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ABSTRACT: Sociomateriality (or sociomaterialism) allows us to approach the information technology (IT) capability research from an angle that has been rarely visited by information systems scholars. While relevant studies presume that humans and materials are distinct and largely independent, sociomateriality emphasizes agency that represents the relational, emergent, and shifting capacity realized through the

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association of actors (both humans and materials). The objective of this paper is to explore the value of conducting IT capability research through the theoretical lens of sociomaterialism. For this, we expand the imbrication metaphor introduced in an early study to explain the formation and advancement of a firm's IT capability from the sociomaterial perspective. Then, the key building blocks of IT capability of an organization are conceptualized based on the combination of existing studies and the expanded imbrication metaphor. Lastly, the effectiveness of formulating IT capability as a third-order construct that substantiates the entanglement concept of sociomaterialism is examined in comparison with that of traditional modeling approaches. We confirm the value of sociomaterialism in conceptualizing IT capability and subsequently in unraveling the true contribution of IT capability toward strengthening business performance. The findings also have practical implications in which *IT capability* is a function of IT management capability as well as IT personnel capability and IT infrastructure capability.

Key words and phrases: imbrication metaphor, IT capability, sociomaterialism, sociomateriality, third-order factor.

Firms are challenged by rapid and constant changes in the dynamics of business competition. Intensified rivalry, globalization, time-to-market pressures, and volatile consumer demands are some of the contributing forces. In the face of such challenges, only the firms that can continuously redefine and enhance their internal capabilities can offer competitive customer values in products and services [70, 79, 83]. Not surprisingly, *IT capability,* broadly defined as the IT function's competence to effectively support business needs, has become a key in transforming a firm into a competitive force [48, 49, 64]. Much effort has been placed on understanding its nature, and studies have revealed both consistent and conflicting findings in important questions, including "What are its building blocks?" "How is it shaped and strengthened at a firm?" and "What are its effects on business performance?"

Recently, there has emergenced a new theoretical perspective, or *sociomaterialism,* that allows us to approach IT capability research from an angle that has been rarely visited by information systems (IS) scholars (e.g., [45, 46, 64]). Sociomaterialism views materiality as an integral aspect of the organizational life because every human activity is bound to materiality. Thus, taking materiality as something that can be downplayed or whose existence is at the mercy of people does not appeal to sociomaterialism. From its viewpoint, the traditional research positioning that regards the value of IT as something to be taken for granted or something subject to a special event has not been effective in revealing its organizational impact [63, 66].

For several decades, researchers have conceived technology effects in an organization through different theoretical lens. Among the notable are contingency theorists, sociotechnical systems theorists, and social constructivists. For about 30 years from the 1950s, contingency theorists (e.g., [68]) dominated technology research in setting theoretical directions. They embraced *technological determinism,* in which technologies are thought to shape different forms of organizing. In this theoretical perspective, therefore, technology's materiality is regarded as a strong causal force. Alternatively, sociotechnical systems theorists who appeared in the 1950s (e.g., [88]) argued for mutuality between technology and social structure. In practice, however, their research resembled that of the contingency theorists' as they were primarily concerned about altering the social to fit the technical [46]. Social constructivists who appeared in the late 1970s disputed the technology determinism and advocated the *human-centered perspective* [66]. They argued that technology effects on an organization are socially constructed. Constructivists generally hold that an organizational change emerges from an ongoing stream of social actions in which people respond to a technology's constraints and affordances [46]. In sum, while the technological determinism and the human-centered perspectives presume that humans and materials are distinct and largely independent [66], they had different views on what constitutes a dominant organizing force: materials (or technologies) versus humans (for more discussions about the history of research on technology and organizing, see [46]).

Sociomaterialism, meanwhile, offers a more balanced view by not privileging. It does not privilege either humans or technologies. Instead, they are inextricably related and enact each other because there is no social that is not also material and no material that is not also social [63]. The theoretical angle presumes that both the *human agency*—the ability of human beings to form and realize goals—and the *material agency*—the capacity for material entities to act on their own, apart from human interventions—plan an important role [43] in the web of their constitutive entanglement or imbrication [45, 64].[1] The importance of such a research paradigm is emphasized by Orlikowski and Scott:

> Who decides what technologies get deployed in organizations, how are these designed, who gets to use and change them, and with what consequences? Given increasing reliance on technologies to get work done within and across organizations, these questions are highly salient and their answers profoundly affect the kinds of organizational realities that are produced. [66, p. 436]

The objective of this paper is to explore the value of conducting IT capability research through the theoretical lens of sociomaterialism. For this, we undertake a comparative study in which the role of IT capability in strengthening firm performance (e.g., business process performance and financial performance) is examined through the modeling drawn from three different ontological approaches. To achieve our research goal, we first extend the imbrication metaphor of human and material agencies [45] to derive three IT capability dimensions (i.e., infrastructure, personnel, and management capabilities) formed by the IT group and to theorize the advancement of a firm's overall IT capability. Then, traditional approaches of modeling IT capability that have dominated IS research are characterized in terms of *unidirectional* and *unrelated* conceptualizations, and the sociomaterialism-based modeling (i.e., *entanglement conceptualization*) that underscores complementarities among the three IT capability dimensions are explained. Subsequently, an IT capability model that reflects the sociomaterial viewpoint is introduced in order to lay the groundwork for empirical testing, and the building blocks (or constituents) of each IT capability dimension are explained. Lastly, the effectiveness of conceptualizing IT capability as a third-order construct is empirically examined in comparison with that of traditional IS approaches (i.e., unidirectional and unrelated conceptualizations), and implications of the findings are discussed.

Imbrication Metaphor of IT Capability

This research is theoretically anchored on the imbrication metaphor of sociomaterialism introduced by Leonardi [45]. However, with its focus on explicating the entanglement between the human agency of "IT users" and the material agency of IT, Leonardi's [45] imbrication metaphor may not be inclusive enough in portraying the dynamic progress of IT capability that is primarily architected by the company's IT unit. Further elaborating on Leonardi's [45] work, we offer an expanded imbrication metaphor (Figure 1) in which the IT unit forms separate agencies by virtue of their unique roles in fostering the IT capability of a firm. As we explain below in this section, the expanded imbrication metaphor offers insights into the conceptualization of an organization's IT capability.

Figure 1 displays two imbrication metaphors: one for IT users as introduced by Leonardi [45] and the other for the IT unit (as IT producers). By dividing the subjects of human agency into IT user and IT producer groups who are fundamentally distinct in their goal orientations, Figure 1 depicts the new imbrication relationship between human agencies and material agencies in a more elaborate manner. In the figure, each circle represents a routine, and M and H represent material agency and human agency, respectively. The two circles on the left are traditional routines, and those on the right are newly formed routines.

Now, let us depict the formation and progression of IT capability based on the expanded imbrication metaphor in Figure 1. For continuity with Leonardi's [45] example, we use the "news dissemination routine" scenario. Coordinators of a not-for-profit organization have recently begun to disseminate newsletters to community members to brief its service activities. For the "news dissemination routine" that creates the community newsletter, coordinators should heavily rely on the word-processing technology. The technology is configured to act in particular ways (material agency), and its functional capability is what led the coordinators to envision the cost-effective creation and dissemination of the newsletter in the first place. IT is therefore a critical enabler for the coordinators to set their goal of disseminating information to community members (human agency). In Figure 1, this routine is depicted as a circle made up of material agency (M1) and human agency (H1).

In using the word-processing technology, however, the coordinators came to the realization that they want to transform the boring text document into a visually appealing, well-formatted newsletter. They also realize that current technology available for document creation lacks capacity such as formatting and graphics necessary to develop attractive newsletters. In facing the gap between the technologies' existing material agency (i.e., its ability to produce simple text documents) and their goal to produce

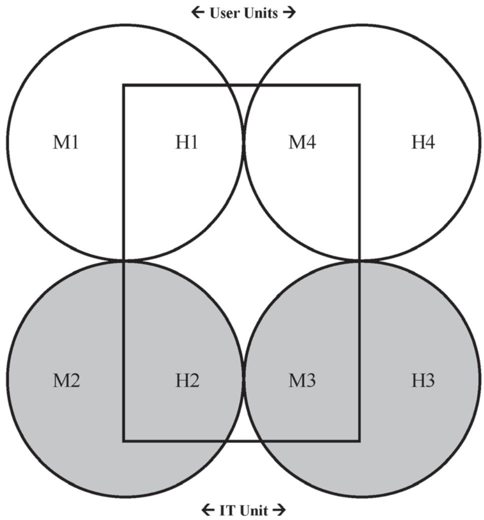


Figure 1. Imbrications of Human and Material Agencies—Expanded View

Note: Circles represent routines; H and M represent human and material agencies, respectively.

a more attractive newsletters, the coordinators develop the perception that the material agency constrains their human agency (i.e., goal). Facing the constraint they can think of alternative solutions such as abandoning the newsletter and delivering news verbally, which should result in a change in the routine. Or the coordinators can seek to alter technology to overcome the gap between the material agency of the existing word-processing program (M1) and the coordinators' collective goal (H1).

