

ABSORPTIVE CAPACITY AND INFORMATION SYSTEMS RESEARCH: REVIEW, SYNTHESIS, AND DIRECTIONS FOR FUTURE RESEARCH¹

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Absorptive capacity is a firm's ability to identify, assimilate, transform, and apply valuable external knowledge. It is considered an imperative for business success. Modern information technologies perform a critical role in the development and maintenance of a firm's absorptive capacity. We provide an assessment of absorptive capacity in the information systems literature. IS scholars have used the absorptive capacity construct in diverse and often contradictory ways. Confusion surrounds how absorptive capacity should be conceptualized, its appropriate level of analysis, and how it can be measured. Our aim in reviewing this construct is to reduce such confusion by improving our understanding of absorptive capacity and guiding its effective use in IS research. We trace the evolution of the absorptive capacity construct in the broader organizational literature and pay special attention to its conceptualization, assumptions, and relationship to organizational learning. Following this, we investigate how absorptive capacity has been conceptualized, measured, and used in IS research. We also examine how absorptive capacity fits into distinct IS themes and facilitates understanding of various IS phenomena. Based on our analysis, we provide a framework through which IS researchers can more fully leverage the rich aspects of absorptive capacity when investigating the role of information technology in organizations.

Keywords: Absorptive capacity, information systems, IT capability, knowledge, organizational learning

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Introduction

If we take a sponge, its ability to absorb water depends on the number of holes in it, the nature of the material and its resistance to taking in water, as well as the amount of water it currently holds. Once absorbed, the water could flow through the holes in the material. The process of squeezing the sponge could facilitate that flow. These structures and processes allow the sponge to meet its basic purpose. Similarly, an organization could absorb knowledge from the outside, but it will do so only if its knowledge repositories and the brains of its individual members are seeking and receptive to that knowledge based on what they already know. The knowledge flows through the organization, and these knowledge flows can be facilitated by the appropriate structures and processes. Furthermore, these structures and processes can create efficient mechanisms for applying the knowledge to useful purposes.

As firms face intense rivalry, globalization, demand for innovation, and time-to-market pressures, *absorptive capacity* is considered to be an imperative for business success (Lane et al. 2006). Absorptive capacity is a firm's ability to identify valuable external knowledge, assimilate or transform this knowledge into the firm's knowledge base, and apply this new knowledge through innovation and competitive actions (Cohen and Levinthal 1990). Developing and maintaining absorptive capacity is vital to a firm's long-term survival and success because absorptive capacity can strengthen, complement, or refocus the firm's knowledge base (Zahra and George 2002). Investments in absorptive capacity also increase a firm's ability to accurately anticipate innovation trends and to take advantage of emerging opportunities before its rivals can recognize them (Cohen and Levinthal 1994).

Absorptive capacity is particularly important to studying information systems phenomena. The rapid convergence and diffusion of computing, communications, and content technologies offers firms significant opportunities for enhancing absorptive capacity. By recognizing information technology as a strategic resource (Wade and Hulland 2004), managers are combining their IT investments (e.g., infrastructural technologies, enterprise systems, common data repositories, and open architectures) with complementary assets to create digital capabilities that improve the firm's absorptive capacity (Gold et al. 2001). In turn, building these digital capabilities enables learning-by-doing which increases absorptive capacity to understand and react to new information technologies (Sambamurthy et al. 2003). Within the context of inter-

organizational systems, organizations can build IT-enabled absorptive capacity supply chain configurations that allow them to process information obtained from their partners to create new knowledge (Malhotra et al. 2005). This new knowledge can be leveraged to gain a competitive advantage in the marketplace, resulting in potential win-win situations for supply chain partners. Therefore, our first objective will be to *demonstrate the application* of absorptive capacity and how it interacts with a variety of IS theoretical perspectives and phenomena.

Absorptive capacity has been applied in a diverse range of research streams, such as knowledge management (Alavi and Leidner 2001), IT governance (Sambamurthy and Zmud 1999), IT innovation (Fichman and Kemerer 1997), and IT business value (Bhatt and Grover 2005). Yet despite a critical mass of IS research that draws upon absorptive capacity, there has been no comprehensive assessment of the role of this powerful construct in the IS field. Such an assessment is important because drawing concepts from other disciplines is useful only if we modify them to create new concepts or nomological networks that are critical for the IS community (Markus and Saunders 2007). These morphed concepts can then be embedded within our knowledge structures, tested, and debated, thereby creating a cumulative tradition and unique discourse that helps us better understand IS phenomena (Hassan 2006). Hence, our second objective is to better *guide the use of absorptive capacity in IS research*.

In sum, the value of this work is in synthesizing the application of absorptive capacity in IS research and demonstrating its power as a key organizational capability. We proceed in three major sections. First, we *introduce* absorptive capacity and discuss its origins and evolution in the organizational literature. Second, we *review* how absorptive capacity has been conceptualized and measured in IS research, as well as how it fits into distinct IS themes within the broader IS nomological network. Based on our review, we provide guidelines to aid future application of absorptive capacity in the study of IS phenomena. Finally, we discuss how IS scholars can use this construct to *further enrich* their understanding of IS phenomena.

What Is Absorptive Capacity?

Absorptive capacity is defined as the ability to identify, assimilate, transform, and apply external knowledge (Cohen and Levinthal 1990). Through its research and development activities, a firm develops collective knowledge about certain areas of markets, science, and technology and how those areas

relate to the firm's products and services (Cohen and Levinthal 1989). This knowledge base enhances the firm's ability to identify and value external knowledge. However, sheer exposure to related external knowledge is not sufficient to ensure that a firm will absorb it successfully (Pennings and Harianto 1992). The knowledge must be assimilated or transformed² into the firm's knowledge base. While a knowledge base enables the associative connections needed for insights related to new knowledge, the organizational assimilation of new knowledge depends more so upon the transfer of knowledge across and within subunits (Cohen and Levinthal 1990).

Firms apply their newly absorbed knowledge in a variety of ways, for example, to replenish their knowledge base (Van den Bosch et al. 1999), to forecast technological trends (Cohen and Levinthal 1994), to reconfigure existing capabilities (Pavlou and El Sawy 2006), and to create innovative products and services. A substantial body of research finds that absorptive capacity contributes both directly (Lichtenhaler 2009) and indirectly (Lane et al. 2006) to firm performance. Finally, while absorptive capacity impacts performance, the focal unit likely learns from this experience, thereby increasing its absorptive capacity and knowledge base (constituting a feedback loop) (Todorova and Durisin 2007). Figure 1 depicts the relationships between prior related knowledge, absorptive capacity processes, and consequences of absorptive capacity.

Scholars have leveraged Cohen and Levinthal's original work on absorptive capacity in several ways. The application of absorptive capacity in such areas as innovation, interorganizational learning, mergers and acquisitions, and new product development signifies its substantial contribution to competitive advantage and firm performance (Lane et al. 2006). In the following sections, we discuss assumptions underlying absorptive capacity, alternative views of this important construct, and how absorptive capacity relates to organizational learning theory.

Assumptions Underlying Absorptive Capacity

Failure to clarify the definition and assumptions of absorptive capacity may lead to idiosyncratic and/or inappropriate use of

²The distinction between assimilation and transformation lies in what happens to the firm's existing knowledge base (Todorova and Durisin 2007). When the new knowledge fits the existing knowledge base well, it is only slightly altered and then *assimilated* into the existing knowledge base. When the knowledge cannot be realistically altered to fit the existing knowledge base, the knowledge base must be *transformed* to adapt the new knowledge that cannot be readily assimilated (Todorova and Durisin 2007, p. 778). Transformation represents an alternative process to assimilation.

the construct. This threatens construct validity (Cronbach and Meehl 1955) and inhibits the building of a cumulative research tradition. Hence, we note several assumptions underlying absorptive capacity.

First, absorptive capacity *depends on prior related knowledge*. Without some prior related knowledge, a firm will not be able to accurately determine the potential value of external knowledge. For instance, a firm cannot accurately assess the value of advances in semiconductor technology if it does not possess a minimum level of knowledge within the semiconductor domain. This also implies that absorptive capacity *is domain-specific*. For example, investigated domains of absorptive capacity include R&D (Cohen and Levinthal 1990), software development (Tiwana and McLean 2005), and new product development (Pavlou and El Sawy 2006).

Second, an organization's absorptive capacity *depends on the absorptive capacities of its individual members*. However, it is not simply the sum of its members' absorptive capacities; rather, it depends "on the links across a mosaic of individual capabilities" (Cohen and Levinthal 1990, p. 133). Thus, a firm's absorptive capacity is formed from an overlap in individual members' knowledge structures as well as the transfers of knowledge across and within organizational subunits. These overlaps imply that absorptive capacity *is firm-specific* and therefore cannot be bought and quickly integrated into the firm.

Finally, absorptive capacity *is path-dependent*. Accumulating absorptive capacity in one period will permit its more efficient accumulation in the next. Likewise, in an uncertain environment, absorptive capacity affects expectation formation, permitting the firm to predict more accurately the nature and commercial potential of technological advances. These two features of absorptive capacity—cumulativeness and its effect on expectation formation—imply that its development is path-dependent.

Absorptive Capacity: Asset, Substantive Capability, or Dynamic Capability?

Organizational scholars have viewed absorptive capacity from two general perspectives: as a "stock" of prior related knowledge and as an "ability" to absorb knowledge. Specifically, absorptive capacity has been conceptualized and measured as either (1) an asset, (2) a substantive (or ordinary) capability, or (3) a dynamic capability (Lane et al. 2006). A fundamental understanding of these views will give us insight into how absorptive capacity can be effectively leveraged in IS research.

