflected actions by organizational participants in their daily work, and can be either explicit and formalized, or more loosely interpreted ways of solving problems (Becker, Lazaric, Nelson, & Winter, 2005). Since this is a gradual process without a fixed starting point (Foss, Heimeriks, Winter, & Zollo, 2012), capabilities development is typically approached through analyzing the use of firm resources when enacting organizational routines.

Current capabilities research has revealed the influence of several types of resources: human resources (McKelvie & Davidsson, 2009), organizational resources, and social capital (Subramaniam & Youndt, 2005), as well as knowledge (Easterby-Smith & Prieto, 2008; Grant, 1996; Montealegre, 2002) and organizational experience (Kotha et al., 2011), learning (Carpenter, Lazonick, & O'Sullivan, 2003), and feedback from both successful (Helfat & Peteraf, 2009) and failed projects (Elmquist & Le Masson, 2009; Marsh & Stock, 2003). Such resources are not only those owned and controlled by a focal organization. Rather, capabilities development relates to the influence on organizational routines at the individual, organization and network levels (Rothaermel & Hess, 2007; Zahra & George, 2002), from the value network (Capaldo, 2007; Newey & Zahra, 2009), including customers, competitors (Lisboa, Skarmeas, & Lages, 2011) and suppliers (Romijn & Albaladejo, 2002), and alliances (Capaldo & Messeni Petruzzelli, 2011).

The organizational structure and types of resources available have also been found to influence the development of capabilities (Persaud, 2005; Rindova & Kotha, 2001), along with internal communication (Smith, Collins, & Clark, 2005), trust (Chen & Wang, 2008), and managerial oversight (Gunther McGrath, 2001; Prieto et al., 2009). Relatedly, entrepreneurial spirit (Akman & Yilmaz, 2008; Dunphy & Herbig, 1994) and organizational culture (Chen & Wang, 2008; Drnevich & Kriauciunas, 2011; Lawson & Samson, 2001; Pandza & Thorpe, 2009) are antecedents of capabilities, e.g. through their openness to constructive conflict and willingness to disband old processes in favor of new ones (Danneels, 2008). Conscious efforts related to managerial agency, such as resource allocation or investments in particular resources (Aral & Weill, 2007) and skills and abilities of managers, are also important antecedents for capability development (Pandza & Thorpe, 2009; Romijn & Albaladejo, 2002; Teece, 2007), especially in its early phases (Narayanan et al., 2009).

In sum, while research on capabilities development has progressed with regard to viewing resources as antecedents of capabilities, and firms typically control both intangible and tangible resources (Nelson & Winter, 1982; Wernerfelt, 1984), the latter have largely been disregarded. This can be attributed to the resource-based view, which argues that sustainable competitive advantage *based on resources* is more likely to rest on intangible resources since these are more difficult to imitate and substitute (Barney, 1991; Dierickx & Cool, 1989; Peteraf, 1993). However, this does not explain the tendency to remain silent regarding the influence from intangible resources on the development of capabilities as a source of competitiveness (Barney, 1991; Montealegre, 2002; Teece et al., 1997). In other words, the research suggests that capabilities that underpin technological and evolutionary fitness (Helfat et al., 2007) operate and gradually evolve in a completely social or intangible context. Specifically, capabilities development research has until now left aside how tangible resources act as antecedents to organizational routines that together constitute the capabilities. We therefore see an opportunity to complement existing capabilities theory through the study of tangible resources as antecedents of capabilities. Given the relative lack of research in this area, a first step is to take an inductive approach to the impact tangible resources have on organizational routines.

Methods

Organizational routines are the unit of analysis in capabilities research (Regnér, 2008), in turn consisting of repeated, collective behavior (Nelson & Winter, 1982) that can be assessed using interview data describing daily work (Reynaud, 2005). Hence, aiming for a better understanding of how organizational capabilities and routines develop in relation to tangible resources, we designed an explorative, inductive interview-based case study. In line with the dominating view in capabilities research (e.g. Amit & Schoemaker, 1993; Grant, 1996) we labeled resources as "tangible" to the extent that they had physical, manifest properties. Analyzing interview accounts in which such tangible resources were central to routines allowed us to distinguish how tangible resources perform as antecedents of organizational capabilities.

Case selection

Case studies are favored when one wishes to paint a more complex picture of the relations between organizational capabilities and their antecedents (e.g. Danneels, 2011; Galunic & Eisenhardt, 2001; Montealegre, 2002; Narayanan et al., 2009). To take full advantage of our approach, we looked for comparable empirical cases (Eisenhardt & Graebner, 2007). Weighing the number of cases against the need for sufficient depth, we limited the study to two cases. We thus purposefully selected (Eisenhardt, 1989) long-time market leaders in competitive and dynamic markets that can be used as a proxy for organizational capabilities (Helfat et al., 2007). We approached two global market leaders in two different industries: Alpha and Beta (pseudonyms used for reasons of confidentiality). Key data of the two cases are given in Table 1.

Our initial fieldwork revealed that both industries were highly competitive, with continuous product development a central feature. Consequently, to ensure data intensity in the units arguably most closely associated with firm performance, our data collection was concentrated to the product development units of each firm. A focus on capabilities in product development as a source of competitive advantage is consistent with prior research (Hagedorn & Duysters, 2002; Lawson & Samson, 2001; Rothaermel & Hess, 2007; Subramaniam & Youndt, 2005), since such capabilities are central to firms in competitive markets (Crossan & Apaydin, 2010; Krishnan & Ulrich, 2001).