To overcome the constraint, the coordinators decide to change the current technology so that the updated technology allows people to make digitized drawings and ask (maybe through the management chain of command) the IS department to provide a technical solution. On receiving the new *goal* (H2), the IS group reviews whether the current technology constrains or affords business needs (M2), and decides that it is unable to satisfy them (M2 → H2). Subsequently, the IS group develops a program with the digitized drawing function in order to offer the technology a new material agency (M3). The imbrication of the existing human agency with a new material agency (H2 → M3) brings changes to the technology.

On receiving the new word-processing application (M4), the coordinators begin to use it to develop digitized drawings. Now, the coordinators develop perceptions that the new technology affords their goal to expand the readership of newsletters. To achieve this goal, however, the coordinators may find themselves adjusting elements of the routine (H4) such as the reorganization of role assignment in drawing, writing, and laying out the newsletter to accommodate both text and images. The imbrication of the material agency with a new human agency (M4 → H4) brings forth an updated news dissemination routine. With the adoption of IT by users forming a new goal, the IT group develops the perception that the new technology (M3) affords the attainment of the IT group's original goal. This also leads to the development of a new goal by the IT group (H3) in order to better manage the features of the new technology. This results in the reconfiguration of the IT group's routines that relate to the planning (e.g., training), decision making (e.g., future budgeting), coordination (e.g., user technical support), and control (e.g., performance monitoring) of the new technology.

Although a relatively small-scale adjustment of a business routine (i.e., news dissemination), the hypothetical scenario offers insights into the value of the sociomaterialism perspective in conducting IT capability research. First, a firm's IT capability can be explained through the iterative process in which the IT unit perception of IT constraints and affordances triggers a sequence of imbrications of human and material agencies, and subsequent changes in technology and associated routines.

Second, the scenario enables us to determine that the IT unit, IT, and IT routines represent core constituencies of IT capability. The IT unit assesses IT constraints and affordances, and develop and deploy new IT features and routines. Once changed through the imbrication of human and material agencies, the IT features and routines sustain themselves as they are continuously utilized and become an integral part of organizational infrastructure. Meanwhile, the IT unit develops perceptions of affordances and constraints based on the infrastructure (IT routines or IT) constructed through past imbrications. In other words, the infrastructure provides the context and the means for organizing to happen, and thus sets the path-dependent advancement of IT capability.

Third, the hypothetical scenario offers insights into the dynamic interactivity among the IT capability dimensions. When we look at an imbricated system of human and material agencies in Figure 1, changes in routines are to changes in technologies because they contain the same building blocks of human and material agencies [45]. In other words, a routine shares its building blocks with a technology just as a technology shares its building blocks with a routine. The result is that a change in a technology at any given time is linked to the routine that comes before and after it. Consequently, besides the IT unit that participates in the imbrication, IT and IT routines are ontologically related despite that they are distinct empirical phenomena [45]. As a result, synergistic interactions (or complementarities) among the IT unit, IT, and IT routines through continuous imbrications of human and material agencies are central in defining the quality of IT capability.

Conceptualization of IT Capability

Traditional Versus Sociomaterialistic Views

The review of current IS studies reveals that the conceptualization of IT capability has traditionally relied on two different avenues. In one approach, the elements that constitute IT capability, including the human (e.g., IT expertise) and the material (e.g., IT infrastructure), are considered distinct and independent actors, and they can be associated through the unidirectional causal relationship with deterministic results [66]. Byrd and Tuner [14], Chen and Wu [16], and Kim et al. [39] are some of the few empirical studies performed on the causality relationship among IT capability forces. This conceptualization approach is conveniently labeled as *unidirectional conceptualization* in our study.

The other traditional conceptualization approach generally agrees with the distinct and independent nature of the key elements of IT capability, but regards that there are no such causal relationships among them [5, 55, 67, 69]. The majority of current empirical studies of IT capability are in line with this modeling paradigm, and we conveniently term it as *unrelated conceptualization* in this study.

Apart from the traditional conceptualization approaches, our research relies on the relational ontology of sociomaterialism [66] as discussed in the previous section. With the embracement of agency imbrication, we posit that IT, humans, and routines are interwoven so that their respective contribution to overall IT capability is difficult to be measured in isolation. With that theoretical positioning, the IT capability dimensions do not exist independently but only in relation to each other. When the IT capability forces are constitutively entangled [3, p. 816], there are no properties native to each constituent. Instead, IT capability is the manifestation of the building blocks as a whole [65]. Hence, this study takes a position that IT capability dimensions are closed, interdependent, and complementary [49, 85], and their synergistic interactions advance a firm's IT capability and subsequent divergence in business performance [27]. This modeling paradigm is termed as *entanglement conceptualization* in our study. To the best of our knowledge, no previous research of IT capability has embraced the sociomaterialism paradigm to comprehend associated issues. Next, we determine the primary dimensions of IT capability through the theoretical lens of sociomaterialism.

IT Capability Dimensions

To determine the primary constituents of IT, the IT unit, and IT routines as three key IT capability dimensions conceived through the imbrications metaphor, we first rely on current IS studies and then map them to the theoretical frame of sociomaterialism. Our literature review reveals that most studies of IT capability take advantage of the resource-based view (RBV) to define the key elements of IT capability [39, 67]. Guided by the RBV, researchers generally agree that IT capability subsumes physical (i.e., IT infrastructure), human (e.g., IT skill or knowledge), and organizational (e.g., relationship infrastructure) elements [4, 7, 16, 26, 27]. One notable observation is that there is little disagreement with the inclusion of IT infrastructure/IT assets and IT human capitals as key determinants of IT capability. As for the organizational aspect of IT capability, however, there is much divergence in the list of considered variables. Among them are access to capital, IT process integration, IT management, IT operations, deployment of IT resources, culture of IT use, and the IT–business relationship [1, 6, 7, 49, 53, 67, 71, 87]. Consequently, empirical studies choose variables that represent a subset of the construct domain [39]. Besides, we note that certain organizational variables of IT capability such as business resources [69] and complementary organizational resources [55] are not native to the IT function [85].

The considerable divergence should be due to both the conceptual broadness of the organizational dimension and the difficulty of finding a theoretical frame that enables the determination of inclusive variables.

We argue that the *routine* concept of the expanded imbrication metaphor (see Figure 1) offers a cohesive frame through which the key organizational variables of IT capacity can be located. As theorized by Leonardi [45], the routine at any moment is the outgrowth of continuous imbrications of the human and material agencies over time. Because of the technicality of its organizational duty, the IT group continuously reproduces implicit and explicit routines (e.g., structures, policies, and decision making) that are highly distinct from those of business functions. According to the RBV, organizational capabilities reside in such routines through which firms physically transform inputs into outputs (e.g., [18, 33, 41]). Routines are so central to an organization that they explain firm performance [61]. Management studies (e.g., [25, 93]) also argued that routines are sources of both stability and changes at an organization. The imbrication of human and technology agencies engenders ongoing variation, selection, and retention of new practices and patterns of actions of a routine, allowing the transformation of its states from apparent stability to considerable changes. Bringing the significant role of routines to the context of IT tasks, we suggest that the management capability of IT routines is critical in elevating business performance. Taken together, the adaptation of the RBV taxonomy (e.g., physical, human, organizational aspects) to the frame of the imbrication metaphor (Figure 1) leads us to propose that *IT infrastructure capability* (for IT), *IT personnel capability* (for IT people), and *IT management capability* (for IT routines) constitute the primary dimensions of a firm's IT capability.

Proposing an IT Capability Model

We propose an IT capability model of a third-order construct manifested by three second-order capability variables (i.e., *IT infrastructure capability, IT personnel capability,* and *IT management capability*) (see Figure 2). Building on the entanglement conceptualization, the three capability constructs have the characteristics of co-specialization in which one has little or no value without the others [17, 87]. Further, as they are interwoven through imbrication processes, they are distinct but interdependent. Their synergistic complementarities are expected to reinforce a firm's IT capability and subsequently to instigate distinguished business performance. Lu and Ramamurthy [49] and Tanriverdi [84, 85] utilized higher-order representation to fully capture such complementarities among lower-order constructs. Likewise, we represent a firm's IT capability as a third-order construct to capture complementarities among the three second-order capabilities. In the meantime, the economic theory of complementarities [57, 58] suggests that the constructs are complementary when the joint value produced through their synergistic interactions is larger than the simple summation of their individual values. This theoretical view on whether the third-order representation captures complementarities among second-order capabilities is empirically examined shortly.