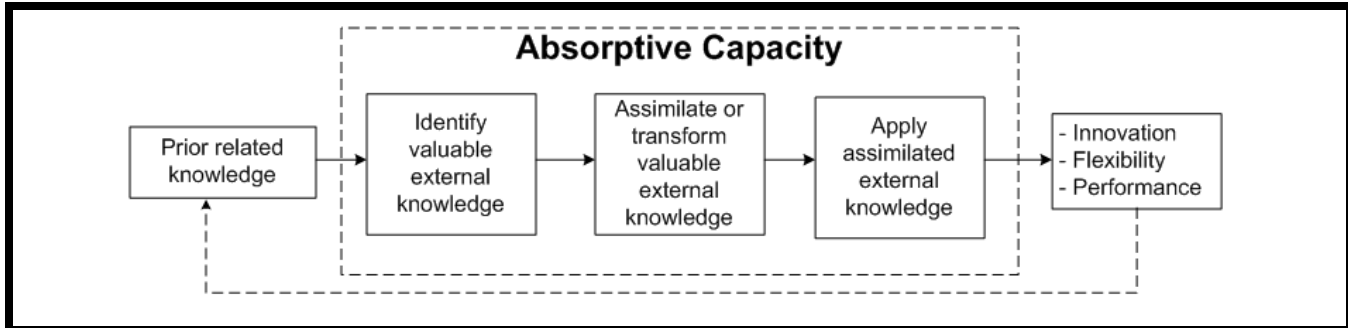


Figure 1. Absorptive Capacity, Prior Related Knowledge, and Outcomes

An asset is defined as anything tangible or intangible that a firm owns, controls, or has access to on a semi-permanent basis (Helfat and Peteraf 2003). When viewed as an asset, absorptive capacity is conceptualized as the level of relevant prior knowledge possessed by the focal unit. This static perspective of knowledge as an object equates absorptive capacity with the firm's knowledge base (i.e., the level of knowledge it possesses at any single point in time). As such, absorptive capacity has been operationalized with variables that serve as proxies for the knowledge base, such as R&D intensity and patents (Mowery et al. 1996; Tsai 2001).

A substantive (i.e., ordinary) organizational capability is a high-level routine (or set of routines) that confers a set of decision options on an organization's management for producing significant outputs of a particular type (Winter 2003). Absorptive capacity as a substantive organizational capability takes into account the routines and processes that firms use to identify, assimilate, transform, and apply external knowledge. Measures that seek to capture a capability view of absorptive capacity include compensation policies, dominant logic, knowledge-sharing routines, and competencies (Lane and Lubatkin 1998; Lane et al. 2001; Szulanski 1996).

Dynamic capability refers to *"the capacity of an organization to purposefully create, extend, or modify its resource base"* (Helfat et al. 2007, p. 4, emphasis in original). Dynamic capability is distinguished from substantive capability in that dynamic capability refers to the ability to change or reconfigure existing substantive capabilities. Thus, the qualifier *dynamic* distinguishes one type of ability (e.g., the substantive ability to develop new services) from another type of ability (e.g., the ability to reform the way the firm develops new services). When conceptualized as a dynamic capability, a firm's absorptive capacity affects its ability to reconfigure its existing substantive capabilities. Measures of absorptive capacity as dynamic capability are often survey-based (Lichtenthaler 2009; Pavlou and El Sawy 2006).

It is important to note the difference between absorptive capacity as asset and absorptive capacity as capability. Conceptualizing absorptive capacity as equal to relevant prior knowledge (i.e., as an asset) fails to take into account the processes by which the unit's knowledge base is replenished through the identification, assimilation, transformation, and application of valuable new knowledge. Van den Bosch et al. (1999) clearly distinguish a firm's prior related knowledge from its absorptive capacity. Furthermore, scholars argue that "possessing relevant prior knowledge is a necessary but not sufficient condition for a firm to have absorptive capacity" (Lane et al. 2006, p. 852). Thus, while a firm's absorptive capacity is dependent upon prior related knowledge (Cohen and Levinthal 1990), the predominant theoretical view is that absorptive capacity is an organizational capability, not an asset (Lane et al. 2006).

Absorptive Capacity and Organizational Learning

Absorptive capacity is clearly related to organizational learning (Lane et al. 2006); unfortunately, this relationship is not clear. To demonstrate how absorptive capacity can make a unique contribution to IS research, it is important that we understand how it relates to broader theories of organizational learning.

Organizational learning theory is concerned with the development of insights, knowledge and associations between past actions, the effectiveness of those actions, and future actions (Huber 1991). Although the organizational learning literature is vast and far-reaching, recent reviews (Bapuji and Crossan 2004; Gupta et al. 2006) reveal that exploration and exploitation (March 1991) have emerged as twin pillars of organizational learning research. Exploration refers to learning gained through processes of concerted variation, organizational experimentation with new alternatives, and quests for

knowledge about unknown market opportunities. Exploitation refers to learning gained via local search, experiential refinement, and the use of existing knowledge, competencies, and technologies. Scholars engaged in organizational learning research recognize that “the long-term survival of an organization depends on its ability to engage in enough exploitation to ensure the organization’s current viability and engage in enough exploration to ensure its future viability” (Levinthal and March 1993, p. 105).

In their review of the absorptive capacity literature, Lane et al. (2006) positioned absorptive capacity within an expanded exploration/exploitation learning framework. Specifically, they relate three absorptive capacity processes (identify, assimilate, and apply external knowledge) to three learning processes (exploratory, transformative, and exploitative learning). Exploratory learning is used to recognize and understand new external knowledge. Transformative learning combines new knowledge with existing knowledge, thereby allowing firms to effectively assimilate valuable external knowledge. Finally, exploitative learning is used to apply the assimilated external knowledge.

While Lane et al. (2006) provide an intuitively appealing conceptualization of absorptive capacity in an organizational learning framework, important nuances exist. On one hand, absorptive capacity is a construct with specific assumptions, dimensions, and boundary conditions. On the other hand, exploration and exploitation are broad concepts, each of which encompasses a range of activities (Gupta et al. 2006). Furthermore, the prior related knowledge aspect of absorptive capacity inherently biases absorptive capacity toward exploitation. Increased learning in a specific area enhances the organization’s knowledge base in that area, which further increases its absorptive capacity and, in turn, encourages more learning in that domain. For example, while Kodak’s deep knowledge of physical, chemical-based film stimulated its absorptive capacity and innovation in areas such as color photography and photo finishing, Kodak missed the digital photography wave and, subsequently, suffered a severe loss in market share and decline in performance (Lucas and Goh 2009). Thus, although absorptive capacity encourages exploitative innovation, the relationship between absorptive capacity and exploration is not clear. In addition to the relationship between absorptive capacity and exploration/exploitation, a number of factors distinguish absorptive capacity from organizational learning (see Table 1).

Having discussed absorptive capacity’s assumptions, conceptualizations, and relationship to organizational learning, we now review and assess this construct’s role in the IS field.

Absorptive Capacity in IS Research ■

IS researchers have been attracted to the absorptive capacity construct for its potential relevance to a variety of IS research problems, such as IT assimilation, IT business value, and knowledge transfer. Yet a comprehensive and systemic assessment of absorptive capacity’s influence and its role in IS research has not been undertaken. Hence, the purpose of our review is twofold. First, we assess the extent to which IS researchers have investigated the *construct space* of absorptive capacity. The construct space refers to the theoretical domain of absorptive capacity (i.e., how it is conceptualized and measured in IS research). In particular, we review the ways in which absorptive capacity has been conceptualized, the levels of analysis at which it has been examined, and its measurement domain. Second, we determine the *network space* of absorptive capacity in IS research. The network space refers to absorptive capacity’s nomological utility in the IS field (i.e., how it is used to inform our understanding of IS phenomena). We undertake a thematic analysis to assess the role of absorptive capacity in the broader IS nomological network.

Literature Review

Since Cohen and Levinthal’s 1990 article is the seminal work on absorptive capacity (Lane et al. 2006), our initial search for evidence of absorptive capacity in the IS literature consisted of articles that reference that article. We also collected articles that reference key absorptive capacity papers (e.g., Szulanski 1996; Zahra and George 2002) but may not reference Cohen and Levinthal. Finally, we also conducted keyword searches on “absorptive capacity” in our journal set. We reviewed 98 articles published in 7 major peer-reviewed MIS outlets between January 1990 and December 2008 (see Table 2). Appendix A lists the 98 articles found in our literature review.

Each paper was also examined to determine how absorptive capacity played a role in the paper’s core model. Categories 1 to 4 below represent a change in the role of absorptive capacity from minor support to an integral role in the study.

1. *Referenced as a background or minor citation:* Articles in this category cite Cohen and Levinthal, but absorptive capacity is not explicitly used in the articles. These articles make an “off-the-shelf” reference to Cohen and Levinthal and often do not use the term “absorptive capacity” (e.g., Saeed et al. 2005; Swanson and Ramiller 2004). Moreover, their theoretical arguments do not require support from absorptive capacity.

Table 1. Differences Between Absorptive Capacity and Organizational Learning

Difference	Absorptive Capacity	Organizational Learning
Construct versus Concept	A <i>construct</i> with well-defined assumptions and boundary conditions	A broad <i>concept</i> that encompasses a variety of processes and constructs
Active versus Passive	Organizations must <i>actively</i> increase their absorptive capacity	Organizations can learn <i>either actively or passively</i>
External versus Internal	Focuses on the role of <i>external</i> knowledge	Spans both <i>internal and external</i> knowledge

Table 2. Distribution of Absorptive Capacity Articles by Journal

Journal	Number of Articles
<i>Decision Sciences*</i>	4
<i>European Journal of Information Systems</i>	12
<i>IEEE Transactions on Engineering Management*</i>	4
<i>Information & Management</i>	13
<i>Information Systems Research</i>	13
<i>Journal of Management Information Systems</i>	17
<i>Journal of Strategic Information Systems</i>	11
<i>Management Science*</i>	1
<i>MIS Quarterly</i>	23
Total	98

*Only IS articles were collected from these journals.