Data collection and analysis

Data were collected over the period of two years and consisted of three types: interview data, group interview data, and documents. The time period allowed for an iterative process, combining the initial analysis with data gathering, a strength in qualitative research (Dubois & Gadde, 2002). In accordance with existing research on routines (Becker & Zirpoli, 2008; Reynaud, 2005), we opted to use interviews as our main source of data. This study builds on 28 formal interviews, spread evenly between the two firms, in addition to numerous follow-up conversations. The interviews were semi-structured and the interviewees ranged from division managers and CEOs to engineers, though concentrated on engineers and middle managers in product development. Since the product development units in the two companies consisted of only some 40 employees each, this gave us a thorough understanding of the work processes in both units.

The first round of interviews, held in 2008, covered the formal and informal organizing and work processes of the units studied. This resulted in case studies of some 50 pages of detailed information for each organization regarding market conditions and the product development process from idea to final design. These within-case analyses were read by and presented to a selected group of interviewees during a group interview in each firm. This added data on the organization as well as increased precision with regard to details of activities, processes, and the like.

In 2009, we carried out a second round of interviews to achieve a more detailed view of the capabilities involved in the innovative work to specifically highlight the ongoing work

Table 1 The firms studied (figures for 2011).

Firm	Alpha	Beta
Approximate number of employees in total/at the focal site/in the studied product development units	16,000/1100/40	30,000/500/40
Turnover	3 billion Euro	6.6 billion Euro
R&D investment (percent of turnover)	2.3%	2.0%
Strategic positioning	Defend its position as market leader by providing customers with high quality products	Provide world-class quality mid-market solutions to avoid price-focused "commodity markets"
Signs of success in innovating	Listed as Thomson Reuters Top 100 Global Innovators [a]	Award-winning innovations [b]
Industry/division in focus	Heat technology products	Pulp and paper
Market position and importance of the studied division within the firm	Having more than 30% market share,[c] constituting 57% of firm's total turnover	15% market share, constituting 40% of firm's total turnover
Number of patents	200 (of 400 in total for firm)	n.a. [d]
Type of production	Process manufacturing	5—6 products annually

[a] http://top100innovators.com/top100 (retrieved 20 June 2012).
[b] For example, technical solutions for rolling paper at the end of paper machines; Beta website (retrieved 20 June 2012).
[c] Alpha website (retrieved 6 June 2012).
[d] As a technical leader, Beta makes selective use of patents to account for the long life expectancy of paper machines combined with weak respect of property rights in important markets. This makes the total number of patents less useful in measuring innovativeness in this case.

in the research process. We established detailed accounts of how work was performed, such as formal efforts to achieve incremental and radical innovation, development processes, intended feedback loops, persons involved in the various processes, management control tools, dependencies between units, what hindered and supported certain actions in innovation work, and the like. This was followed by a second group interview similar to the first, validating basic facts as well as gathering additional data.

Internal and official documents provided background information. Drawing on the strengths of documents for revealing primarily formal and ostensive, rather than performative aspects of routines (Becker et al., 2005), documents were used mainly to provide context with respect to organizational structure, planning of product development, and managerial support systems. Internal documents also helped to establish our view of the firms as successful by providing information regarding the market situation and the performance of each organization in its market, verified by publicly available documents.

When analyzing the data, we were struck by the discrepancy between our empirical material and existing theory on the antecedents of organizational capabilities: the tangible resources emphasized in the interviews, such as laboratory facilities, computer hardware, etc., were not accounted for in current capabilities theory. We therefore had to categorize interview accounts inductively to recognize tangible resources and their roles in the routines for our cases of product development. Specifically, we analyzed the data focusing on: (1) the types of tangible resources, and (2) the organizational routines in product development.

Tangible resources central to work processes were mentioned in all of the interviews. Consistent with critical realist views on materialism in organization studies (Reed, 2005) and in line with the dominating view in capabilities research (Grant, 1996), we inductively identified resources as tangible to the extent that they had physical, manifest properties, such as the "plant and equipment which can be purchased off-the-shelf" (Teece et al., 1997:519). Despite the wide range of resources, they could be condensed into three conceptual categories. Firstly, laboratories and test facilities were used widely in the development projects for testing, trying out ideas in real life and validating, but also by being emphasized in other roles. Secondly, computers and databases, intrinsically involved in modern product development, served as instruments in- and control devices of innovation work in all phases of innovation projects, and also took unexpected roles. Lastly, physical access categorizes physical resources with an impact on contact and communication between employees, involving the way individuals and units were located in relation to one another both locally in and between buildings at one site, and globally between dispersed sites.

In the data, *organizational routines* appeared as ongoing, formal and informal processes and ways of working (Nelson & Winter, 1982; Zollo & Winter, 2002). Consequently, we searched the data for patterns in how the work was performed (Becker & Zirpoli, 2008) to identify organizational routines. When it came to capabilities developing gradually through interaction with their organizational context (Feldman, 2000; Pentland & Feldman, 2005; Rerup & Feldman, 2011), and more specifically with firm resources, we analyzed accounts in the interviews of situations where tangible resources stood "at the center of routines" (D'Adderio, 2011). Concretely, this involved identifying, structuring and analyzing interview accounts involving tangible resources.