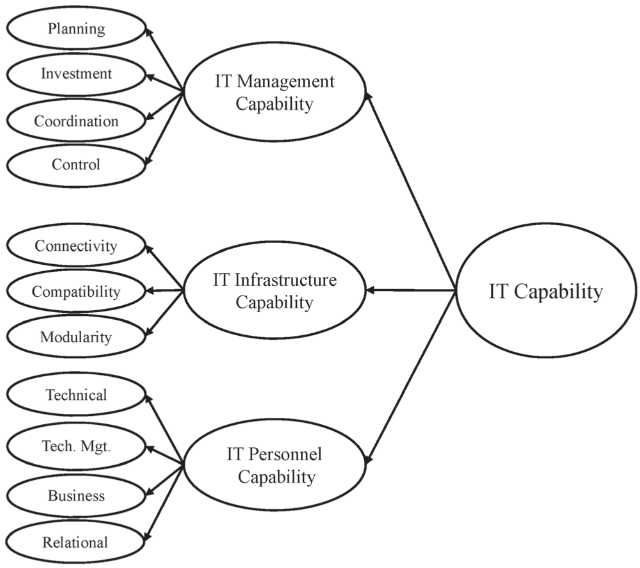


Figure 2. IT Capability Model

Notes: Planning = IT planning; Investment = IT investment; Coordination = IT coordination; Control = IT control; Technical = technical knowledge; Tech. Mgt. = technology management knowledge; Business = business knowledge; Relational = relational knowledge.

Further, in line with Lu and Ramamurthy's [49] and Tanriverdi's [84, 85] modeling approaches, the directionality between the higher-order and lower-order constructs is set reflective to capture the complementary interactions among the three dimensions of IT capability. With the reflective modeling, the third-order factor represents an underlying phenomenon of covariations between the second-order factors [22]. The formative modeling, meanwhile, is not appropriate for capturing the complementary nature as it excludes interactions or covariations between the lower-order constructs [38]. In the next section, we discuss the key building blocks of each IT capability dimension.

Building Blocks of IT Capability Dimensions

IT Infrastructure Capability

We use *IT infrastructure capability* to refer to the ability of the IT infrastructure (e.g., applications, hardware, data, and networks) to enable the IT staff to quickly develop, deploy, and support necessary system components for a firm. In advancing the capability, strengthening the IT infrastructure's *flexibility* is particularly imperative when faced with uncertain business conditions (e.g., hypercompetition, economic pressure, and emergence of social marketing) and changing long- and short-term corporate strategies (e.g., mergers, acquisitions, and strategic alliances) [5, 37, 49, 94]. With a flexible IT infrastructure, the IT team becomes agile in developing necessary applications, creating effective information- or data-sharing channels across business units, and launching systems that reinforce functional integration, which should result in better business processes at a firm [5]. In fact, interviews with IT practitioners revealed that improving the IT infrastructure's flexibility is the number one decision criterion in IT-related decision making [54].

It has been shown that the flexibility of a firm's IT infrastructure is primarily conditioned by the level of *connectivity* among different systems (e.g., customer relationship management, supply chain management, enterprise resource planning, and databases), *compatibility* that enables transparent information and data flows (e.g., databases managed by uniform metadata), and *modularity* in which IT modules (e.g., software modules) can be easily and cost-effectively added, modified, and removed as needed [14, 21, 37]. In a world filled with uncertainties [54], an organization should be ready to quickly build up new competence and adapt to emerging business paradigms, and much of this rests on IT capability these days. A firm that has a flexible IT infrastructure capability by virtue of its strength in connectivity, compatibility, and modularity should find that it is easier, quicker, and less painful in introducing systems when needs arise.

IT Personnel Capability

IT personnel capability represents the IT staff's professional ability (e.g., skills or knowledge) fundamental to undertake assigned tasks. Studies underscore that IT staff should be competent in four distinct but equally important skill sets: technical knowledge (e.g., operating systems, programming languages, database management, and networking), technology management knowledge (e.g., IT resource management, IT deployment, and operation), business knowledge (e.g., understanding of internal business units), and relational knowledge (e.g., ability for interpersonal communication and collaboration with business functions) [1, 7, 39, 53, 55, 71, 72]. Competent IT personnel can align IT strategies with business strategies; design or redesign IT with business performance in mind; develop IT with *connectivity, compatibility,* and *modularity* in mind; and anticipate future IT needs in order to support business demands. Likewise, firms that lack IT expertise may find it more difficult than the competition to perform such tasks when the market demands [72]. It should be a gradual process for an IT professional to develop balanced proficiency in terms of managing current IT infrastructure, obtaining business knowledge of internal business units, and building a collaborative relationship with business functions at a company. Because the process of capability development is localized to a firm [53, 78], it should be difficult for the competition to imitate [5, 53].

IT Management Capability

We define that *IT management capability* is the IT unit's ability to handle routines in a *structured* (rather than ad hoc) manner to manage IT resources in accordance with business needs and priorities. Such management routines may be performed by the IT group that is either an independent functional unit or is distributed to each key business function within a firm. The routines are instilled in an organization ostensively (i.e., schematic) and performatively (i.e., improvisatory actions) [25]. Although there are numerous routines unique to the IT group, Kim et al. [39] argued that IT planning, IT investment decision making, IT coordination, and IT control routines are the fundamental building blocks of IT management capability. Not only do they represent primary elements of the IT management cycle, but they are also salient daily activities of the IT unit [10, 20, 36, 76]. Consistent with Kim et al. [39], therefore, the four routines became the core constituents of IT management capability in our research.

IT planning is the IT group's routine to prepare the deployment or utilization of IT in a structured manner to support business functions, including goals and strategies. IT planning is important in that the resulting plan provides a roadmap for subsequent routines such as IT coordination. Among the important elements of the IT planning routine are (1) identification of innovative, useful IT applications throughout the firm, (2) determination of priority for IT projects, (3) management of IT diffusion, and (4) revision of IT plans in the face of changing environments [10, 36, 80]. They are repetitive and highly recognizable actions of the IT group and are expected to elevate the IT capability of a firm when adequately structured.

IT investment decision making is about attaining optimal IT resource selections through structured mechanisms such as the enterprise funding model in order to balance investment costs and the strengthening of a firm's strategic position [51, 54]. Stories of IT project failure or cost overruns abound [75, 76], and an important contributor to the failure is weak structures of and foresights into the IT investment decision process [31, 75, 76]. IT investment decisions should be the result of cost–benefit analysis based on various assessment dimensions, including finance, technology, hidden costs and benefits, and social subsystem costs and benefits [29, 75, 76].

IT coordination represents a form of routine that structures the cross-functional (i.e., IT and business units) synchronization of IT initiatives through mechanisms such as reports, direct contacts, task forces, and informal and formal gatherings of interdepartmental teams [10, 20, 36]. Structural design and process specification may be particularly important in IT coordination [20]. With structural design, a cross-functional team is formed to become a formal and ongoing conduit for horizontal communications between organizational units. Also, coordination processes (e.g., how members interact, the frequency of interactions, and the timing and function of their communications) can be articulated to guide cross-functional IT coordination.

The control routine is to ensure that the IT controlling functions are structured formally or informally and IT-related activities are adequately performed in accordance with them. Undertaking IT projects of various scales requires commitment of resources, including budgets and human resources, and controlling is exercised to ensure proper utilization of the resources. For example, among the controlling functions are the evaluation of IT proposals with reference to IT plans, clarification of responsibilities for IT units, development of performance criteria for IT services, and continuous performance monitoring of the IT unit [36]. The effectiveness of the IT control routine should be conditioned by the IT governance such as the roles and responsibilities of the IT chain of command and formal and informal rules, procedures, and policies introduced to regulate or rein in IT-related activities [9, 10, 36]. To further its effectiveness, IT control may resort to more tight/refined and managerially based control than loose/informal and technically based control [36].

Taken together, firms with competent IT management capability can structure planning, investment decision, coordination, and control activities through formal and informal procedures. This should translate into an ability to deploy the right IT to the right business process to respond to changing market conditions in a timely manner [55, 94].