2. *Provides theoretical support:* Articles in this category use absorptive capacity to develop the logic for the paper’s propositions or hypotheses. For instance, absorptive capacity motivates the concept of business managers’ IT competence (Bassellier et al. 2003; Bassellier et al. 2001) and knowledge brokering (Pawlowski and Robey 2004). Likewise, researchers justify investments in IT by arguing that IT infrastructure investments increase the absorptive capacity of the firm (Chatterjee et al. 2002; Chircu and Kauffman 2000).
3. *Used in a hypothesis, proposition, or the research model:* Articles here explicitly use absorptive capacity in a proposition or hypothesis. For example, Fichman (2004) posits that increases in exploitable absorptive capacity increase the option value of positioning investments in IT platforms. Similarly, absorptive capacity is positively related to expertise integration in information systems development teams (Tiwana and McLean 2005).
4. *Forms the theoretical base for the article:* Here, articles use absorptive capacity to motivate the entire study. Simply stated, these articles would be significantly altered or would not exist if it were not for absorptive capacity. For example, Boynton et al. (1994) use absorp-

tive capacity as a framework to examine key factors affecting IT use in large organizations. Likewise, Malhotra et al. (2005) study IT-enabled absorptive capacity configurations in supply chains.

Thirty-seven percent of the studies (37 papers) use Cohen and Levinthal as a minor citation. Almost half of the 98 papers use absorptive capacity as theoretical support, and the remaining papers use absorptive capacity in the research model (13 percent of papers) or as a theoretical base (5 percent of papers). Table 3 (in the next section) details further analysis of the role of absorptive capacity in IS research.

The Construct Space of Absorptive Capacity in the IS Field

Although this initial descriptive analysis shows that absorptive capacity has played a notable role in IS research, we undertook deeper analyses to gain a better understanding of the construct space of absorptive capacity in the IS literature. These include assessment of absorptive capacity’s (1) conceptualizations, (2) levels of analysis, and (3) measurement domain.

Table 3. Absorptive Capacity Conceptualizations and Role in IS Research

	Asset	Capability	No Explicit Conceptualization	Total
1. Referenced as minor citation	4	2	31	37
2. Provides theoretical support	18	18	7	43
3. Used in hypothesis, proposition, or model	3	10	0	13
4. Forms theoretical base for paper	0	5	0	5
Total	25	35	38	98

Conceptualization

We investigated the extent to which scholars understood the original theoretical context for the absorptive capacity construct. The three categories used for this criterion are (1) the construct is characterized as an asset (i.e., knowledge base), (2) the construct is characterized as a capability, and (3) neither of the above.

Consistent with organizational science literature, IS researchers conceptualize absorptive capacity as either an *asset* (i.e., knowledge base) or a *capability* (substantive or dynamic). Many IS researchers adapt Cohen and Levinthal's (1990) definition and maintain the notion that absorptive capacity is an organizational capability. However, much of the IS literature also views absorptive capacity as an asset; specifically, as the extent of prior related knowledge possessed by the organization. For example, prior related knowledge facilitates the assimilation of complex IT innovations (Fichman and Kemerer 1997; Liang et al. 2007). Since absorptive capacity is a function of the depth and breadth of a firm's knowledge structures, an IT platform that enables both inter- and intra-organizational knowledge sharing can indirectly enhance a firm's absorptive capacity (Chatterjee et al. 2002). Prior related knowledge also expedites knowledge transfer between ERP consultants and ERP end users (Ko et al. 2005).

Some IS researchers seek to capture a capability view of absorptive capacity. For example, absorptive capacity is conceptualized as a set of routines and processes by which new product teams acquire, assimilate, transform, and exploit external knowledge (Pavlou and El Sawy 2006). A software development team's absorptive capacity contributes to the team's expertise integration, which in turn facilitates team creativity (Tiwana and McLean 2005). Interorganizational systems also promote knowledge development within supply chains, thereby leveraging and enhancing absorptive capacity configurations between supply chain partners (Malhotra et al. 2005).

Table 3 details conceptualizations (i.e., asset, capability, no conceptualization) and role of absorptive capacity in IS research. We identified only two studies that explicitly conceptualize absorptive capacity as a dynamic capability (Malhotra et al. 2005; Pavlou and El Sawy 2006). Hence, for the purposes of our review we combine substantive capability and dynamic capability in the "capability" category. Of the 43 papers that use absorptive capacity as theoretical support, 16 percent (7 papers) fail to clearly conceptualize the construct. Absorptive capacity forms the theoretical base for 5 percent of the studies (5 papers).

A clear pattern is that as absorptive capacity gets incorporated into formal research models (rows 3 and 4 of Table 3), there is greater agreement in conceptualizing absorptive capacity as a capability. For instance, absorptive capacity is conceptualized in terms of relevant prior knowledge and diversity of knowledge (i.e., as an asset) when investigating different measures of IT-related organizational innovation (Fichman 2001). When explicitly integrated into a formal model, absorptive capacity is recognized as a capability that affects functional competencies in new product development teams (Pavlou and El Sawy 2006). This pattern shows that when absorptive capacity plays a more prominent role in IS research, IS scholars tend to take a more holistic view of the construct.³

³It is useful to note that almost all of the organizational literature, including Cohen and Levinthal's (1989, 1990) original work, treats absorptive capacity as an organizational-level construct (Lane et al. 2006). However, some IS researchers loosely refer to absorptive capacity as a "theory" rather than a construct. Although there are many extant definitions of theory (see Gregor 2006), in general a theory is "a statement of relations among concepts within a set of boundary assumptions and constraints" (Bacharach 1989, p. 496). As a construct, absorptive capacity does not consist of a set of relations among concepts. Even when absorptive capacity forms the theoretical base of a study, it is often accompanied by a theory (e.g., institutional theory, resource-based view of the firm). Therefore, we would not endorse the use of absorptive capacity as a theory but as a construct.

Table 4. Absorptive Capacity Conceptualizations and Level of Analysis

	Asset	Capability	No Explicit Conceptualization	Total
Individual	12	7	6	25
Group/Team	0	2	0	2
Organization	13	22	29	64
Interorganizational	0	4	3	7
Total	25	35	38	98

Level of Analysis

Although absorptive capacity is recognized as a multilevel construct, organizational scholars tend to omit the absorptive capacity of individual organizational members (Lane et al. 2006). However, IS scholars have examined absorptive capacity at multiple levels of analysis. Table 4 details our investigation of the levels of analysis at which absorptive capacity is conceptualized and possibly measured. A vast majority of IS research investigates absorptive capacity at the organizational level (64 papers, or 65 percent of all studies). Organizational-level studies in which absorptive capacity is not explicitly conceptualized often use absorptive capacity as a background or minor citation (e.g., Swanson and Ramiller 2004; Templeton et al. 2002). Only 35 percent of the organizational-level studies conceptualize absorptive capacity as a capability. We identified only 2 studies of absorptive capacity at the group level (Pavlou and El Sawy 2006; Tiwana and McLean 2005). Relatively few studies (7 papers, or less than 8 percent) investigate absorptive capacity at the inter-organizational level.

A notable proportion of our article set investigates absorptive capacity at the individual level (25 papers, or 26 percent). Absorptive capacity conceptualizations vary widely at this level. For instance, absorptive capacity is conceptualized as prior related knowledge (Ko et al. 2005); as a “function of existing cognitive structures or prior related knowledge that enables individuals to recognize the value of new knowledge, assimilate it, and apply it” (Massey and Montoya-Weiss 2006, p. 100); or, simply as an individual’s ability to utilize available knowledge (Griffith et al. 2003). We note that while seven articles conceptualize absorptive capacity as an individual’s ability to absorb knowledge (i.e., capability), most of the individual-level articles view absorptive capacity as an asset (12 papers).⁴

⁴We note that no individual-level article conceptualized absorptive capacity as a dynamic capability. This is most likely due to the fact that dynamic capability is inherently an organizational-level construct (see Helfat et al.

Measurement Domain

To conduct valid empirical research, the conceptual domain of absorptive capacity should be effectively converted into the operational domain (Straub et al. 2004). Therefore, in addition to recognizing how absorptive capacity is *conceptualized*, we also attempt to understand the various ways in which it is *operationalized*.

Defining absorptive capacity and its level of analysis has important implications for its measurement.⁵ Within the IS literature, nine studies directly measure absorptive capacity. All nine studies measure absorptive capacity via survey mechanisms (i.e., perceptual measures). Four of these studies measure absorptive capacity as an asset. For example, two studies (Ko et al. 2005; Xu and Ma 2008) adapt Szulanski’s (1996) work to measure a client’s ERP implementation knowledge (e.g., implementation vision, implementation understanding, technical competence, and managerial competence).

The remaining five studies operationalize absorptive capacity as a capability. For example, the absorptive capacity of senior leadership teams is measured as a senior leadership team’s ability to recognize valuable business and IT information, develop learning, and apply the learning in guiding organizational IT innovation activities (Armstrong and Sambamurthy 1999, p. 306). Absorptive capacity is also measured with survey items to capture the effective acquisition, assimilation, transformation, and exploitation of knowledge by new product development work units (Pavlou and El Sawy 2006). Table 5 details these studies by context, definition, source (citation) of absorptive capacity, operationalized absorptive capacity components, and sample items.

2007). Hence, conceptualizing absorptive capacity as a dynamic capability at the individual level would be inappropriate.

⁵Within the organizational literature, researchers have operationalized absorptive capacity through proxies such as R&D intensity (Tsai 2001), patents (Ahuja and Katila 2001), and firm size (Mowery et al. 1996). Organizational scholars have noted that directly operationalizing absorptive capacity as a capability is an accurate representation of firm-level absorptive capacity (Jansen et al. 2005; Lane et al. 2006).