Beyond merely being mentioned by interviewees, tangible resources were found as antecedents to organizational routines in over 50 substantial interview accounts describing development work. Following suggestions by Eisenhardt and Graebner (2007), we used charts and tables to match the empirical accounts of the three categories of tangible resources to their influence on organizational routines (see Tables 2—5). The tables also helped us to separate accounts of positive versus negative influence (e.g. Gunther McGrath, 2001) as well as to show nuances with respect to whether the impact was viewed as strong or weak (Dougherty & Hardy, 1996), such as the difference between a mere annoyance versus a substantial hinder to the capabilities. Several of the accounts overlapped and enabled us to validate data from multiple sources, but we have deliberately given primacy throughout our presentation to accounts that show variation to add richness to our analysis. Four distinct routines with one or a combination of more tangible antecedents emerged from our data: idea generation, idea validation, knowledge integration, and knowledge development — all of which are central to and refer specifically to product innovation (Kusunoki, Nonaka, & Nagata, 1998) in particular, or to different aspects of innovation (March, 1991) in general. Selected quotations form the empirical data are presented in Tables 2—5 to illustrate both the breadth of data and the types of influence that emerged, while excluding clear overlaps (e.g. one interviewee repeating the same influence).

Findings

Product development in both Alpha and Beta was described as highly advanced and structured, e.g. in terms of formal structure, reporting, roles, communication and processes; it is typical for firms operating under competitive pressure to continuously produce innovative products (Persaud, 2005). In addition, informal and cultural aspects of both organizations also appeared, such as a strong personal strive among engineers to conduct tests and find innovative solutions to problems beyond those closely related to firm profits.

Both firms separated their Research departments from their Development departments. While Research was responsible for the early phases of projects, Development worked on developing, improving and effectuating these ideas in later stages. The former also worked with developing completely new product ideas, typically relating to new materials or technologies, emerging or newly detected customer needs, whereas the latter departments were formed around evaluating and validating knowledge and investing in further development in areas considered to be the most technically and commercially viable. Both firms used typical standardized and formalized stage-gate project management models with decision points. They also both had designated project managers, though they implemented things differently and were given slightly different mandates. The tangible resources themselves belonged to three categories: laboratories and test facilities; computers and databases; and physical access. These resources played central roles in four ongoing and continuous product development routines. The influential role played by tangible resources in each routine is presented below.

Generating ideas

A first challenge at the heart of to product development relates to idea generation, that is, creating new, but not yet confirmed solutions to challenges in development work. Firms that rely on continuous innovation consciously aim to promote creativity (Hirst, Van Knippenberg, & Zhou, 2009; Oltra & Flor, 2003). Typically, dedicated staff pick up new ideas from outside the focal firm as well as develop new ideas internally. In the firms studied, the respective Research departments each employed five to ten engineers, all assigned the task of coming up with radically new ideas, drawing on cross-departmental contacts, scouting out external organizations partners through seminars and connections to researchers and customers. Although separate from some formal structure and reporting, little in these departments was left to chance. Instead, these units engaged in the development and improvement of structured ways of producing new ideas. Alpha and Beta's routines for idea generation were both supported and hindered by tangible resources of two types: computers and databases, and physical access.

Computers had a dual influence. On one hand, computers were needed to develop creative solutions in both firms. In the case of Alpha, the flexibility of computer aided design (CAD) programs in particular supported experimentation, and this firm's engineers were actively encouraged to play around with and test new ideas in CAD, furthering progress on several new ideas. On the other hand, views on computers and databases in the form of computer-based project management systems were more varied. In Alpha, the innovation process was divided into four phases separated by decision- or "action" points. Alpha was thorough in implementing this system, supported by a large unit of specially designated and trained project managers to lead and oversee projects, and the use of the project management system appeared a natural part of the development work.

A very similar system used in Beta had, in contrast, a very different effect, hampering instead its idea-generating routine. Although they did acknowledge some positive features, Beta engineers, used to working in an organic, informal and entrepreneurial organization, often dutifully fed data into the system retrospectively, but otherwise avoided it, considering it an administrative burden that hindered the "core" of engineering work — that of developing new ideas. Some engineers even resisted using their project management system, feeling that it fit an "ideal" project but was ill-suited for the organic nature of real projects. A research engineer from Beta explains: "[The system] describes an ideal project. But when you're sitting there alone, acting as innovator and tester and everything else, a process like that hampers core activities." Considering it an annoyance, the system was something employees at Beta went out of their way to avoid.

Also physical location was reported to have a dual influence on the routine of generating ideas. Several interviewees described how new ideas arose unexpectedly in informal meetings, such as when people met in the hallways. As

Table 2 Influence of tangible resources on the routine of idea generation.