Research Method

Test Models

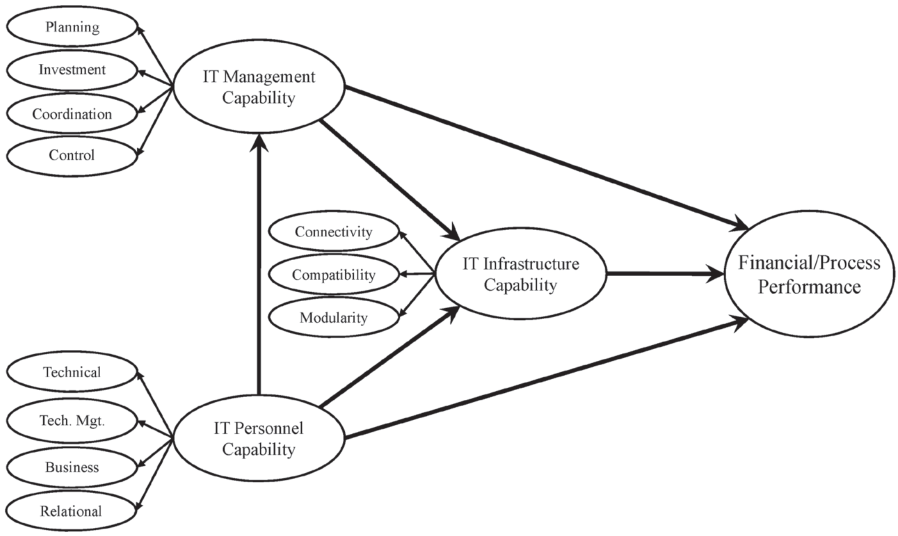
As stated, the main goal of this research is to empirically explore the potential of the sociomaterial lens in conceptualizing IT capability and compare its effectiveness against more conventional modeling approaches used to discover IT's business value. For this, we empirically compare IT capability conceptualization grounded on sociomaterialism (i.e., entanglement conceptualization) with those based on two other ontological perspectives (i.e., unidirectional conceptualization and unrelated conceptualization) (see Figure 3):

1. The *unidirectional conceptualization* indicates that IT personnel capability, IT infrastructure capability, and IT management capability are distinct and independent. With the directionality, the following casual relationships are defined to be consistent with previous theoretical and empirical studies [14, 36]: (a) IT personnel capability influences IT management capability and IT infrastructure capability, (b) IT management capability influences IT infrastructure capability, and (c) IT personnel capability, IT management capability, and IT infrastructure capability influence business performance.
2. The *unrelated conceptualization* presumes that there are no such causal relationships among the three IT capabilities, but they directly influence business performance [7, 55].
3. With the *entangled conceptualization,* the third-order IT capability formed as a consequence of synergistic engagement among the three constituents directly affects business performance.

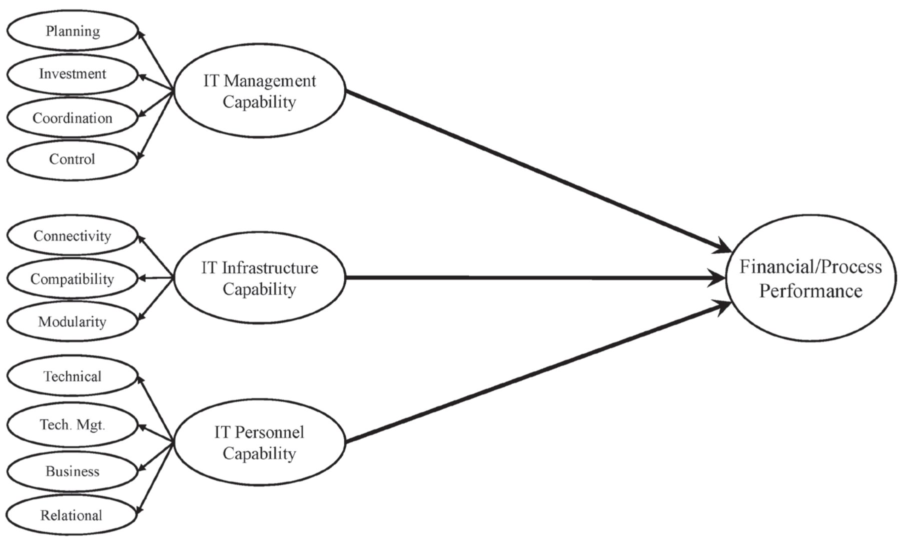
We test the influence of IT capability on business performance in terms of both business process performance and perceived financial performance. Business performance may be partially conditioned by factors such as industry type and firm size, and thus they are controlled for in the data analysis.

Survey Development

Table 1 summarizes the operational definitions of the study constructs. All the construct measures were drawn from previous works and adapted as needed (see the Appendix). More than 130 question items relevant to both IT capability and business



(a) Unidirectional Conceptualization



(b) Unrelated Conceptualization

Figure 3. Conceptualization Approaches of IT Capability

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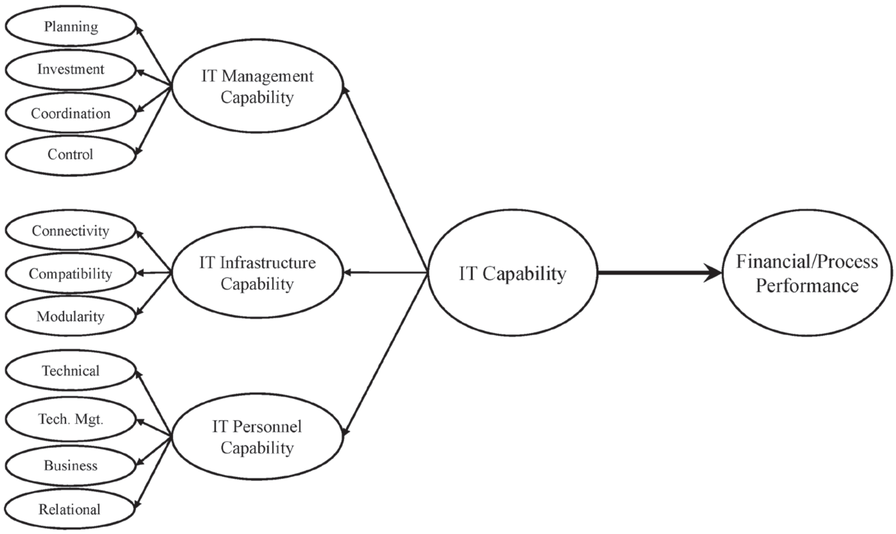

(c) Entanglement Conceptualization

Figure 3. Continued

performance were identified from extant studies as potential survey items, and they were systematically reduced to a manageable size through several content validation activities. The key informants of IT capability and business performance should differ, and thus we exercised two separate content validation processes. IT executives and university researchers reviewed those of IT capability, and business executives and university researchers assessed those of financial and business process performance. The content validation process went through several iterations. In each iteration, participants assessed and discussed *content domain representativeness* (whether included measures are consistent with a target construct's concept domain) and *content domain relevance* (if there are extraneous, contaminating measures of a construct) [28]. Also, participants were asked to identify and suggest improvements of measures with inadequate wording, semantic ambiguity, or insignificance. Through the iterative process, the questionnaires were continuously refined.

Five senior IT executives and three university researchers participated in the content validation of the initial IT capability items. For this, they met three times over the two-week period and chose 50 questions, which were subsequently subject to another content validity session with 20 senior IT managers. The review by senior IT managers resulted in dropping four additional items, and consequently 46 items of IT capability survived the iterative procedure (see the Appendix). The questionnaire was then mailed to and reviewed by another group of 20 senior IT managers, confirming no need for additional changes to the remaining items of IT capability. An iterative process similar to that of IT capability was applied to select the appropriate survey items of financial and business process performance. For this, three faculty members and five business executives participated in the focus group interviews, and then another group of ten business managers further examined the content reliability of the remaining items. In

Table 1. Operational Definitions of Study Variables

Constructs dimensions	Definition
Business process performance	A firm's competence to change existing business processes better than competitors do in terms of coordination/integration, cost reduction, and business intelligence/learning
Financial performance	Overall financial performance over the past three years
IT infrastructure capability	The ability of a firm's IT infrastructure to enable quick development and support of various system components
Connectivity	Ability to connect internal and external IT elements
Compatibility	Ability to share various types of information and data regardless of technical basis
Modularity	Ability to add, remove, and modify system or software components
IT personnel capability	The level of professional skills or knowledge of IT staff
Technical	IT staff's knowledge about technical elements, including operational systems, programming languages, database management systems, and networking
Technology management	IT staff's knowledge of IT resource management necessary to support business goals
Business functional	IT staff's understanding of various business functions and business environment
Relational	IT staff's ability to communicate and work with people from other business functions
IT management capability	The ability of a firm to manage IT resources to deliver business value
IT planning	The level at which the planning of IT deployment and utilizations is structured according to formal and informal procedures
IT investment decision making	The level at which investment decision making about IT resources is structured according to formal and informal procedures
IT coordination	The level at which coordination efforts between IT staff and business clients is structured according to formal and informal procedures
IT control	The level at which IT control activities (e.g., development, management, and operation) is structured according to formal and informal procedures

the end, nine survey items, including four indicators of business process performance and five indicators of financial performance, were retained for the survey.