Table 5. Measures of Absorptive Capacity in IS Research

Context of Study	Definition and Source	Absorptive Capacity Measurement					Sample Items
		Asset	Capability				
			Identify	Assimilate	Transform	Apply	
The influence of senior leadership and IT infrastructures on IT assimilation in firms (Armstrong and Sambamurthy 1999)	The ability of senior leadership teams to recognize valuable business and IT information, develop learning, and apply the learning in guiding the IT innovation activities in their firm (Cohen and Levinthal 1990)		X	X		X	CIO's level of knowledge regarding: 1. Firm's present and future products, markets, strategies, and processes. 2. How to utilize your IT infrastructure to address firm's current business needs. 3. How to identify relevant emerging IT for supporting your firm's activities.
Knowledge transfer from consultants to clients in ERP implementations (Ko et al. 2005)	The ability of a recipient to recognize the importance and value of externally sourced knowledge, assimilate it, and apply it (Cohen and Levinthal 1990; Szulanski 1996)	X					1. (<i>Client Alisha</i>) and I have a common language to deal with the (<i>Purchasing</i>) module. 2. (<i>Client Alisha</i>) has a vision of what the implementation of (<i>Purchasing</i>) module project is trying to achieve. 3. (<i>Client Alisha</i>) has information on the state-of-the-art of the (<i>Purchasing</i>) module.
Expertise integration and creativity in information systems development (Tiwana and McLean 2005)	The ability of the members of a team to interrelate with the expertise of their peer team members (Cohen and Levinthal 1990; Van den Bosch et al. 1999)		X	X			Members of this team: 1. Can interrelate to each other's unique skills and abilities. 2. Can interrelate to each other's unique expertise. 3. Recognize the potential value of their peers' expertise.
Leveraging IT capabilities in new product development (Pavlou and El Sawy 2006)	The ability to acquire, assimilate, transform, and exploit existing resources to generate new knowledge (Cohen and Levinthal 1990; Zahra and George 2002)		X	X	X	X	1. We are successful in learning new things within this group. 2. We are effective in developing new knowledge or insights that have the potential to influence product development. 3. We are able to identify and acquire internal (e.g., within the group) and external (e.g., market) knowledge.
Assimilation of ERP systems (Liang et al. 2007)	Prior knowledge that facilitates assimilation of external information and its application to commercial ends (Cohen and Levinthal 1990)	X					1. Prior to the ERP Implementation, our employees in general had extensive experience in using computer based applications in their work processes. 2. It is well known who can help solve problem associated with the ERP package. 4. Our company can provide adequate technical support to using ERP.
Leveraging absorptive capacity in ERP usage (Park et al. 2007)	The ability of an organizational member to value, assimilate, and apply new knowledge (Cohen and Levinthal 1990)		X	X		X	1. I can use ERP very well if I have only software manuals for reference. 2. I can apply the knowledge derived from ERP to my tasks. 3. I can apply the advanced processes derived from ERP to my tasks.
Knowledge management orientation (Wang et al. 2008)	Firms' ability to recognize the value of new, external knowledge, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990)		X	X			1. We use information technology to access a wide range of external information and knowledge on competitors and market changes, etc. 2. Through sharing information and knowledge, we often come up with new ideas that can be used to improve our business. 3. We have networks of sharing knowledge with other organizations on a regular basis.
Absorptive capacity and IT-enabled engineering work (Deng et al. 2008)	A person's ability to recognize the value of new, external knowledge, assimilate it, and apply it to commercial ends (Cohen and Levinthal 1990)	X					1. I have general knowledge of this process for which I am using the software. 2. I have expertise on this process. 3. I have a theoretical understanding of this process.
Absorptive capacity and knowledge transfer (Xu and Ma 2008)	The ability to recognize the value of new information, assimilate it and apply it (Cohen and Levinthal 1990)	X					1. I have a vision of what this project is trying to achieve. 2. I have the technical competence to absorb the ERP knowledge. 3. I have a clear understanding of goals, tasks, and responsibilities of this project.

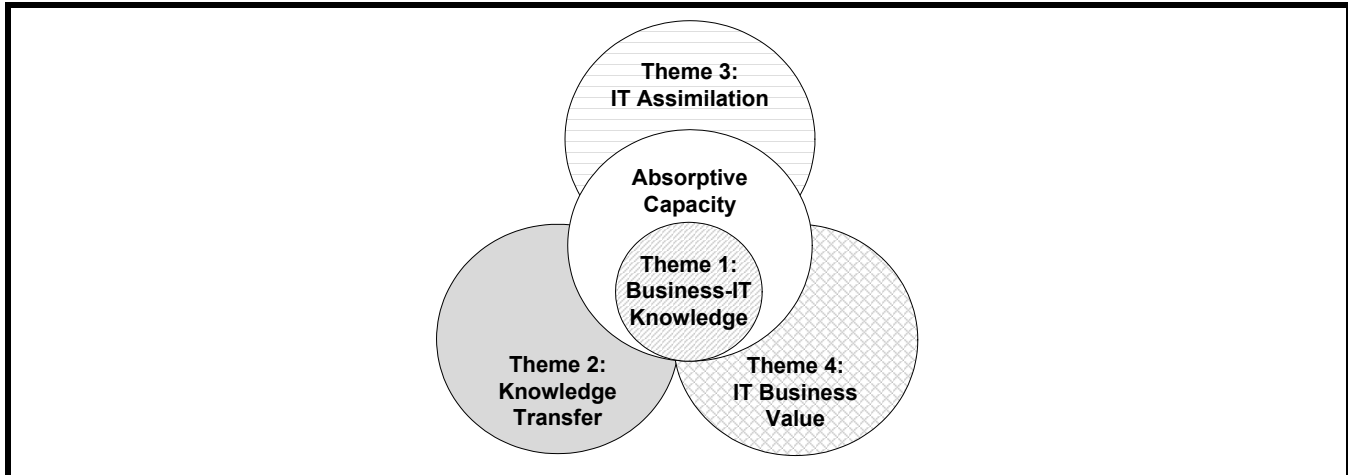


Figure 2. A Thematic Map of Absorptive Capacity in IS Research

In summary, our analysis of the construct space of absorptive capacity in IS research finds that the construct has been (1) inconsistently conceptualized (asset versus capability), (2) investigated at multiple levels of analysis, and (3) operationalized in various ways. Below, the second component of our literature review investigates the network space of absorptive capacity in IS research.

The Network Space of Absorptive Capacity in the IS Field

The second objective of our literature review is to determine the extent to which absorptive capacity has been used to help understand IS phenomena (i.e., network space). We undertake a thematic analysis to assess the role of absorptive capacity in the IS nomological network.

Thematic analysis is a process used in reviews of the IS literature (Leidner and Kayworth 2006) as well as reviews of absorptive capacity in the organizational literature (Lane et al. 2006). Such analysis systematically categorizes content of text and identifies relationships among the categories (Berg 2004). It is valuable for making sense of a large domain of research, and it can guide future research (Boyatzis 1998).

Our thematic analysis proceeded in four stages.

1. For each of the 61 papers in our set that makes use of absorptive capacity (i.e., more than a background or minor citation), we created a short summary of its topics, its use of absorptive capacity in an IT context, and its theoretical and empirical contributions.

2. Two of the authors grouped the papers into themes based on the summaries in an iterative process. From these groups of papers, preliminary themes emerged. Our creation and evaluation of themes was guided by three criteria: (1) the recurrence of the same thread of meaning in different words; (2) the repetition of words, phrases, or sentences; and (3) the importance attached to the concepts by the author(s) (Owen 1984). Hence, a theme is a set of papers that is internally consistent with respect to a phenomenon. This process resulted in four interrelated themes.
3. The themes and relationships were presented to the other two authors, and adjustments were made based on discussions.

Finally, the authors collaborated in writing summaries and constructing models of the research associated with each theme.

Figure 2 depicts the final set of four themes. Two themes embody research streams (IT assimilation, IT business value), while two are closer to a concept (knowledge transfer, business-IT knowledge). Absorptive capacity is a central construct linked to each theme.

We discuss each theme below. In line with our objective for this study, our assessment of the IS literature focused on identifying how the absorptive capacity construct has been used in each of the themes. We hope to identify the antecedents and consequences of absorptive capacity in IS research. We also aim to investigate what firms with higher absorptive capacity do differently than firms with lower absorptive

capacity (especially with regard to IT). Yet our approach is not simply to review IS research by identifying relationships among constructs. Rather, we identify distinct nomological networks surrounding absorptive capacity to provide a holistic perspective on the construct's position in IS research. We also investigate the role of IT (i.e., the IT artifact, see Orlikowski and Iacono 2001) as it relates to absorptive capacity.

Theme 1: Business-IT Knowledge

A firm's absorptive capacity is derived in part through the character and distribution of expertise within the organization (Cohen and Levinthal 1990). Likewise, the development of a firm's absorptive capacity will build on prior development of its constituent, individual, absorptive capacities (Lane et al. 2006). One of the many specialized components of a firm's overall knowledge base is business-IT knowledge: the combination of IT-related and business-related knowledge possessed by and exchanged among IT managers and business unit managers (Boynton et al. 1994; Nelson and Coopridge 1996). Expanding business-IT knowledge increases IT-related absorptive capacity, thereby enabling managers to identify, assimilate, and apply IT-related knowledge from the external environment. Hence, research in this theme focuses on understanding antecedents (e.g., technologies and business processes) and consequences (e.g., IT innovation and effectiveness) of business-IT knowledge (Nelson and Coopridge 1996).

Business-IT knowledge exists at the individual and collective level. At the individual level, business-IT knowledge is viewed as a competency possessed by one of two types of individuals: business managers and IT professionals. For instance, IT competence refers to the set of IT-related explicit and tacit knowledge that business managers possess that enables them to exhibit IT leadership in their area of business (Bassellier et al. 2001). Similarly, business competence in IT professionals is defined as "the set of business and interpersonal knowledge and skills possessed by IT professionals that enable them to understand the business domain, speak the language of business, and interact with their business partners" (Bassellier and Benbasat 2004, p. 676). Business-IT knowledgeable managers are more likely to champion IT projects (Bassellier et al. 2003), exercise rationality in IT planning (Ranganathan and Sethi 2002), form business-IT partnerships (Bassellier and Benbasat 2004), and work in decentralized or federally governed firms (Sambamurthy and Zmud 1999).