Resource category	Physical source of influence	Influence on routines	Illustrative interview quotes
Computers and databases	Design computers	Experimentation enhanced by access to advanced computer software	We try to be open about allowing people to try different designs within the given time frames. This might mean an engineer arguing for new, stronger geometry features. Then I assign the time to make a CAD model: Show me the simulation, and then we'll discuss it. (Early Research Group Manager, Alpha)
		Possibility of simulating more freely allows testing more ideas	Things have changed — with computers we can simulate the geometry, see how something affects durability. It's quite fun; it benefits all of us. (R&D Group Manager, Alpha)
	Computer-based project management systems	Lack of flexibility in computer-based management systems hampers the ability to innovate	[The system] describes an ideal project. But when you're sitting there alone, acting as innovator and tester and everything else, a process like that hampers core activities. (Creative Engineer, Beta)
		Computers can at best support idea generation, but not produce new ideas	Innovation comes out of serendipity, mostly someone realizing that what might not work in his or her area solves a problem in another. Computers don't notice such things; it's people. People see an opportunity, where two old things intersect to make something new. (Idea Scout, Alpha)
Physical access	Office design and physical proximity of research groups	Access to colleagues enhances exchange of ideas	It's really easy to get stuck if you sit [generating ideas] alone. Then it's important to be able to take a step back and look at it from other perspectives. Discussing things with other engineers supports that. (Construction Group Manager, Beta)
		Physical access supports informal contacts between engineers, and hence generates new ideas	Ideas often come to you when you talk to others. [. . .] You get the best solutions out of spontaneous meetings. When you run into each other. Our office landscape is partly open. It's quite easy to go to your workmate and discuss things, and come up with something. (Construction Group Manager, Beta)
	Physical distance between offices	Isolation between later-phase units, Construction engineers from early phases, and research engineers, reducing idea generation	Those of us in Construction [sub-section of the Development unit] who work with development want to move away from Development and work in the Research building with a round table in the middle so that we can play with ideas. But then, we end up back in the knowledge discussion: Construction [the department] says: "No".
	Physical distance between buildings at research site	Physical separation between research and development units reduce idea generation	Unfortunately, we [part of Construction group] are not in the same building as RTD. So if we have to talk to the RTD people, we have to go over there. We've even got to go to the Pilot Plant to discuss things and come up with different solutions. (Construction Group Manager, Beta)
	Site size and physical distance from other sites	Isolation from other engineers increases the risk of day-to-day work, at the expense of innovative research work	Research units can't be too small; you need critical mass. Those that are too small immediately become too short-sighted, because they have to prioritize the present at the expense of conceptual plans. (R&D Manager, Alpha)
		Isolation of research units reduces available resources that focus on long-term research, hampering idea generation	To develop really radical innovation, you need a lot of research and knowledge accumulation. It's difficult to get sufficient speed when you're interrupted. (Early Research Group Manager, Alpha)

expressed by one construction group manager at Beta, such spontaneous meetings, enabled by working in the same building, furthered idea generation by offering the best solutions: ''You get the best solutions out of spontaneous meetings. When you run into each other.'' The importance of these impromptu meetings made also seemingly small distances matter. Beta engineers in the Development department found being located in a different building than the engineers of the early idea generation department (i.e. Research) problematic, since they could not offer or access input from that Research department. A request from a group of Beta's Development engineers to move to the Research unit was denied on the grounds that this would render their expertise less accessible to colleagues in the Development unit. A Development manager explains: ''Those of us in Construction [sub-section of the Development unit] who work with development want to move away from Development and work in the Research building with a round table in the middle so that we can play with ideas. But then, we end up back in the knowledge discussion: Construction [the department] says: 'No'.'' Though only separated by a few minutes on foot, the reduced physical access from being situated in different buildings also reduced communication, and thereby hindered idea generation.

A different but related influence from a lack of physical access could be observed in Beta. The need during peak periods, typically at the end of projects, often exceeded personnel resources in the Development department. To resolve this, engineers from the Research department (responsible for idea generation) were called in to help out, at the expense of their own work. In effect, this meant balancing workloads in ongoing projects by reducing the resources available for developing new, radical innovations. While similar in type, in Alpha this problem appeared mainly in small, international units, geographically isolated from the main development site. With at times literally only a handful of engineers in each department, there was little slack, and prioritizing delivery projects meant drawing on the time of Research engineers, thus crowding out long-term, visionary work. The consequence of this was that the routine of generating ideas was interrupted. As witnessed by one Research group manager at Alpha: ''To develop really radical innovation, you need a lot of research and knowledge accumulation. It's difficult to maintain sufficient speed when you are interrupted'' pointing to the effects from physical isolation hindering accessing assistance.

In sum, tangible resources affected the organizational routine of generating new ideas, and did so in several ways. While simplifying experimentation, computers were not necessary for idea generation, it was considered supportive. Poorly adjusted project management systems had, at the same time, a negative influence on the same routines. Similarly, these routines are seen to be strongly supported by physical access between engineers, though this could also become a drawback when short-term obligations meant fewer resources for idea generation. Examples from the data are presented in Table 2.

Validating ideas

A second routine in product development in the two cases appears in data related to the validating of ideas. As

Table 3 Influence of tangible resources on the routine of idea validation.

Resource category	Physical source of influence	Influence on routines	Illustrative interview quotes
Laboratories and test facilities	Central laboratory tests	Establishes whether computer calculations were correct	We use the virtual world a lot, but often it's not enough. You have to test things. (Early Research Group Manager, Alpha)
	Local R&D laboratory tests	Identifies and weeds out untenable ideas through physical testing	We run products through our test lab to verify if it works or not, if it needs to be looped back, or if it fulfills expectations and is a ''go''. (Early R&D Manager, Alpha)
	Pilot plant tests	Ensures that products work in real-life environments	You have to make paper. Simulation is used to predict and optimize pressure or turbulence levels. But if you're going to build one of these machines you have to make paper first. (Development Manager, Beta)
	Adjacent laboratory tests	Validates designs that require new materials through cooperation with in-house laboratories	I have a lot of contact with Operations and with MAC: Materials and Chemistry. It's a laboratory with the knowledge of materials responsible for developing rubber for gaskets. (Construction Manager, Alpha)
	External research institutes	Validates conceptual designs via early testing	Already early in the project we performed smaller ''bench tests'' without a paper machine at STFI, this research institute in Stockholm, to see whether it was worth doing full-scale testing on the Pilot Plant. (Project Manager, Beta)

described above, the aim of organizations that rely on their ability to innovate is often to come up with radically new ideas. Typically, some of these cannot be realized for commercial (Akman & Yilmaz, 2008) or technical reasons. The pressure to innovate therefore also includes developing methods for selecting the ideas in which to invest time, efforts, and money. Both firms had developed routines for validating ideas. The experience of engineers with hard-earned knowledge of what had worked in the past was central in these routines. Also toll-gates, formal evaluation and decision points forced engineers to provide a standardized basis for decisions taken by senior engineers or management. However, none of this was possible without the tangible resources that were used. Since the experience of engineers refers to past projects, and innovation to new, untested ideas, assessing potential ventures using experience-based evaluations alone left a measure of uncertainty that remained to be validated.