Data Collection

For our survey data, we use a sampling frame from firms listed in the database available through the Financial Supervisory Service of the Korean government. The database had a mailing list of 1,835 firms (629 firms listed on the Korea Stock Exchange, 857 firms listed on the KOSDAQ [Korean Securities Dealers Automated Quotations], and 349 unlisted firms). A random sample of 800 firms was chosen from the sampling frame. Then, two respondents of each selected firm were identified based on their capacity as key informants by virtue of their current position, practical experience, and professional knowledge. The key informants, including chief information officers (CIOs), directors, and senior managers, were believed to offer a more accurate assessment of the surveyed issues than those randomly chosen [80]. A key informant from the IT strategy/planning department and a key informant from a business department were identified for each firm so that their respective assessment on the IT capability and business performance items constitute a matching set with no risk of common method bias. All the surveyed firms had a formal and sizable IT function.

Out of 800 firms contacted, 375 firms responded to the IT survey and 395 firms responded to the business survey. The relatively high response rate was achieved partially by mailing a follow-up survey to nonrespondents four weeks after the initial mailing. The matching of two survey groups resulted in 251 response sets. However, 8 were dropped because they were incomplete, leaving the final sample consisting of 243 response sets, with a joint response rate of 30.3 percent. We tested for the possibility of response bias through the comparison of early (20 percent) and late (20 percent) response groups [32]. None of the *t*-tests conducted on the survey items were statistically different. Further, the profiles of the survey respondents and those on the mailing list were compared in terms of organization size and industry, and chi-square tests indicated no nonresponse bias. This suggests that nonresponse bias is unlikely to be a problem in this study.

The surveyed organizations represented diverse industry groups (Table 2): manufacturing (29 percent); telecommunication and IT (23.9 percent); financial services, banking, and insurance (17.3 percent); retail (14 percent); and transportation and utilities (15.6 percent). The average number of employees of surveyed firms was 4,277, and their average revenue was $447 million. Of the respondents for *IT capability,* 47.7 percent were either CIOs or vice presidents (VPs) of the IT unit and the rest had titles of senior VP, VP of technology, assistant VP, and director of IT. For *business performance,* 50.6 percent of the respondents were at the rank of senior VP, VP, assistant VP, or director. All of those surveyed indicated that they were within two levels from the highest position of their organizational hierarchy.

Analysis

Tests of Construct Validity

Per Spanos and Lioukas [82] and Tanriverdi [85], the construct validity (item reliability, dimensionality, convergent validity, and discriminant validity) of the first-, second-, and third-order constructs was methodically examined in a stepwise manner by comparing the performance of various measurement models. The ultimate goal of the stepwise analysis was to demonstrate the construct validity of the third-order *IT capability* construct. SPSS 18.0 was used to obtain coefficient alpha values, and

Table 2. Sample Characteristics

Categories	Frequency	Percent
Industry type		
Manufacturing	71	29.2
Telecommunication and IT	58	23.9
Financial services, banking, and insurance	42	17.3
Retail	34	14.0
Transportation and utilities	38	15.6
Firm size (number of employees)		
More than 3,000	65	26.7
More than 1,000	67	27.6
More than 500	40	16.7
More than 300	39	16.0
Less than or equal to 300	32	13.2

LISREL 8.52 was used for the confirmatory factor analysis (CFA). In the initial examination of the measurement models, one item (MD4) of the *modularity* variable was dropped due to weak reliability.

Item Reliability

Table 3 presents reliability tests of the first-order dimensions of IT capability. The coefficient alpha values range from 0.800 to 0.948 and the composite measure reliability scores are higher than 0.800, demonstrating the internal consistency of all the first-order factors [62].

Dimensionality, Convergent Validity, and Discriminant Validity (First-Order Constructs)

For each second-order construct (e.g., IT management capability), three alternative first-order factor models (i.e., Models 1, 2, and 3 in Table 4) are compared in terms of dimensionality, convergent validity, and discriminant validity to determine the best one. Then, in order to examine the effectiveness of the high-order modeling, the best performer of the three first-order factor models is compared against the factor model with a second-order construct (i.e., Model 4) that accounts for the relationship among the first-order factors. Model 1 hypothesizes that a unidimensional factor accounts for the variance of all the measurement items. Model 2 hypothesizes that the measurement items are grouped to uncorrelated first-order factors (e.g., planning, investment decision, coordination, and control). Model 3 hypothesizes that the measurement items form into freely correlated first-order factors (e.g., planning, investment decision, coordination, and control).

Table 3. Properties and Internal Consistency of IT Capability Measure

First-order dimensions	Alpha	Composite measure reliability	Items	Unstandardized estimates	Standardized estimates	Standard errors	*t*-values	R^2
IT planning (PL)	0.903	0.908	PL1	1.00	0.80	—	Scaling	0.63
			PL2	1.19	0.91	0.07	16.74	0.83
			PL3	1.16	0.87	0.07	15.65	0.75
			PL4	1.11	0.79	0.08	13.72	0.62
IT investment decision making (IV)	0.905	0.905	IV1	1.00	0.80	—	Scaling	0.64
			IV2	1.03	0.84	0.06	14.90	0.70
			IV3	1.02	0.78	0.07	13.59	0.61
			IV4	1.07	0.81	0.07	14.11	0.65
			IV5	1.09	0.82	0.07	14.33	0.66
IT coordination (CO)	0.886	0.888	CO1	1.00	0.80	—	Scaling	0.63
			CO2	0.93	0.79	0.06	13.37	0.62
			CO3	1.09	0.88	0.07	15.18	0.77
			CO4	1.00	0.79	0.07	13.28	0.62
IT control (CR)	0.889	0.901	CR1	1.00	0.79	—	Scaling	0.61
			CR2	0.99	0.83	0.06	14.17	0.68
			CR3	1.11	0.88	0.07	15.35	0.77
			CR4	1.12	0.84	0.07	14.54	0.70
Connectivity (CN)	0.800	0.800	CN1	1.00	0.71	—	Scaling	0.50
			CN2	1.11	0.65	0.12	9.02	0.42
			CN3	1.31	0.74	0.13	10.14	0.55
			CN4	1.09	0.73	0.11	9.93	0.52

Compatibility (CP)	0.802	0.804	CP1	1.00	0.67	—	Scaling	0.45
			CP2	1.14	0.71	0.12	9.36	0.51
			CP3	1.11	0.71	0.11	9.37	0.51
			CP4	1.17	0.75	0.12	9.70	0.55
Modularity (MD)	0.911	0.918	MD1	1.00	0.73	—	Scaling	0.54
			MD2	1.39	0.96	0.08	15.47	0.93
			MD3	1.33	0.95	0.08	15.36	0.91
Technical knowledge (TK)	0.910	0.911	TK1	1.00	0.85	—	Scaling	0.71
			TK2	0.94	0.82	0.05	15.69	0.67
			TK3	0.88	0.79	0.06	14.70	0.62
			TK4	1.06	0.84	0.06	16.16	0.70
			TK5	1.01	0.81	0.06	15.21	0.64
Technology management knowledge (MK)	0.884	0.893	MK1	1.00	0.76	—	Scaling	0.58
			MK2	0.96	0.81	0.07	13.25	0.65
			MK3	0.96	0.88	0.06	14.50	0.76
			MK4	0.94	0.83	0.06	13.65	0.69
Business knowledge (BK)	0.875	0.879	BK1	1.00	0.86	—	Scaling	0.74
			BK2	0.96	0.82	0.06	15.97	0.68
			BK3	0.96	0.85	0.05	16.75	0.72
			BK4	0.82	0.67	0.07	11.65	0.45
Relational knowledge (RK)	0.948	0.948	RK1	1.00	0.87	—	Scaling	0.76
			RK2	0.98	0.90	0.04	20.12	0.80
			RK3	1.03	0.93	0.04	21.65	0.85
			RK4	1.01	0.93	0.04	21.70	0.86