Business-IT knowledge at the collective level is markedly different from that possessed by individuals. At the collective level, business-IT knowledge refers to the shared domain

knowledge of business and IT managers (Armstrong and Sambamurthy 1999; Reich and Benbasat 2000). Specifically, business managers understand the organizational implications of IT, and IT managers understand ways in which IT can improve organizational efficiency and effectiveness. Armstrong and Sambamurthy (1999) conceptualize two dimensions of a senior leadership teams' business-IT knowledge: objective knowledge and systems of knowing. Objective knowledge refers to the explicit, visible knowledge possessed by individual team members. Systems of knowing refer to team members' ability to share perspectives, pool knowledge, and develop shared understanding (Nahapiet and Ghoshal 1998). Systems of knowing increase the group's objective knowledge (Armstrong and Sambamurthy 1999). While objective knowledge is similar to a knowledge base, a system of knowing constitutes a socialization capability that increases the group's business-IT knowledge. Other antecedents to collective business-IT knowledge include participation in planning (Kearns and Sabherwal 2007), structures of interaction among individuals (Armstrong and Sambamurthy 1999), and communication between IT and business managers (Reich and Benbasat 2000). Organizations with high levels of collective business-IT knowledge are aligned in their business and IT objectives (Kearns and Sabherwal 2007), experience improved customer service process performance (Ray et al. 2005), and enjoy greater IT capability effectiveness (Armstrong and Sambamurthy 1999).

Thematic Takeaway: Business-IT knowledge is a subset of the firm's absorptive capacity. Research in this stream has adopted a static view of absorptive capacity; that is, business-IT knowledge is a subset of the firm's knowledge base. Business-IT knowledge exists both within individuals and within collectives. This research stream tends to take a nominal view of IT; specifically, IT is often positioned as a label for knowledge (e.g., IT knowledge).

Theme 2: Knowledge Transfer

Knowledge transfer research is concerned with identifying and understanding the factors that enable or inhibit the transfer of knowledge from a source to a recipient (Alavi and Leidner 2001). A recursive relationship exists between knowledge transfer and absorptive capacity: while knowledge transfer can increase a recipient's absorptive capacity, the recipient's lack of absorptive capacity may inhibit the level of knowledge transfer between the source and the recipient (Alavi and Leidner 2001; Szulanski 1996). Within this theme, absorptive capacity is usually conceptualized and measured as an asset (i.e., prior related knowledge; see Ko et al. 2005). Knowledge transfer can occur at multiple levels, including individuals, groups, and organizations.

Based on the assumption that a firm's absorptive capacity depends on the transfers of knowledge across and within subunits (Cohen and Levinthal 1990), IS researchers have touched on the relationship between IT-enabled knowledge transfer among organizational members and the organization's absorptive capacity. For instance, organizational absorptive capacity is enhanced through intra-organizational knowledge flows and by recombining knowledge through informal information trading (Teigland and Wasko 2003). Yet the value of intra-organizational information trading is only realized when individuals within the firm assimilate and apply the information (Teigland and Wasko 2003). Work on knowledge brokering suggests that by facilitating the transfer of knowledge among organizational units, knowledge brokers not only increase the recipient's absorptive capacity but also contribute to the depth and breadth of an organization's knowledge base (Pawlowski and Robey 2004). In the context of ERP implementation, a client's absorptive capacity facilitates the transfer of ERP-related knowledge from consultants (Ko et al. 2005; Xu and Ma 2008). These findings support arguments that knowledge recombination across unit boundaries enhances the firm's absorptive capacity (Cohen and Levinthal 1990; Van den Bosch et al. 1999).

The relationship between absorptive capacity and knowledge transfer has also been investigated at the interorganizational level. By engaging in interlinked processes that enable high quality information sharing, as well as building IT infrastructures that allow them to process information obtained from their partners, organizations increase their ability to acquire, assimilate, transform, and exploit market knowledge (Malhotra et al. 2005). Thus, interorganizational information systems enhance the recursive relationship between absorptive capacity and knowledge transfer at the interorganizational level, resulting in improved operational efficiency and partner-enabled market knowledge creation.

Thematic Takeaway: Research in this theme generally finds that a recipient's absorptive capacity (conceptualized as prior related knowledge) can facilitate or inhibit knowledge transfer. Moreover, the relationship between absorptive capacity and knowledge transfer takes place at multiple levels of analysis. Although IS researchers have discussed the role of IT in knowledge transfer, there appears to be limited empirical investigation of the use of IT in the relationship between absorptive capacity and knowledge transfer.

Theme 3: IT Assimilation

IT assimilation is defined as the extent to which the use of technology diffuses across organizational projects or work processes and becomes routinized in the activities of those

projects and processes (Purvis et al. 2001). Within this stream of research, IS scholars conceptualize and measure absorptive capacity as an asset, specifically in terms of two components: related knowledge and knowledge diversity. Related knowledge is defined as the extent of abstract knowledge, know-how, and skills possessed by the organization in areas related to the focal innovation, and knowledge diversity is defined as the range of knowledge possessed by the organization with respect to the focal innovation (Fichman 2001). Prior related knowledge and knowledge diversity are key characteristics of an organization's knowledge base and, subsequently, its absorptive capacity (Cohen and Levinthal 1990). Research in this stream is conducted at the organizational level. In looking at technology diffusion, researchers employ a proxy view of IT.

Related knowledge and knowledge diversity lower the knowledge barriers erected by complex technologies (e.g., data warehouses, ERP systems). Knowledge barriers arise because the technological and managerial knowledge required to successfully deploy complex technologies extends beyond simple awareness of the innovation and its potential benefits (Fichman and Kemerer 1999). The know-how and technical knowledge associated with such technologies is tacit and relatively immobile, and has to be recreated by users via processes of learning by using (Attewell 1992). Hence, the depth of related knowledge facilitates assimilation by making it easier for organizations to acquire new knowledge related to the focal innovation (Liang et al. 2007). Likewise, organizations that are more diverse in their knowledge structures (i.e., greater breadth of knowledge) are more likely to absorb and appreciate the value of any information that is encountered (Fichman 2001). Thus, an organization's absorptive capacity (defined in terms of prior related knowledge and diversity of knowledge) positively affects the assimilation of complex IT innovations.

Thematic Takeaway: Researchers have consistently found empirical support for a positive relationship between absorptive capacity and IT assimilation. Research in this stream tends to conceptualize absorptive capacity as prior related knowledge. Also, much of the research in this theme has investigated absorptive capacity at the organizational level. The focal innovation in IT assimilation studies is often characterized as a complex technology.

Theme 4: IT Business Value

IT business value is defined as "the organizational performance impacts of information technology at both the intermediate process level and the organization-wide level, and comprising both efficiency impacts and competitive impacts"

(Melville et al. 2004, p. 287). A principal finding is that IT is valuable, but its extent and dimensions are contingent on complementary organizational resources (Melville et al. 2004; Wade and Hulland 2004), one of which is absorptive capacity (viewed in terms of both asset and capability). Specifically, research within this theme investigates how IT business value results from a synergistic relationship between an organization's IT capabilities and absorptive capacity. Moreover, research in this theme is conducted at multiple levels of analysis, including teams, organizations, and organizational dyads.

One line of research investigates IT's impact on a firm's absorptive capacity in terms of the firm's knowledge base. The innovative capability of an organization is a function of the richness of its knowledge structures (Cohen and Levinthal 1990, 1994). Since rich knowledge structures are built through both inter- and intra-organizational knowledge sharing, an IT platform with a strong reach and range can contribute to the innovative capability of an organization (Chatterjee et al. 2002; Srivardhana and Pawlowski 2007). For instance, knowledge infrastructure capabilities (e.g., technology, structure, and culture) and knowledge process capabilities (e.g., acquisition, conversion, application, and protection of knowledge) enhance an organization's knowledge base, which in turn increases the organization's capacity to identify, assimilate, and apply new knowledge (Gold et al. 2001).

When absorptive capacity is conceptualized as a capability, it serves as a complement to IT capabilities in generating business value. Within the context of new product development (NPD), a team's ability to effectively use IT functionalities to support IT-related activities enhances its absorptive capacity, which ultimately impacts the firm's competitive advantage in NPD (Pavlou and El Sawy 2006). At the interorganizational level, engaging in interlinked processes that enable high quality information sharing and building IT infrastructures allows firms to process information obtained from their supply chain partners, potentially increasing their ability to acquire, assimilate, transform, and exploit market knowledge to gain a competitive advantage (Malhotra et al. 2005). Moreover, by building absorptive capacity in their supply chains, organizations are better positioned to take advantage of market opportunities and increase operational efficiency. Additional outcomes of IT-enabled absorptive capacity configurations in supply chains include reduced costs (Lee et al. 2006), increased supply chain flexibility (Gosain et al. 2004), increased supply chain coordination (Patnayakuni et al. 2006), enhanced adaptive knowledge creation (Malhotra et al. 2007), and outsourcing success (Lee 2001).

Thematic Takeaway: Research in this theme finds that synergies between absorptive capacity and IT capabilities impact

firm performance. While IT business value researchers have conceptualized absorptive capacity as both asset and capability, the growing trend seems to be moving toward the latter. Much of the IT business value research is conducted at the organizational level. The IT artifact is predominantly viewed as either information processing or productivity tool.

Thematic Analysis: Key Findings

The results of our thematic analysis show that absorptive capacity has played an important role in IS research. Absorptive capacity has been leveraged in a variety of research streams: business-IT knowledge, knowledge transfer, IT assimilation, and IT business value. Table 6 compares themes in terms of role of absorptive capacity, role of IT, and key findings. Appendix B provides further detail on the antecedents, consequences, and specific role of absorptive capacity within each theme.