The laboratories and test facilities influenced, and indeed were necessary for, the idea validation routine. As expressed by one engineer from Alpha: ''You have to test things.'' Alpha used experienced staff to test new products at several stages in several laboratories to weed out ideas that did not work. Beta faced a similar, yet slightly different challenge in its need to validate ideas and add to its knowledge about a certain solution to a problem. In Beta, their large machines were developed and assembled according to customer specifications. This made each machine partly unique, and untested before production. Further, the humidity, temperature shifts, and vibrations when running a machine at different speeds were too complex to model in computers. Thus, every technical innovation created uncertainty: would the new machine produce high quality paper under real-life conditions? A Beta engineer explains that the only way to reduce uncertainty is to use physical testing: ''You have to make paper.'' To avoid the risk of building unusable machines, Beta used a Pilot Plant; a full-scale machine in which machine elements could be moved and changed to simulate a new technology.

Thus, a range of laboratories and test facilities owned by the organizations studied or used in cooperation with external organizations not only supported, but were necessary in routines for validating ideas in both firms. Expectations and assumptions about the technical feasibility of ideas were tested by experts in simulating real-life conditions, thereby singling out ideas with the highest prospects of being turned into successful products. Table 3 summarizes the influence of tangible resources on the routine of validating ideas into actionable knowledge.

Integrating knowledge

A third routine revolves around integrating validated new ideas into existing knowledge systems (Grant, 1996), identified as central to product development (Kusunoki et al., 1998). Both of the firms studied worked consciously to integrate new ideas into the design of products in a planned, ordered, and step-wise manner, typically combined with more overarching product launches. For instance, Beta used a pre-defined product map of their product range, governing which product designs new ideas had to be integrated into. The two resource categories of laboratories and test facilities, and computers and databases influenced the routine of knowledge integration.

Managers from Beta's Development department co-operating with the Research unit actively encouraged their engineers to participate in tests conducted by the latter and, in particular, test runs in the Pilot Plant. Managers saw this partly as a way of motivating employees from Development as it was considered inspiring to see the working of a complete product, if only in a laboratory setting, up and running. More importantly, however, managers saw the need to bridge a gap created by job division and physical separation between the units. Inviting engineers from Development to tests run by Research helped to integrate different views into a holistic understanding of the product and to receive direct feedback on how a technical solution worked, or did not work.

It was not only resources controlled by the focal firms that influenced the development of knowledge; tangible resources in their network also had an impact. Beta received technical feedback when renting its Pilot Plant to customers, helping to refine Beta's application skills. Importantly, engineers made visits to customers and suppliers to participate in tests. For instance, Beta's engineers were invited by the belt supplier to oversee testing to ensure that the newly designed belt transporting the pulp through the machine was not too sticky and thus possibly damage the paper. The R&D manager at Beta explains the role of these tests as ensuring, for instance, ''sufficient dryness at a certain energy level.'' Drawing also on tangible resources formally owned by other organizations thus furthered the integration of already validated knowledge with the knowledge of suppliers and customers.

Computers and databases also played a somewhat unexpected role. Given that the final product was too complex to calculate using computers, another role of the computers was important: that of getting ''things down on paper'' to document the process and show others. Put differently, this physical resource served the purpose of making ideas accessible to others, to facilitate knowledge sharing and integration. Beyond this, echoing the influence on idea generation, project management systems designed to contain updated and relevant project data were perceived instead as a burden, locking in and isolating knowledge. Thus, engineers in Beta often circumvented these systems, opting to use other means of communicating instead.

The data indicate that the routine of knowledge integration was affected by different tangible resources, and in different ways. Whereas the use of computers supported the communicating and integration of knowledge that was otherwise difficult to communicate, computer-based management systems were perceived as hampering knowledge integration.

Developing knowledge

A fourth routine observed in product development in both firms related to the development of knowledge already in use in product development processes. This differs from idea generation in its degree of newness; typically, knowledge development is concerned with gradual and incremental

Table 4 Influence of tangible resources on the routine of knowledge integration.

Resource category	Physical source of influence	Influence on routines	Illustrative interview quotes
Laboratories and test facilities	Testing at the Pilot Plant	More engineers than strictly necessary invited to participate in tests, thus spreading organizational knowledge	Two managers try to invite people from Construction to the Pilot Plant more. Apart from enhancing learning, the purpose is to give feedback and make it more fun for engineers. (Construction Group Manager, Beta)
		Test-run data on the entire machine as used by customers is fed back into Beta	They [customers renting the Pilot Plant] come to our Pilot Plant to verify and make an estimate of how good of a paper our machines will allow them to make. (Research Manager, Beta)
		Co-development of knowledge in joint cross-boundary projects	I work a lot with people from [a supplier of belts]. I make visits to their test facilities to watch their tests. (Project Manager, Beta)
	Suppliers' laboratories	Co-development of knowledge in joint cross-boundary projects	Tests clarify, for instance, the functionality of this new cloth: Will we be able to make the transfers from one belt to another so that it works? Will we achieve sufficient dryness at a certain energy level? Is it fast enough? Is the paper produced of sufficient quality? (R&D Manager, Beta)
Computers and databases	Design software	Used to create illustrations of ideas, which are used to communicate to others, thus enabling discussions	The least problematic is the development work on the computer. It's more a tool to get things down on paper, so to speak. (Development Manager, Beta)
	Project management software	Alternative ways of working developed or maintained rather than using project management systems	We have a specific project management tool. We do have a database for all our documents and templates, outlining how to write a project specification, how to write a final report. But communication within projects is all about meetings, e-mail, phone calls. (Project Manager, Alpha)

improvement of existing knowledge that is conceptually different from developing completely new products or areas of application (Helfat & Raubitschek, 2000). For instance, in Alpha, this involved using a different alloy to achieve partially different temperature resistance, or, conversely, achieving the same product characteristics but at a lower cost. This appeared to a large extent as the result of conscious efforts in both firms, both formal and informal, and tangible resources played a central role in these routines.