Table 4. Dimensionality and Convergent Validity of the First-Order Constructs

Second-order construct	Fit indices	Model 1	Model 2	Model 3	Model 4	Target coefficient
IT management capability	χ^2	945.96	768.23	116.43	120.20	—
	df	119	119	113	115	—
	Normed χ^2	7.95	6.45	1.03	1.04	0.99
	CFI	0.94	0.94	0.99	0.99	—
	TLI	0.93	0.93	0.99	0.99	—
	NFI	0.92	0.93	0.98	0.98	—
	RMSEA	0.17	0.15	0.04	0.04	—
IT infrastructure capability	χ^2	732.14	292.63	109.50	109.50	—
	df	44	44	41	41	—
	Normed χ^2	16.61	6.65	2.67	2.67	1.00
	CFI	0.82	0.90	0.97	0.97	—
	TLI	0.78	0.88	0.96	0.96	—
	NFI	0.81	0.89	0.96	0.96	—
	RMSEA	0.25	0.15	0.08	0.08	—
IT personnel capability	χ^2	1289.68	909.44	311.62	321.83	—
	df	119	119	113	115	0.98
	Normed χ^2	10.84	7.64	2.76	2.79	—
	CFI	0.91	0.93	0.98	0.98	—
	TLI	0.90	0.92	0.97	0.97	—
	NFI	0.90	0.92	0.97	0.97	—
	RMSEA	0.20	0.17	0.08	0.08	—

Notes: df = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; NFI = normed fit index; RMSEA = root mean square error of approximation. Model 1 hypothesizes the existence of a unidimensional factor. Model 2 hypothesizes a multidimensional model with uncorrelated first-order factors. Model 3 hypothesizes a multidimensional model with freely correlated first-order factors. Model 4 hypothesizes a second-order construct with associated first-order constructs.

The comparison of Models 1 and 2 in Table 3 shows that Model 2 is a better-fitting model for all three second-order constructs, indicating that the multidimensional model that consists of uncorrelated first-order factors is superior to the unidimensional factor model. It supports the *multidimensionality* of the first-order constructs for all three second-order constructs. Further comparison of Model 2 with Model 3 indicates that Model 3, the multidimensional model with freely correlated first-order factors, is superior to Model 2, the multidimensional model with uncorrelated first-order factors in all three second-order constructs. In Model 3, standardized loadings of the measurement items on their respective factor are all highly significant ($p < 0.001$), offering support for convergent validity (see the t-value of each measure in the Appendix).

Then, discriminant validities among the first-order factors of each second-order construct are assessed using the chi-square difference test [89], which compares the constrained model's fit and the unconstrained model's fit. With the constrained model, the correlation between two first-order constructs (IT planning and IT coordination) is constrained to 1.0, indicating that the two first-order constructs are not distinct (null hypothesis). The unconstrained model represents the alternative hypothesis in which the correlation between the two first-order constructs is allowed to vary freely, thus presuming their conceptual distinctness. Table 5 reports that all the chi-square differences are significant at the $p < 0.0001$ level, indicating the superiority of the unconstrained models over constrained models. This becomes a strong indication of discriminant validity among the first-order constructs.

With convergent and discriminant validities among the first-order factors confirmed, we then tested whether a second-order construct accounts for the relationships among the first-order factors. Model 4 in Table 4 hypothesizes a second-order construct (IT management capability) with associated first-order constructs (planning, investment decision, coordination, and control) (i.e., a multidimensional model with a second-order factor). Previous studies used three criteria for comparing first-order (e.g., Model 3) and second-order (e.g., Model 4) factor models: (1) goodness-of-fit statistics for the two models [87, 90], (2) significance of the second-order factor loadings [87, 90], and (3) target coefficient (T) statistics [52]. When Model 3, as the best performer of the first three (i.e., Models 1, 2, and 3), is compared with Model 4 (see Table 4), they indicate almost identical model fit statistics. All the second-order factor loadings are highly significant ($p < 0.001$). The target coefficient values (i.e., 0.99, 1.00, and 0.98) are very close to the theoretical upper limit of 1, indicating that the second-order factors account for most of the relationship among the first-order factors, which is strong support for the parsimonious second-order factor models.

Dimensionality, Convergent Validity, and Discriminant Validity (Second-Order Constructs)

With the compelling appeal of the second-order factor model above, we now proceed to test the second-order constructs' validity. For this, two alternative second-order factor models (Models 1 and 2 in Table 6) are compared in terms of convergent validity and discriminant validity to determine the better one. Then, in order to examine the

Table 5. Results of Discriminant Validity Test Among First-Order Constructs

First-order constructs	Constraint model χ^2 (df)	Unconstrained Model χ^2 (df)	$\Delta\chi^2$	*p*-value
IT management capability				
IT planning and IT investment	63.97 (27)	45.79 (26)	18.81	< 0.0001
IT planning and IT coordination	29.10 (20)	17.87 (19)	11.23	< 0.0001
IT planning and IT control	58.31 (20)	51.64 (19)	6.67	< 0.0001
IT investment and IT coordination	53.94 (27)	42.13 (26)	11.81	< 0.0001
IT investment and IT control	50.31 (27)	41.11 (26)	9.20	< 0.0001
IT coordination and IT control	18.31 (20)	14.44 (19)	3.87	< 0.0001
IT infrastructure capability				
Connectivity and compatibility	76.50 (20)	60.50 (19)	16.00	< 0.0001
Connectivity and modularity	74.57 (14)	51.58 (13)	22.99	< 0.0001
Compatibility and modularity	38.37 (14)	23.34 (13)	15.03	< 0.0001
IT personnel capability				
Technical and technology management	137.79 (27)	130.64 (26)	7.15	< 0.0001
Technical and business	113.36 (27)	108.06 (26)	5.30	< 0.0001
Technical and relational	112.91 (27)	107.74 (26)	5.17	< 0.0001
Technology management and business	64.49 (20)	57.26 (19)	7.23	< 0.0001
Technology management and relational	97.27 (20)	89.76 (19)	7.51	< 0.0001
Business and relational	51.60 (20)	45.56 (19)	6.04	< 0.0001

Notes: df = degrees of freedom. While the constrained model sets correlations between first-order constructs at 1.0, the unconstrained model allows the correlations to change freely.

effectiveness of the higher-order modeling, the better performer of the two second-order factor models is compared against the factor model with a third-order construct (Model 3) that accounts for the relationship between the two second-order factors. Models 1 and Model 2 in Table 6 hypothesize that the first-order factors form into

Table 6. Dimensionality and Convergent Validity of the Second-Order Constructs

Third-order construct (*t*-values)	Fit indices	Model 1	Model 2	Model 3	Target coefficient
IT capability (IT management capability = scaling; IT infrastructure capability = 7.89*; IT personnel capability = 9.48*)	χ^2	1902.34	1613.25	1613.25	—
	df	934	931	931	—
	Normed χ^2	2.03	1.73	1.73	1.00
	CFI	0.98	0.98	0.98	—
	TLI	0.98	0.98	0.98	—
	NFI	0.96	0.97	0.97	—
	RMSEA	0.06	0.05	0.05	—
Model 2 (freely correlated second-order factors)					
IT management capability	IT planning (scaling)				
	IT investment decision making (9.96*)				
	IT coordination (9.61*)				
	IT control (10.45*)				
IT infrastructure capability	Connectivity (scaling)				
	Compatibility (6.34*)				
	Modularity (6.53*)				
IT personnel capability	Technical knowledge (scaling)				
	Technology management knowledge (9.85*)				
	Business knowledge (10.72*)				
	Relational knowledge (10.95*)				

Notes: df = degrees of freedom; CFI = comparative fit index; TLI = Tucker–Lewis index; NFI = normed fit index; RMSEA = root mean square error of approximation. Model 1 hypothesizes a multidimensional model with uncorrelated second-order factors. Model 2 hypothesizes a multidimensional model with freely correlated second-order factors. Model 3 hypothesizes a third-order construct with associated second-order constructs. *t*-values are in parentheses.
* $p < 0.001$.

uncorrelated and freely correlated second-order factors, respectively. The comparison of two models indicates that Model 2, freely correlated second-order factors, is superior to Model 1, uncorrelated second-order factors. In Model 2, the standardized factor loadings of the first-order factors on their respective second-order factors are all highly significant ($p < 0.001$), highlighting convergent validity (see the t-value of each first-order factor in Table 6).

Discriminant validity among the second-order constructs is also assessed using the chi-square difference test [89]. Table 7 reports the results that all chi-square differences are significant at the $p < 0.0001$ level, indicating superiority of Model 2 (unconstrained model) over Model 1 (constrained model). The results strongly support discriminant validity among the second-order constructs.

With the confirmation of the convergent and discriminant validities among the second-order factors, we proceeded to test if the third-order factor (Model 3 in Table 6) explains the relationships between the second-order factors. In comparing the third-order factor model (Model 3) with the second-order factor model (Model 2), two out of three criteria (i.e., goodness-of-fit statistics and target coefficient, T, statistics) cannot be used because the two models have the same degrees of freedom, which produce identical fit indices and target coefficient (T) statistics. We can only confirm that the loadings between the second-order factors and the third-order factor are highly significant ($p < 0.001$) (see Table 6). Meanwhile, we can compare the effectiveness of Models 2 and 3 by linking them to a criterion variable such as firm performance and reviewing the significance of the structural path (nomological validity) [90]. The test is shown next.