As evidenced by Table 6, our thematic analysis reveals several interesting findings. First, business-IT knowledge is often conceptualized as a subset of the firm's overall absorptive capacity. As a key IT capability, business-IT knowledge contributes to greater performance and IT effectiveness. Consistent with referent organizational research, IS researchers find that a recipient's absorptive capacity impacts the level of knowledge transferred from a knowledge source. Third, a substantial stream of research finds that absorptive capacity reduces knowledge barriers, thereby facilitating the assimilation of complex IT innovations. Finally, the IT business value theme shows that IT capabilities and absorptive capacity create synergies that improve competitive advantage and firm performance.

Our review also shows that IT plays a variety of roles in absorptive capacity-informed IS research. In the business-IT knowledge and knowledge transfer themes, researchers often take a nominal view of IT: for instance, the IT artifact is seemingly absent (Orlikowski and Iacono 2001). As a result, there is limited theory describing how IT influences absorptive capacity. The IT assimilation theme views IT as proxy, and the IT business value theme usually views IT as a tool for increasing productivity and information processing capabilities.

Consistent with our construct space review, absorptive capacity is often conceptualized and measured as an asset. Moreover, absorptive capacity is viewed at multiple levels of analysis. The next section combines the results of our thematic analysis with our review of the construct space of absorptive capacity to better formulate what we know regarding absorptive capacity in IS research.

Theme	Key Findings	Role of IT
Business-IT Knowledge	A subset of the firm's absorptive capacity, business-IT knowledge impacts performance and IT effectiveness	<i>Nominal</i> : Researchers invoke a nominal view of the IT artifact
Knowledge Transfer	A recipient's absorptive capacity impacts the level of knowledge transfer	<i>Nominal</i> : Researchers tend to omit IT when investigating absorptive capacity and knowledge transfer
IT Assimilation	Absorptive capacity influences IT assimilation	<i>Proxy</i> : IT is often a complex innovation that diffuses throughout an organization
IT Business Value	IT business value can be derived from the synergistic effects of absorptive capacity and IT capabilities	<i>Tool</i> : The IT artifact is characterized as either an information processing or productivity-enhancing tool that can facilitate a firm's absorptive capacity

Absorptive Capacity in IS Research: Limitations and Guidelines

The value added to date by the absorptive capacity construct is rich and diverse. We are better able to explain and predict various phenomena, such as (1) how business-IT knowledge develops and impacts firm performance, (2) the barriers and enablers of the assimilation and diffusion of complex IT innovations, (3) the role of IT in the recursive relationship between absorptive capacity and knowledge transfer at multiple levels, and (4) how IT capabilities interact with absorptive capacity to contribute to improved organizational effectiveness and performance. Yet despite these findings, there are limitations in the IS field's use of absorptive capacity. Next, we describe these limitations and provide guidelines describing how scholars can avoid them in future research.

Limitation 1: Conceptualizing Absorptive Capacity

A notable amount of IS research conceptualizes absorptive capacity as an asset, in particular, as prior related knowledge. Conceptualizing absorptive capacity as an asset raises construct validity issues and fails to capture the processes by which an organization absorbs knowledge. Possessing relevant prior knowledge is a necessary but insufficient condition for a firm to have an effective absorptive capacity capability. The focus on prior related knowledge also makes it more difficult to make recommendations for managers.

We recommend that IS researchers conceptualize absorptive capacity as a capability rather than an asset. Researchers who wish to investigate only the level of prior related knowledge should be clear that they are not examining absorptive capacity. Furthermore, absorptive capacity is a multidimensional construct with several interrelated capabilities (e.g., knowledge identification, assimilation, application).

Limitation 2: Level of Analysis

IS scholars have investigated absorptive capacity at multiple levels of analysis: namely, at the individual level and at the collective level. It is important to note key differences between these levels. A collective describes "any interdependent and goal-directed combination of individuals, groups, departments, organizations, or institutions" (Morgeson and Hofmann 1999, p. 251). In contrast to an individual's absorptive capacity, a collective entity's absorptive capacity is dependent upon several factors, such as the coordination between its individual members, the overlap in their cognitive schemas, and the diversity in their knowledge bases (Cohen and Levinthal 1990). Likewise, organizational learning processes may be far more complex than individual-level learning processes (Crossan et al. 1999). Thus, "collective" absorptive capacity is quite different from "individual" absorptive capacity.⁶ As a result, the nomological net surrounding collective absorptive capacity will be similar to, yet quite distinct from, the nomological net surrounding individual absorptive capacity.

Researchers should consider absorptive capacity to be a collective construct. Scholars interested in how IT facilitates individual learning should draw from and build on appropriate individual learning literature.

⁶Researchers interested in the intersection of IT and learning at the individual level may do better to rely on individual learning research (e.g., Bloom 1956; Gagne 1984; Piaget 1952). For example, one could investigate how IT impacts an individual's ability to acquire verbal knowledge, organize cognitive schemas, develop mental models, and implement cognitive strategies in organizational settings (Kraiger et al. 1993).

Limitation 3: Measurement

Our review uncovered several measurement problems: (1) IS researchers often define absorptive capacity as a capability, yet operationalize it as an asset; (2) researchers have attempted to adapt measures of organizational absorptive capacity to the individual level; and (3) researchers often do not use established measures of absorptive capacity in a similar context. These limitations complicate construct validity and inhibit the building of a cumulative research tradition.

Researchers should also bear in mind that, as a knowledge-based construct, absorptive capacity is domain-specific. For example, a firm may have high absorptive capacity in new product development yet have low absorptive capacity in supply chain operations. Developing measures that capture the knowledge specificity of absorptive capacity will strengthen construct validity and provide greater implications for managers. Hence, researchers should identify the particular knowledge domain for absorptive capacity relevant to a specific research context.

We recommend that IS researchers conceptualize and measure absorptive capacity as a capability. Furthermore, absorptive capacity should be empirically investigated using metrics that fully capture each of its dimensions. Where possible, researchers should avoid general measures of absorptive capacity and attempt to measure absorptive capacity with respect to specific knowledge domains.

Limitation 4: Lack of IT Artifact

Our thematic analysis shows that a substantial amount of absorptive capacity-informed IS research invokes a “nominal view” of the IT artifact. IT artifacts are noticeably absent from these articles. For example, much of the business-IT knowledge literature fails to discuss the specifics of the focal IT under investigation (if any). We see similar results in the knowledge transfer theme, where researchers tend to focus on the conditions that enable or inhibit knowledge transfer between two parties. There are a handful of exemplars, such as Pavlou and El Sawy’s (2006) examination of the impact a group’s use of knowledge management systems and cooperative work systems has on its absorptive capacity, as well as several studies investigating the relationship between absorptive capacity and complex IT innovations (see the IT assimilation theme).

Failure to adequately conceptualize the role of IT with respect to absorptive capacity results in missed opportunities to offer more grounded insights into IT-related phenomena. This is complicated by the fact that absorptive capacity is often

conceptualized as an asset (see Limitation 1). While the role of IT as a storage mechanism for knowledge assets is relatively well-established (Alavi and Leidner 2001; Stein and Zwass 1995), we know little regarding how IT impacts the identification, assimilation, transformation, and application of external knowledge. In addition to extending scholarly research, understanding how IT facilitates knowledge absorption processes and developing specific research contexts will provide relevant implications for managers.

IS researchers should adequately conceptualize and describe the relationship between IT and absorptive capacity. Furthermore, researchers should conduct holistic investigations of the relationship between IT and absorptive capacity. Scholars should also develop specific theoretical (and, if appropriate, empirical) contexts and state their study’s boundary conditions.

Table 7 summarizes these limitations and guidelines for future research. The next section attempts to address these anomalies by synthesizing prior work on absorptive capacity in the IS field into a general framework that can be leveraged in future research.

A Framework for Investigating the Interaction of Information Technology and Absorptive Capacity

Absorptive capacity is a powerful construct that can be used to investigate a range of IS phenomena. However, we are more interested in exploring the *relationship* between IT and absorptive capacity than promoting the *insertion* of the absorptive capacity construct in IS work. With our review serving as a foundation, we present a framework in which scholars can investigate how the value-adding synergies between IT capabilities and complementary organizational capabilities positively influence absorptive capacity.

Theoretical Base

A firm’s absorptive capacity is inherently dependent upon the personal knowledge and mental models of its members, who scan the environment, bring knowledge into the firm, and apply the knowledge in products and processes (Cohen and Levinthal 1990). However, bounded rationality limits the ability of individuals to receive, store, retrieve, and transmit information without error (Simon 1976). Thus, bounded rationality places a limit on an individual’s absorptive capacity, which in turn limits the firm’s absorptive capacity.

Table 7. Limitations and Guidelines Concerning Absorptive Capacity in IS Research

Limitation	Description	Guidelines
Conceptualization	A substantial number of IS articles conceptualize absorptive capacity as an asset. Conceptualizing absorptive capacity as an asset raises construct validity issues and fails to capture knowledge absorption processes. Possessing relevant prior knowledge is a necessary but insufficient condition for a firm to have an effective absorptive capacity capability. This also underestimates the role IT can play in knowledge absorption.	<ul style="list-style-type: none"> • Conceptualize absorptive capacity as a capability • Employ a holistic approach to the relationship between IT and absorptive capacity
Level of Analysis	IS scholars have investigated absorptive capacity at the individual level. Failure to take into account the differences between individual absorptive capacity and collective absorptive capacity undermines construct validity and inhibits theoretical development.	<ul style="list-style-type: none"> • Conceptualize and measure absorptive capacity as a collective construct • Build on appropriate learning research
Measurement	IS researchers often define absorptive capacity as a capability and yet measure it as an asset, thereby undermining construct validity. Adapting measures of organizational absorptive capacity at the individual level also complicates construct validity. Scholars eschew established measures of absorptive capacity, inhibiting the building of a cumulative research tradition. Finally, researchers often miss capturing the domain-specific nature of absorptive capacity.	<ul style="list-style-type: none"> • Conceptualize and measure absorptive capacity as a multidimensional capability • Develop metrics that capture each of absorptive capacity's dimensions • Measure absorptive capacity with respect to specific knowledge domains
IT Artifact	A substantial amount of IS research employs a nominal view of the IT artifact in relation to absorptive capacity. Conceptualization of IT is absent from these studies. Furthermore, absorptive capacity is often conceptualized as an asset or at a "macro" or abstract level, thereby making it difficult to provide relevant implications for managers.	<ul style="list-style-type: none"> • Describe the relationship between IT and absorptive capacity • Develop theoretical contexts with well-defined boundaries

Nevertheless, IT can influence the computational and communication abilities of individuals (Bakos and Treacy 1986), thus expanding the limits of rationality and, in turn, the limits of absorptive capacity.