At Alpha, tests were used beyond confirming expectations. One construction group manager described how he consciously designed new products to exceed expected technical limits, knowing almost certainly that the design would not stand up to testing without breaking. The aim was to learn: while a test of a design that did not break was considered a success in terms of meeting expectations and minimizing 'time to market', this did not necessarily lead to developing new knowledge. The same manager explains: "It's in our blood, so to speak, to push the limits. It's in the soul of the engineer to ask: 'Can I make that angle steeper?' [...] The lab won't like it, but the engineer wants to test the limits." In this sense, cracks and deformations in laboratory tests would reveal limits with respect to functionality, materials and design, flawed from a project management perspective, allowed the development of knowledge.

Different from the influence idea generation, where mainly internal laboratories mattered, knowledge development was clearly influenced by a variety of laboratories and test facilities, also outside the firms. The firms found long-standing cooperation with universities useful for idea generation: both with the relevant departments at the local universities; and Alpha with various departments at universities in Italy and France. All provided novel ways of solving problems, thus played a central role in developing knowledge.

In both Alpha and Beta testing in laboratories provided huge amounts of data. As one project manager in Beta noted, the bulk of the work consisted of processing the data after testing, by feeding it into mathematical algorithms used for design programs, and thereby explicating test results into application skills. Knowledge was moreover developed through network relations to suppliers and customers. For instance, the development of a completely new form of paper machine relied heavily on the co-development of a new belt material. Beyond the validation mentioned earlier, the face-to-face collaboration with the belt supplier also contributed to further develop Beta's internal knowledge. A Beta research manager explains how visits from the suppliers allowed them to extend their existing knowledge: "The product manager knows how the product works at the customer site and offers suggestions for improvements." Vice versa, Beta also benefitted from visits to customer laboratories: young engineers often attended assembly and start-up of delivered products, exposing them to potential areas of improvement, furthering the organizational knowledge through initial test runs.

Table 5 Influence of tangible resources on the routine of knowledge development.

Resource category	Physical source of influence	Influence on routines	Illustrative interview quotes
Laboratories and test facilities	Laboratory tests	Tests existing products with minor design changes, e.g. a slightly different angle or a new alloy	It's in our blood, so to speak, to push the limits. It's in the soul of the engineer to ask: "Can I make that angle steeper?" [...] The lab won't like it, but the engineer wants to test the limits. (Construction Group Manager, Alpha)
	External research institute	Provides learning opportunities through cooperation in university laboratories	In that project, we worked with five universities: Nancy, Toulouse, Grenoble, Lund and Chalmers. (Concept Development Manager, Alpha)
		Provides data for refining algorithms, design and materials knowledge	We get an extreme amount of data from testing. So the bulk of the work afterwards is to process the data. We make diagrams and compare and try to find loose ends. (Project Manager, Beta)
	Pilot Plant test runs	Provides data for refining algorithms, design and materials knowledge	[The Pilot Plant] provides data expressed in mathematical models and puts it back into the construction work. (Construction Group Manager, Beta)
		Continuous access to the Pilot Plant allows increased knowledge	I believe we have more application skills, more resources in R&D, especially in Materials. Maybe one competitor has something similar, but it's something quite unique in the industry. (Product Manager, Alpha)
	Customers' laboratories and plants	Honing knowledge from start-ups at customer sites	The product manager knows how the product works at the customer site and offers suggestions for improvements, either in terms of construction or development of something new that has to be tested in the Pilot Plant. (Research Manager, Beta)
Computers and databases	Product databases	Organizational knowledge more fragmented, decontextualized, and less up-to-date when made explicit in databases	The database only shows you the picture; you don't know what it looks like inside or why it looks the way it does. So when people refer to the databases — "We have that written down" — that doesn't work. We've been flooded by databases. (Development Manager, Beta)
	Project management software	Software takes time and energy from development work, so employees avoid using it	We're not very good at using the project management system. [Corporate headquarters] has many, many databases. Databases are great, but we have an unbelievable amount of databases. And everyone is a database owner and runs it like his or her own company. (Project Manager, Beta)

In contrast to this positive influence from laboratories and test facilities, the data indicates that computers and databases took time away from development work much like the influence on idea generation. At Beta, several people felt "flooded" by databases, some of which had been ordered by corporate headquarters, as they required managing, essentially stealing time from development work. Even local use of databases hindered knowledge development, however. In an effort to articulate and spread knowledge, local management had decided that the development of a particular part or segments of a machine should no longer be the responsibility of a product manager. Instead, everyone should be responsible, and details on the design and development should be made explicit and accessible in databases. This, however, resulted in much of the contextual and tacit knowledge being lost. In the words of a Beta development manager: "The database only shows you the picture; you don't know what it looks like inside or why it looks the way it does. So when people refer to the databases — 'We have that written down' — that doesn't work." In essence, contextual and tacit knowledge was lost by the use of an anonymous database.