Comparing Conceptualization Approaches of IT Capability

This section compares the three conceptualization approaches (i.e., *unidirectional, unrelated,* and *entanglement conceptualizations*) in explaining business performance, and the results are summarized in Table 8. Both the unidirectional and unrelated conceptualizations are grounded on Model 2 in Table 6, which allows free correlations among second-order factors, and entanglement conceptualization is represented by Model 3 in Table 6, the third-order factor. The analysis reveals that the influence of second-order IT capabilities on financial performance is insignificant in both unidirectional conceptualization and unrelated conceptualization. With entanglement conceptualization in the form of the third-order factor, the effect of IT capability on financial performance is highly significant. In both unidirectional and unrelated conceptualizations, IT personnel capability and IT infrastructure capability significantly ($p < 0.05$) affected business process performance, but the effect of IT management capability was not substantiated. With entanglement conceptualization of IT capability, the association between IT capability in its third-order construct and business process performance was very strong ($p < 0.001$). Although the R^2 value generally increases with the number of independent variables, that of entanglement conceptualization and those of the unidirectional and unrelated conceptualization approaches remain

Table 7. Results of Discriminant Validity Test Among Second-Order Constructs

Second-order constructs	Constraint model χ^2 (df)	Unconstrained model χ^2 (df)	$\Delta\chi^2$	p-value
IT management capability and IT infrastructure capability	532.05 (343)	503.59 (342)	28.46	< 0.0001
IT infrastructure capability and IT personnel capability	848.89 (343)	798.22 (342)	50.67	< 0.0001
IT personnel capability and IT management capability	968.38 (519)	916.47 (518)	51.91	< 0.0001

Table 8. Comparisons of the Conceptualization Approaches of IT Capability

Conceptualization approaches	Standardized path coefficient	t-value	R^2
Dependent variable: Perceived financial performance			
Unidirectional conceptualization			
IT personnel capability	–0.17	–0.78	0.180
IT management capability	0.35	1.35	
IT infrastructure capability	0.11	0.67	
Unrelated conceptualization			
IT personnel capability	–0.17	–0.78	0.186
IT management capability	0.35	1.33	
IT infrastructure capability	0.12	0.69	
Entanglement conceptualization			
IT capability	0.28	4.08***	0.176
Dependent variable: Business process performance			
Unidirectional conceptualization			
IT personnel capability	0.50	2.31*	0.380
IT management capability	–0.23	–0.90	
IT infrastructure capability	0.36	2.12*	
Unrelated conceptualization			
IT personnel capability	0.50	2.26*	0.405
IT management capability	–0.24	–0.93	
IT infrastructure capability	0.39	2.20*	
Entanglement conceptualization			
IT capability	0.59	6.98***	0.366

* $p < 0.05$; *** $p < 0.001$.

close in our tests. This result indicates that the third-order model effectively captured superadditive value synergies arising from the complementarity of the second-order factors [85], providing the nomological validity of the higher-order IT capability.

Taken together, the results become an indication that both the *unidirectional* and *unrelated conceptualization* approaches have a much greater chance of underestimating the effect of IT capability as a whole. The analysis demonstrates the effectiveness of empirical approach grounded on the entanglement conceptualization of IT capability.

Discussion

Research Contributions

Several contributions have been made in this research. First, despite the notable rarity of sociomaterialism-driven IS research, we empirically demonstrated its value in the conceptualization of IT capability and subsequently in substantiating the fact that IT capability as a whole is highly germane to strengthening business performance. The IS community has experienced challenges in proving the significance of IS as a source of business value [55, 59, 92]. Besides the old-fashioned dispute of productivity paradox, we can also observe inconsistency of empirical studies in associating IT capability dimensions, especially technology and material aspects, with business performance. For example, Powell and Dent-Micallef [69] discovered the effect of IT human resources on firm performance but not the influence of technology. Similarly, Bhatt and Grover's [7] research showed the effect of IT business expertise and relationship infrastructure on competitive advantage but not IT infrastructure quality. Meanwhile, Tippins and Sohi [87] reported that IT competency had no direct bearing on firm performance. Our analysis also revealed that the three constituents of IT capability had mixed effects at best on financial and business process performance when the modeling was grounded on unidirectional or unrelated conceptualization. Although we have reached the point that industry practitioners are unable to dispute the criticality of IT in making or breaking businesses, it is also true that the research community is, to a certain degree, still grappling with the demonstration of IT's business value in a convincing manner [63, 64, 65, 66]. This research, which views the overall IT capability of a firm through the complementary entanglement of lower-order IT capacity, may reveal the missing link.

Second, our empirical work grounded on the expanded imbrication metaphor highlights the legitimacy of the broader perspective that embraces *IT management capability* as a key competence dimension in understanding an organization's IT capability through the theoretical lens of routines. Most studies agree that the human (e.g., IT personnel knowledge) and the material (e.g., IT infrastructure) agencies are key constituents of IT capability [1, 5, 53, 55, 69, 87]. In addition, a number of studies added the IT–business relationship dimension (e.g., relationship assets, IT–business process integration, IT–business partnership, IS partnership quality, and relationship infrastructure) to the equation of IT capability [7, 67, 71, 73]. Managing the IT–business relationship, however, is a form of routine that requires much coordination and thus is narrower in its definitional scope than IT management capability. In fact, research on IT capability and that on IT management have evolved separately in the IS field, and this might have resulted in a weak tie between them. Our research builds a compelling argument that the typology of IT capability in terms of IT personnel capability, IT infrastructure capability, and IT management capability becomes a viable framework on which IT's business value research can be expanded.

Third, another contribution of this research is the conceptualization of a reflective higher-order construct. Our work theorized a third-order IT capability grounded on sociomaterialism and empirically proved its utility in manifesting the entanglement phenomenon. In our analysis, the abstraction of the third-order construct was, overall, more effective than the alternative modeling approaches in capturing variations of business performance. The encouraging outcome is an indication that achieving theoretical parsimony is not the sole benefit of the higher-order conceptualization of a construct [22]. In other words, even if the third-order model achieved structural parsimony relative to the second-order models, the former displayed a reliable explanatory power on firm performance, underscoring that the higher-order construct (e.g., second, third, or more) can be powerful in revealing the theorized interactions between the lower-order constructs. In fact, although the second-order factor has been populated by researchers, the third- or higher-order construct modeling has received much skepticism on the ground of weak theoretical justifications. With the compelling results of our analysis, however, we contend that the choice of higher-order construct be based on its merit in portraying a phenomenon through a particular theoretical lens. Although the validity testing of higher-order constructs has been a challenge, the assessment approach we adopted for the third-order construct can be relatively easily expanded to even higher-order constructs. With the relevancy of the sociomaterial perspective in better comprehending implications of IT capability at the organizational context, we encourage researchers to appropriate the higher-order factor and its systematic validation to examine the dynamics of entanglement among its constituents.

Managerial Implications

The current literature argues that the IT function should be agile in creating, managing, and improving IT capability to respond to continuously changing organizational demands [67]. Nonetheless, there has been little elaboration on how IT resources are planned and structured to improve the IT capability of a firm. This study offers more concrete guidance on how to make a firm's IT more relevant. Above all, to be consistent with the three building blocks of IT capability, IT managers need to diversify their perspective of IT capability to human, material, and routine resources. In general, many firms view technical and human elements as core IT resources, but not necessarily the routine component. However, our research underscores that IT resource planning and management wrap around the aspects of all three dimensions as integral building blocks of a firm's overall IT capability. In other words, the IT capability of a firm in reinforcing firm performance is incomplete if any of the three capability dimensions is weak. This is especially so because they are complementary in their entangled relationship.

While existing studies suggested that IT business values are produced when IT is adequately fused with business elements (e.g., redesign of business processes, training of human resources, strategic partnership, modification of incentive systems and organizational structures) [5, 12, 49], our research implies that effective synergy between IT capability factors alone can become a source of business value and competitive advantage. Our study, therefore, offers IT managers a ground on which they can develop ideas and solidify strategies to ultimately form synergistic balance among the three building blocks of IT capability.

Limitations and Future Research

One main limitation of our study is that we are unable to test the generalizability of our findings, leaving this to future research. For instance, to provide greater confidence in the results, methods such as a holdout sample can be utilized in which a sample is divided into two and their respective results can be compared. Although ideal when sample data can be easily obtained, it poses a great deal of difficulty when each firm becomes a unit of analysis. Making the data gathering even more challenging, the firm-level records in our sample were the result of paired matching process between IT and business function respondents. Therefore, further studies are warranted to generalize the study findings.