Although IT can expand a firm's bounded rationality and absorptive capacity, investing in IT alone is often insufficient to create lasting value (Mata et al. 1995; Powell and Dent-Micallef 1997). As a result, researchers are beginning to investigate how the synergies derived from IT capabilities and complementary capabilities enhance other organizational capabilities (e.g., absorptive capacity) (Bharadwaj et al. 2007; Brynjolfsson and Hitt 2000; Tanriverdi 2006). Synergy is often used to describe relationships that result in positive outcomes (Nevo and Wade 2010; Tanriverdi 2006). We define synergy as the increase in value resulting from the interaction of complementary organizational capabilities. According to the theory of complementarities, the value of an organizational capability can increase in the presence of other complementary organizational capabilities (Milgrom and Roberts 1995). Specifically, complementarity occurs when

the returns to a capability vary in the levels of returns to the other capabilities. Capabilities are distinct, yet they are also interdependent. With this perspective in mind, in the next section we investigate how value synergies from complementarities between IT capabilities and organizational capabilities enhance a firm's absorptive capacity.

How Does IT Influence Absorptive Capacity?

As evidenced by our review, there have been few detailed investigations of the relationship between IT and absorptive capacity. Also, there appears to be confusion over whether absorptive capacity is an asset or a capability, as well as ambiguity over its appropriate level of analysis. Moreover, the IT artifact is often absent when absorptive capacity appears in IS research. We hope to address these limitations by proposing a framework that describes the relationships between IT capabilities, complementary organizational capabilities, and absorptive capacity processes. Figure 3 depicts our conceptual model. We propose that synergies arising from interac-

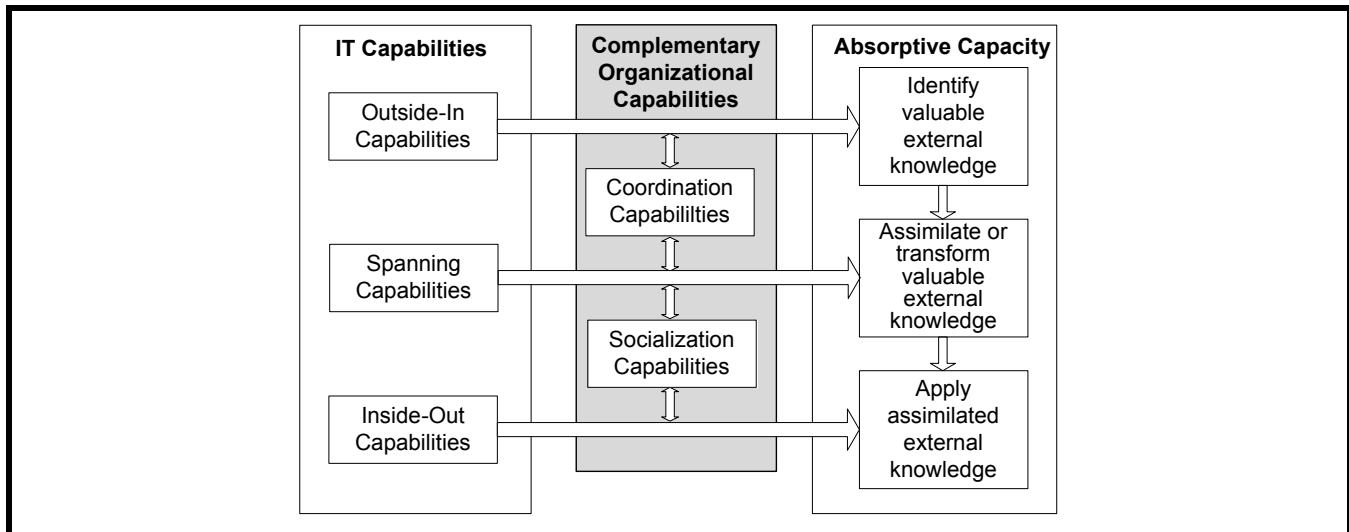


Figure 3. The Relationship Between IT Capabilities, Complementary Organizational Capabilities, and Absorptive Capacity

tive relationships between IT capabilities (outside-in, spanning, and inside-out) and complementary organizational capabilities (coordination and socialization) positively influence a firm's ability to identify, assimilate, transform, and apply valuable external knowledge. We describe these concepts and relationships in greater detail in the following sections.

Absorptive Capacity: Dimensions and Key Combinative Capabilities

Absorptive capacity is a multidimensional construct that consists of three distinct yet interrelated capabilities: knowledge identification, knowledge assimilation/transformation, and knowledge application (Lane et al. 2006). A firm's ability to absorb valuable external knowledge depends on its level of prior related knowledge (Cohen and Levinthal 1990). Yet in addition to its knowledge base, a firm needs to develop structures and processes that facilitate knowledge absorption. Prior research finds that two types of organizational capabilities impact absorptive capacity: coordination capabilities and socialization capabilities (Jansen et al. 2005; Van den Bosch et al. 1999). Coordination and socialization are relatively broad constructs; thus, we need to investigate them at a more fine-grained level.⁷ Furthermore, since a firm's absorptive capacity is dependent upon the exchange of knowledge between organizational members (Cohen and Levinthal 1990), we focus on coordination and socialization capabilities that impact knowledge exchange.

Coordination capabilities refer to a firm's ability to manage the dependencies among its various activities (Malone and Crowston 1994). We focus on coordination capabilities that enhance knowledge exchange across intra- and interorganizational boundaries. For example, job rotation is a coordination capability that facilitates knowledge identification and assimilation (Jansen et al. 2005). Other knowledge-exchanging coordination capabilities include cross-functional interfaces, participation in decision making, and cross-functional training (Galbraith 1973; Van de Ven et al. 1976). These coordination mechanisms bring together different sources of expertise and increase interaction between functional areas.

Socialization capabilities capture a firm's ability to produce a shared ideology that offers organizational members an attractive identity as well as collective interpretations of reality (Van den Bosch et al. 1999). In doing so, socialization capabilities create the conditions necessary for knowledge exchange and combination to occur (Nahapiet and Ghoshal 1998; Todorova and Durisin 2007). Common socialization capabilities include cohesion, shared language, and shared goals. Organizations with strong socialization capabilities are characterized by a consistent set of beliefs, a high degree of shared values, a common language, and well-established behavioral norms (Nahapiet and Ghoshal 1998).

IT Capabilities

Following Wade and Hulland (2004), we conceptualize three types of IT capabilities: outside-in, inside-out, and spanning.

⁷We thank a reviewer for pointing this out.

We propose that these three types of IT capabilities facilitate absorptive capacity processes, especially when used in conjunction with complementary organizational capabilities.

Outside-in IT capabilities are outward-facing. For example, a virtual community is an outside-in IT capability that allows firms to develop external relationships and collect knowledge from the external environment. Interorganizational electronic business interfaces increase a firm's ability to identify and exchange valuable knowledge from its supply chain partners. Hence, outside-in IT capabilities facilitate a firm's knowledge identification capability. *Inside-out IT capabilities* are inward-focused. For instance, technology platforms and IT skills are inside-out IT capabilities that enhance a firm's ability to seize market opportunities. Integrated information systems provide immediate access to standardized data across organizational units, which in turn allow the organization to more readily apply new knowledge to create products and services. Thus, inside-out IT capabilities increase a firm's knowledge application capability. Finally, *spanning IT capabilities* integrate a firm's outside-in and inside-out capabilities. For example, knowledge management systems enable storing, archiving, retrieving, and sharing of current knowledge to gain a better understanding of how new external knowledge relates to what organizational members already know. Similarly, interorganizational interpretation systems help firms manipulate and interpret knowledge received from organizational partners, thereby enhancing knowledge assimilation. Hence, spanning IT capabilities facilitate a firm's knowledge assimilation/transformation capability.

In Pursuit of Absorptive Capacity: Creating Synergy Between IT Capabilities and Organizational Capabilities

The first dimension of absorptive capacity captures the extent to which a firm is able to identify and assess the value of external knowledge. We posit that outside-in IT capabilities—combined with complementary coordination capabilities—positively impact a firm's knowledge identification capability.

Outside-in IT capabilities are externally oriented. As such, they focus on leveraging and managing external relationships and resources. For example, Dell launched a website⁸ in which individuals submit ideas for new products and services. As an outside-in IT capability, this virtual community allows the firm to collect vast amounts of information from community members (Nambisan 2002). However, simply collecting information will not significantly impact the firm's ability to identify and recognize what information might be valuable.

⁸<http://www.ideastorm.com>.

To reap greater value from this virtual community, the firm should put in place coordination mechanisms that facilitate the flow of valuable knowledge into the firm. For example, the firm could create a "VC team" that monitors and engages the virtual community. This team would engage community members in two-way dialogues that enhance the intensity and richness of the interaction between community members. These social interactions create a valuable flux of knowledge (Nonaka and Konno 1998) that in turn can be assimilated and potentially applied to future products and services.