Over all, laboratories and test facilities in- and outside of the focal organizations had a broad and positive influence on the routines involved in knowledge development, indicating the importance of drawing on external resources for developing knowledge. In contrast, databases were described as having a negative influence on knowledge development. Table 5 summarizes the instances where tangible resources influenced the development of existing knowledge.

Discussion

Theories specifically concerned with the development of organizational capabilities have given priority to intangible resources as antecedents of capabilities (e.g. Arikan & McGahan, 2010; Montealegre, 2002). In accordance with this theory we have argued that organizational capabilities consist of routines, that these routines develop over time by being enacted in their organizational context (Pentland & Feldman, 2005; Teece et al., 1997), and that tangible resources are likely to play an underestimated role in developing capabilities. In this study, we analyzed tangible resources in product development as antecedents of the development of capabilities in two industrial firms successful in highly competitive markets. In doing so, our study identified tangible resources of significant importance for selected product development routines. The tangible resources in the study belonged to three categories and appeared in varying, but important, combinations for four organizational routines in the product development process.

Our findings corroborate earlier research indicating organizational context to be relevant for capabilities, or more precisely, those organizational routines that can be identified as collective and patterned behavior (Nelson & Winter, 1982) in product development (e.g. Eisenhardt & Martin, 2000) being developed through interaction with firm resources. In particular, our data highlights how tangible resources were instrumental in four product development routines typical to firms under competitive pressure to continuously innovate. The two firms in our study appointed specific personnel and invested substantial intangible and tangible resources, and organized both formally and informally, to further the generating (Gunther McGrath, 2001; Lawson & Samson, 2001) and validating of new ideas (Kusunoki et al., 1998), and the integrating (Grant, 1996) and development of knowledge (Persaud, 2005; Marsh & Stock, 2006), suggesting a substantial influence on the organizational capabilities of developing new products in these firms. As a whole, our data point to the benefits of widening the scope on the antecedents of capabilities development, to include both intangible and tangible resources.

In accordance with the main thrust of earlier research, intangible resources such as human capital (McKelvie & Davidsson, 2009), knowledge (Montealegre, 2002) and experience (Kotha et al., 2011; Marsh & Stock, 2003) were clearly central antecedents for capability development. However, such intangible resources were unable to fully account for the product development capabilities, e.g. for assessing how a new, yet untested design would function in response to real life circumstances. In these instances, potentially valuable but uncertain ideas required validation through physical laboratory testing. From a theoretical standpoint, this adds a tangible component to the variation-selection emphasized in capabilities research on routine development (Nelson & Winter, 1982; Zollo & Winter, 2002), and illustrates a direct influence of tangible resources on the development of organizational capabilities.

This influence of tangible resources varied depending on the routines being influenced. While lack of physical access negatively influenced cross-functional information sharing in early idea generation, our data does not indicate a similar negative influence in the area of knowledge development. A possible explanation for this is that cross-functional communication was not required to the same extent in knowledge development; mainly drawn upon once the main parameters of the product design were already settled and work focused more on incremental development. The functional organizational structure and the corresponding physical configuration of the workplace that hindered early research processes appear to be neutral or even supportive of knowledge development. This supports the view that intangible (Subramaniam & Youndt, 2005) as well as tangible antecedents have a context-specific and highly local, differentiated influence depending on the organizational routines that are being influenced.

Our findings also stress the intertwined influence on capabilities from various kinds of antecedents. The influence of tangible antecedents on capabilities was not independent of that of intangible antecedents, and vice versa. In our data, most of the identified routines were influenced by feedback from testing conducted by internal and external laboratories and test facilities, both from successful (Helfat & Peteraf, 2009) and failed laboratory testing (Elmquist & Le Masson, 2009; Marsh & Stock, 2003), illustrating how tangible resources influenced intangible resources. There was a mediating influence also in the other direction. For example, although both firms used very similar computer-based project management systems, the enthusiasm among engineers differed significantly: such systems were found ill-equipped to function in the organic, informal and entrepreneurial culture in Beta, while engineers in the formalized culture of Alpha expressed no such caveats. While previous studies have identified culture as an important antecedent to capabilities (Akman & Yilmaz, 2008; Pandza & Thorpe, 2009), parts of our data illustrate how culture as an intangible antecedent influenced the use of tangible resources. Taken as a whole, our findings thus highlight the multifaceted, reciprocal relation between tangible and intangible antecedents of organizational capabilities, adding to existing theory how tangible antecedents influence capabilities directly and in interaction with intangible antecedents.

Our data also cast additional light on the findings of earlier studies. For instance, current research stresses how organizational capability produces creativity as the result of organizational structure (Persaud, 2005; Carpenter et al., 2003). Structure, in turn, is connected to the degree of managerial oversight that, if too rigid, can hamper creativity (Gunther McGrath, 2001; Prieto et al., 2009) since the engineers who do the creating typically require a certain amount of autonomy (Yuan & Woodman, 2010). While the data included the influence of organizational structures and the need for autonomy for engineers, this influence was connected with access between engineers, in turn largely defined by physical resources. In both cases, the physical location of staff followed the organizational structure, but it was overwhelmingly the lack of physical access (both engineers of different departments being located at different research sites, or in different buildings at the same site) that influenced capability development. Also, seemingly minor reductions in physical access appeared to be vastly underestimated in current research compared to the weight given to, for example, the degree of managerial oversight or organizational structure. In other words, addressing tangible resources as related to but distinctly separate from intangible resources provides a more precise view of the antecedents of capabilities, and thus offers a complementary or even competing explanation previously neglected in the research on capabilities development. Our findings thereby suggest a need for reconsideration of the dominating theoretical understandings of capability development that highlight only intangible antecedents (e.g. Montealegre, 2002) in situations involving substantive use of tangible resources.