This study focused on complementarity of IT infrastructure, IT personnel, and IT management in understanding a firm's IT capability. One of the next logical steps is to theorize and validate complementarity between the three IT capability dimensions and business resources. In doing so, a particular role of IT management capability is expected. Because IT management capability adds more dynamism and unpredictability to the traditional static view of IT resources, its incorporation into the research of complementarity between IT capability and business resource should be highly revealing. This may allow us to better grasp the effect of alignment and synergy between IT capability and specific business capability on firm performance. Furthermore, we may be able to assess the relative contribution of two capability types in shaping firm performance.

Lastly, the building blocks (e.g., human, material, and routine) of IT capability and those of capabilities in other disciplines (e.g., management, marketing, operations, and international businesses) are expected to resemble those in the dynamics of the structural elements, and therefore this research may offer insights in the conceptualization or reconceptualization of domain-specific capabilities. For instance, theoretical attempts may be replicated in conceptualizing marketing capabilities (e.g., dynamic marketing capabilities [15], marketing planning and implementation capabilities [91], marketing proficiency [40], marketing intensity of multinational enterprises [42], pricing and distribution capabilities [96], customer service capability [60], and customer response capability [34]), operations capabilities (e.g., business process capability [74], competence in modular production practices [95], quality management capabilities [24], production competence [30], and resource planning and operations capabilities [2]), and research and development (R&D) capabilities (e.g., R&D intensity of multinational enterprises [42], technological innovativeness [56], and technological area experience [50]).

Conclusion

THE FINDINGS OF OUR RESEARCH UNDERSCORES the prospect of sociomaterialism in assisting the IS community to better comprehend the role of IT on business performance. Reflecting the reality that implicated IT elements are not discrete but represent constituents of an inextricably interwoven whole, sociomaterialism is expected to allow us to unravel their true contribution to business. We learned that the employment of sociomaterialism can be especially instrumental in building the theory of IT capability such as the definition of IT capability dimensions and their engagement. Furthermore, it is not difficult to conceive that IT capability is not the only research subject that will benefit from this viewpoint. Meanwhile, we also came to the realization that to capitalize its potential to aid IS research, the IS community needs parallel efforts that not only conduct empirical studies anchored on the theory but also tailor and extend the traditional sociomaterial perspective to the context of IT producers (rather than IT users). Finally, we would like to suggest that the value of the sociomaterialistic viewpoint in IS research can be further enhanced when it is utilized in conjunction with other established theories as needed.

NOTE

1. Imbrication indicates the interweaving of human and material agencies [46]. To imbricate means to arrange distinct elements in overlapping patterns so that they function interdependently.

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Appendix: Survey Measures

		Sources
IT planning		
PL1	We continuously examine the innovative opportunities for the strategic use of IT. (scaling)	[10, 36, 80]
PL2	We enforce adequate plans for the introduction and utilization of IT. (16.71*)	[36]
PL3	We perform IT planning processes in systematic and formalized ways. (15.65*)	[77, 80]
PL4	We frequently adjust IT plans to better adapt to changing conditions. (13.72*)	
IT investment decision making		
IV1	When we make IT investment decisions, we think about and estimate the effect they will have on the quality and productivity of the employees' work. (scaling)	[76, 77]
IV2	When we make IT investment decisions, we consider and project about how much these options will help end users make quicker decisions. (14.94*)	
IV3	When we make IT investment decisions, we consider and estimate whether they will consolidate or eliminate jobs. (13.61*)	
IV4	When we make IT investment decisions, we think about and estimate the amount and cost of training that end users will need. (14.10*)	
IV5	When we make IT investment decisions, we consider and estimate the time managers will need to spend overseeing the change. (14.34*)	
IT coordination		
CO1	In our organization, IS and line people meet frequently to discuss important issues both formally and informally. (scaling)	[10, 36]
CO2	In our organization, IS people and line people from various departments frequently attend cross-functional meetings. (13.38*)	[20, 47]
CO3	In our organization, IS and line people coordinate their efforts harmoniously. (15.16*)	[47]
CO4	In our organization, information is widely shared between IS and line people so that those who make decisions or perform jobs have access to all available know-how. (13.31*)	
IT control		
CR1	In our organization, the responsibility and authority for IT direction and development are clear. (scaling)	[36]
CR2	We are confident that IT project proposals are properly appraised. (14.23*)	
CR3	We constantly monitor the performance of IT functioning. (15.43*)	
CR4	Our IT department is clear about its performance criteria. (14.53*)	

		Sources
Connectivity		
CN1	Compared to rivals within our industry, our organization has the foremost available IT systems and connections. (scaling)	[13, 21]
CN2	All remote, branch, and mobile offices are connected to the central office. (9.26*)	
CN3	Our organization utilizes open systems network mechanisms to boost connectivity. (10.30*)	
CN4	There are very few identifiable communications bottlenecks within our organization. (10.20*)	
Compatibility		
CP1	Software applications can be easily transported and used across multiple platforms. (scaling)	[13, 21]
CP2	Our user interfaces provide transparent access to all platforms and applications. (9.32*)	
CP3	Information is shared seamlessly across our organization, regardless of the location. (9.38*)	
CP4	Our organization provides multiple interfaces or entry points for external end users. (9.69*)	
Modularity		
MD1	Reusable software modules are widely used in new system development. (scaling)	[11, 13, 21]
MD2	End users utilize object-oriented tools to create their own applications. (15.48*)	
MD3	IT personnel utilize object-oriented technologies to minimize the development time for new applications. (15.37*)	
MD4	The legacy system within our organization restricts the development of new applications. (reverse scale) (removed)	
Technical knowledge		
TK1	Our IT personnel are very capable in terms of programming skills (e.g., structured programming, Web-based application, CASE tools, etc). (scaling)	[8, 11, 13, 44]
TK2	Our IT personnel are very capable in terms of managing project life cycles. (15.58*)	
TK3	Our IT personnel are very capable in the areas of data and network management and maintenance. (14.71*)	
TK4	Our IT personnel are very capable in the areas of distributed processing or distributed computing. (16.16*)	
TK5	Our IT personnel create very capable decision support systems (e.g., expert systems, artificial intelligence, data warehousing, mining, marts, etc). (15.16*)	
Technology management knowledge		
MK1	Our IT personnel show superior understanding of technological trends. (scaling)	[87]
MK2	Our IT personnel show superior ability to learn new technologies. (13.27*)	
MK3	Our IT personnel are very knowledgeable about the critical factors for the success of our organization. (14.49)	[13]
MK4	Our IT personnel are very knowledgeable about the role of IT as a means, not an end. (13.70*)	[87]

(continues)

		Sources
Business knowledge		
BK1	Our IT personnel understand our organization's policies and plans at a very high level. (scaling)	[13, 21]
BK2	Our IT personnel are very capable in interpreting business problems and developing appropriate technical solutions. (15.97*)	[13, 86]
BK3	Our IT personnel are very knowledgeable about business functions. (16.75*)	
BK4	Our IT personnel are very knowledgeable about the business environment. (11.66*)	[86]
Relational knowledge		
RK1	Our IT personnel are very capable in terms of planning, organizing, and leading projects. (scaling)	[8, 13, 21, 44]
RK2	Our IT personnel are very capable in terms of planning and executing work in a collective environment. (20.11*)	[13, 35, 86]
RK3	Our IT personnel are very capable in terms of teaching others. (21.64*)	[13, 44, 86]
RK4	Our IT personnel work closely with customers and maintain productive user/client relationships. (21.72*)	[13, 35, 44, 86]
Business process performance		
BP1	Our company' is better than competitors in connecting (e.g., communication and information sharing) parties within a business process. (scaling)	[87]
BP2	Our company is better than competitors in reducing cost and human labor within a business process. (14.27*)	[19, 23]
BP3	Our company is better than competitors in bringing complex analytical methods to bear on a business process. (13.41*)	[23, 81]
BP4	Our company is better than competitors in bringing detailed information into a business process. (13.21*)	
Perceived financial performance		
FP1	Over the past 3 years, our financial performance has been outstanding. (scaling)	[69]
FP2	Over the past 3 years, our financial performance has exceeded our competitors'. (18.92*)	
FP3	Over the past 3 years, our sales growth has been outstanding. (16.83*)	
FP4	Over the past 3 years, we have been more profitable than our competitors. (18.12*)	
FP5	Over the past 3 years, our sales growth has exceeded our competitors'. (18.57*)	

Note: t-values are in parentheses; * $p < 0.001$.