In sum, our empirical findings cast new light on firm resources as antecedents of organizational capabilities. Tangible resources had a clear influence (and ongoing mutual influence) on firm routines, both independently of and in interaction with intangible resources. While the theoretical divide between tangible and intangible resources argued for in seminal capabilities literature (Barney, 1991; Grant, 1996; Teece et al., 1997) may thus help to analytically structure antecedents, it excludes a more holistic picture of the antecedents that explains the development of organizational capabilities. Consequently, a more inclusive approach in empirical research as well as in theoretical model-building appears to be a central step to further theoretical understanding of the development of organizational capabilities. Our study is a step in this direction.

Conclusions

Capabilities research is intensely concerned with capabilities that provide technological and evolutionary fitness that explain whether and how organizations achieve their goals (Amit & Schoemaker, 1993; Grant, 1996; Teece et al., 1997), in turn making the development of capabilities a central issue for firms in competitive markets (Arikan & McGahan, 2010; Prieto et al., 2009). This paper deals with the tendency in the capability research to explicitly stress the importance of certain antecedents by virtue of their being intangible. While important, theoretically compelling, and potentially representing some of the most important antecedents, this is likely to yield an incomplete picture of the circumstances in which capabilities develop. This paper has therefore aimed to contribute to capabilities theory by studying how organizational capabilities develop when tangible resources are acknowledged as significant antecedents of organizational routines. Our study thereby makes important contributions to the capabilities research.

Firstly, our study advances capabilities theory by extending the understanding of the relationship between organizational antecedents and capabilities development. We examine how tangible antecedents influence the development of four organizational routines that in turn constitute central aspects of organizational capabilities in product development. The analysis shows that three categories of tangible resources, alone and in combination, in various ways influence the development of organizational capabilities in interaction with the local organizational context. Alongside intangible antecedents identified in earlier research, including organizational knowledge (Grant, 1996; Montealegre, 2002), culture (Pandza & Thorpe, 2009), and communication (Smith et al., 2005), we thus extend the scope of antecedents of organizational capabilities to include also tangible resources.

Secondly, our study also substantiates a more complex view of the influence from organizational antecedents on capabilities development. We were able to demonstrate the multifaceted and reciprocal influence of tangible and intangible resources on organizational capabilities. Our findings show that concepts preferred in existing research, which typically emphasize intangible organizational resources such as organizational structure (Persaud, 2005) or management oversight (Gunther McGrath, 2001), had to do with antecedents such as laboratories, physical distance, and computers. Tangible resources also influenced intangible antecedents, such as laboratories increasing organizational experience, in turn associated with capabilities development (Kotha et al., 2011). This suggests that organizational capabilities develop under intertwined and reciprocally mediating influences of intangible and tangible resources, in turn pointing to potential boundary conditions for previous theory, which emphasizes only intangible resources, in organizational conditions that also involve tangible resources.

Stretching beyond our empirical findings, our conclusions also have implications for the overall pursuit of capabilities research to explain lasting differences in firm performance. Our finding that tangible resources influence capabilities development contrasts with — and complements — the dominant view in current theory. The explicit delimitation to intangible resources in seminal works (Barney, 1991; Teece et al., 1997) builds on the *conceptual* argument that tangible resources available "off the shelf", being available to all competitors, do not play a role in sustained resource- or capabilities-based competitive advantage (Peteraf, 1993; Teece et al., 1997). While we agree that competitors can often acquire the same or similar tangible resources, we propose that this does not necessarily mean that they actually do, since decisions-makers responsible for resource orchestration are unlikely to have perfect information about the importance of all resources involved (Denrell, Fang, & Winter, 2003). This makes it likely that, within an industry, also generally available tangible resources remain heterogeneously dispersed between firms. In turn, paired with our *empirical* finding that tangible resources constitute important antecedents of organizational capabilities, this suggests that such lasting heterogeneity of tangible resources may help to create differences in organizational capabilities, in turn contributing to the overall strive in capabilities research to unravel the sources of a firm's competitiveness and differences in firm performance. This has the theoretical implication that current capabilities research may have been premature in delimitating its attention to intangible resources. Consequently, a broader focus including also tangible resources as antecedents of capabilities as suggested in this study appears to benefit the search for antecedents of organizational capabilities and lasting differences in firm performance.

This, as every study, has its limitations. Empirically, we prioritized in-depth data to study the product development routines constituting organizational capabilities key to the competitiveness in two purposefully selected cases in mature yet dynamic markets, implying several boundary conditions for our findings. Furthermore, tending toward the explorative, our study gives a broad set of indications of influence on capability development, rather than establishing a range of causal relationships. This reduces the degree to which the results can be generalized in the statistical sense, and specific findings remain to be validated, opening fruitful avenues of future research. Considering the limitations in empirical scope of our study, future qualitative studies could extend our insight into the roles played by intangible resources in different industries in which tangible resources can be expected to vary and thus play different roles, such as in professional service firms. Mirroring the tradeoffs of the methodology used in this study, future quantitative research can provide generalizable insights regarding the influence of tangible resources on organizational capabilities, and on the interaction between tangible and intangible antecedents of organizational capabilities, for example, regarding different types of tangible resources and potential differences between industries.

We have argued that tangible resources remain a much understudied antecedent of organizational capabilities. Our findings show that extending capabilities research to include the tangible reality of organizing open the way to new insights regarding how organizational capabilities develop. In line with the basic premise of the capabilities research program, this appears to hold important insights to further illuminate the sources of lasting differences in firm performance of importance for large parts of current strategic management research. Ours being a first glance, we would welcome others to shed more light in this direction.

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