At the interorganizational level, outside-in IT capabilities like standard electronic business interfaces result in lateral forms of communication that strengthen knowledge flows across organizational boundaries (Malhotra et al. 2005). Prespecified formats promote information exchange and manipulation, thereby contributing to a recipient firm's ability to recognize valuable knowledge from its supply chain partners. Interorganizational joint decision making is one coordination capability that complements standard electronic business interfaces. By engaging in collaborative decision making related to the factors that influence their electronically interfaced processes, firms that employ joint decision-making mechanisms share richer knowledge related to customers, technologies, and markets. Moreover, coupling the information exchanged through standard electronic interfaces with joint decision-making processes results in a deeper understanding of the needs of each partner, which in turn increases their environmental awareness (Van de Ven 1976). Hence, outside-in IT capabilities combined with complementary coordination capabilities enhance a firm's knowledge identification capability.

P1: Synergies arising from complementarities between outside-in IT capabilities and knowledge-exchange coordination capabilities will have a positive effect on a firm's ability to identify and recognize the value of external knowledge.

Newly identified knowledge brought into the firm is in "raw" form: that is, it is most likely not ready for immediate use by the firm. At this point, the firm only knows that the knowledge is valuable to it in some way. Coordination capabilities and socialization capabilities help a firm assimilate and transform raw knowledge, thereby embedding the new knowledge into its knowledge base (Jansen et al. 2005). We propose that synergies between spanning IT capabilities and both coordination and socialization will impact knowledge assimilation/transformation.

Organizations use cross-functional interfaces such as liaison personnel and teams to facilitate knowledge exchange (Gupta and Govindarajan 2000). These cross-functional interfaces contribute to an organization's ability to overcome differ-

ences, infer issues, and build shared understanding about new external knowledge. The use of certain knowledge management systems enhances this process. For example, cross-functional teams can leverage IT tools for storing, archiving, retrieving, and sharing historical information to gain a better understanding of how new external knowledge relates to what they already know. These knowledge management tools expand the communication and information processing abilities of cross-functional teams. This, in turn, helps team members create shared perspectives regarding new knowledge. Thus, a cross-functional team's ability to effectively leverage knowledge management systems constitutes a spanning IT capability that, when used in conjunction with coordination capabilities, enhances knowledge assimilation.

A firm may identify valuable external knowledge and yet have significant difficulty assimilating that knowledge. When new knowledge cannot be easily incorporated into existing cognitive structures (i.e., it cannot be assimilated), the cognitive structures must be transformed to adopt to an idea that they cannot assimilate (Todorova and Durisin 2007). One mechanism that enhances knowledge transformation is job rotation (the lateral transfer of employees between jobs). Job rotation enhances redundancy as well as diversity of backgrounds, increases problem-solving skills, and develops organizational contacts (Cohen and Levinthal 1990). By introducing individuals with new perspectives and backgrounds, job rotation facilitates a diversity of knowledge structures within and across organizational units. Rotation of employees who each possess diverse and varied knowledge also augments a firm's capacity for making novel linkages and associations (Cohen and Levinthal 1990). Firms that possess spanning IT capabilities such as knowledge directories may be able to further capitalize on the benefits of job rotation. For example, an organizational unit dealing with complex new knowledge can use a knowledge directory to rapidly locate individuals who have related knowledge and expertise. The unit can then request that those individuals be rotated to their area for a certain span of time. In matching their specific knowledge problem to an expert, units can develop preferences for job rotation schedules, thereby increasing the unit's potential for knowledge transformation.

P2: Synergies arising from complementarities between spanning IT capabilities and knowledge-exchange coordination capabilities will have a positive effect on a firm's ability to assimilate and transform external knowledge.

In addition to coordination capabilities, socialization capabilities also influence knowledge assimilation and transformation. For example, a shared language influences the conditions for knowledge exchange and combination (Nahapiet and Ghoshal 1998). Knowledge progresses through developing

new concepts and ideas (Nonaka and Takeuchi 1995). Yet, to develop such concepts and combine knowledge gained through social interaction, the different parties need a shared language and some overlap in knowledge (Boland and Tenkasi 1995). A shared language can complement the use of transformational technologies in the assimilation of knowledge. As a spanning IT capability, transformational technologies allow for the creation and manipulation of digital artifacts, which can be transferred between parties (Leonardi and Bailey 2008). However, barriers to transferring knowledge across time and space inhibit knowledge assimilation. These knowledge transfer barriers can be alleviated when a shared language exists among parties. A shared language makes it more likely that the recipient will correctly interpret the knowledge embodied in the artifacts. Even if immediate interpretation is not realized, a shared language provides a mechanism by which the sender and recipient can arrive at a shared interpretation of the knowledge at hand (Nahapiet and Ghoshal 1998).

Firms can also combine spanning IT capabilities and socialization capabilities to enhance interorganizational knowledge assimilation and transformation. Interorganizational interpretation systems afford the manipulation and interpretation of knowledge received from organizational partners, thereby enhancing knowledge assimilation (Malhotra et al. 2005). The existence of shared goals between organizational partners will complement the use of interpretation systems in knowledge assimilation activities. Shared goals represent the extent to which organizational partners have a common understanding and approach to the achievement of network tasks and outcomes (Inkpen and Tsang 2005). If two organizational partners share a common goal (e.g., new product development in a particular market), they will be more likely to transfer knowledge relevant to that goal (Almirall and Casadesus-Masanell 2010). Furthermore, interpretation systems make it easier for the recipient firm to assimilate this specific knowledge into its knowledge base. Thus, the use of interorganizational interpretation systems, complemented by a set of shared goals, positively influences knowledge assimilation and transformation.

P3: Synergies arising from complementarities between spanning IT capabilities and knowledge-exchange socialization capabilities will have a positive effect on a firm's ability to assimilate and transform external knowledge.

Firms apply their newly assimilated knowledge to create knowledge outputs and commercial outputs. Effective knowledge application is partially dependent upon the organization's socialization capabilities. Socialization capabilities contribute to the development of broad, implicit rules for appropriate organizational behavior (Camerer and Vepsa-

lainen 1988). As a result, socialization capabilities enhance the application of new knowledge to products, services, and other organizational activities (Jansen et al. 2005). We propose that synergies between inside-out IT capabilities and socialization capabilities will impact knowledge application.

Cohesion refers to the density of linkages within a collective entity (Burt 1987). As a socialization capability, cohesion serves as a governance mechanism, facilitates trust and cooperation, and develops overlaps in cognitive structures (Jaworski and Kohli 1993). It encourages communication and improves the efficiency of knowledge exchange across organizational units. In this manner, cohesion allows firms to readily apply new knowledge (Zahra and George 2002). The relationship between cohesion and knowledge application can be impacted by integrated IS capability, an inside-out IT capability. Integrated IS capability captures the degree to which the firm's information systems provide integrated access to data across organizational units (Bharadwaj et al. 2007). By providing mechanisms for quickly reporting and sharing new knowledge across functional boundaries, these systems are more likely to increase the flow of knowledge throughout the entire organization (Davenport 2000). Synergies derived from knowledge flows sustained by integrated systems, as well as trust, communication, and cooperation of cohesive units, will enhance the firm's ability to apply new knowledge to products, services, and other innovative activities.

P4: Synergies arising from complementarities between inside-out IT capabilities and knowledge-exchange socialization capabilities will have a positive effect on a firm's ability to apply external knowledge.

Our framework alleviates the issues raised earlier. We conceptualize absorptive capacity as an organizational capability with multiple dimensions. We also theorize the collective nature of absorptive capacity. While we do not provide an empirical examination, our conceptualization of absorptive capacity lends itself to relatively straightforward measurement practices. Finally, we delineate the concrete role of IT. Specifically, we discuss how IT capabilities can be combined with complementary organizational capabilities to enhance a firm's absorptive capacity. Although we discussed specific coordination, socialization, and IT capabilities, these were only to support our arguments. There are certainly other capabilities and contexts that can be investigated, such as control mechanisms, culture and innovativeness.⁹ We hope that these propositions form the basis for further hypothesis

⁹We thank a reviewer for pointing this out.

development and testing. In addition to our proposed framework, there are numerous opportunities for IS researchers to apply the diverse role of absorptive capacity in their work.

- Scholars can expand our understanding of absorptive capacity's role in IT innovation processes beyond the assimilation stage. How does absorptive capacity influence IT innovation? Moreover, how does experience gained from IT innovation feed back into the firm's absorptive capacity?
- How does IT impact the path-dependent nature of a firm's absorptive capacity? Do the synergies between IT capabilities and complementary capabilities turn into rigidities that eventually create a rigid or narrow absorptive capacity? How might IT break the path-dependent nature of absorptive capacity (e.g., major IT implementation projects, digital options)?
- Another avenue for future research is to examine absorptive capacity as a digital capability. How do firms go about making IT investments that become digitally embedded in absorptive capacity processes? What is the relationship between digital absorptive capacity and competitive advantage? Under what conditions is such an advantage sustainable?
- How does IT impact the absorption of digitized versus non-digitized knowledge? What is the nature of the interplay among IT capabilities, complementary capabilities, and absorptive capacity as knowledge moves from non-digitized to digitized (and vice versa)? How does this interplay impact the creation of both digital and non-digital products and services? Answers to these questions and others could provide key insight into future research and relevant implications for managers.

Conclusion

Our literature review shows that absorptive capacity plays a role in several important streams of IS research; namely, business-IT knowledge, knowledge transfer, IT assimilation, and IT business value. However, absorptive capacity has been conceptualized and measured in diverse ways, leaving its broader role ambiguous and underutilized in the IS nomological network. Furthermore, IT is seemingly absent from much of the absorptive capacity-informed research. We addressed these limitations by developing a general framework in which IS researchers can investigate how IT influences absorptive capacity. We hope this framework provides a stimulus for future research surrounding IT, absorptive capacity and organizational effectiveness.

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ABSORPTIVE CAPACITY AND INFORMATION SYSTEMS RESEARCH: REVIEW, SYNTHESIS, AND DIRECTIONS FOR FUTURE RESEARCH

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Appendix A

Papers Collected in Literature Review

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Appendix B

Detailed Description of Thematic Analysis Findings

In this appendix, we describe in greater detail the role of absorptive capacity in IS research. For the sake of clarity, we only include salient IT constructs in these models.

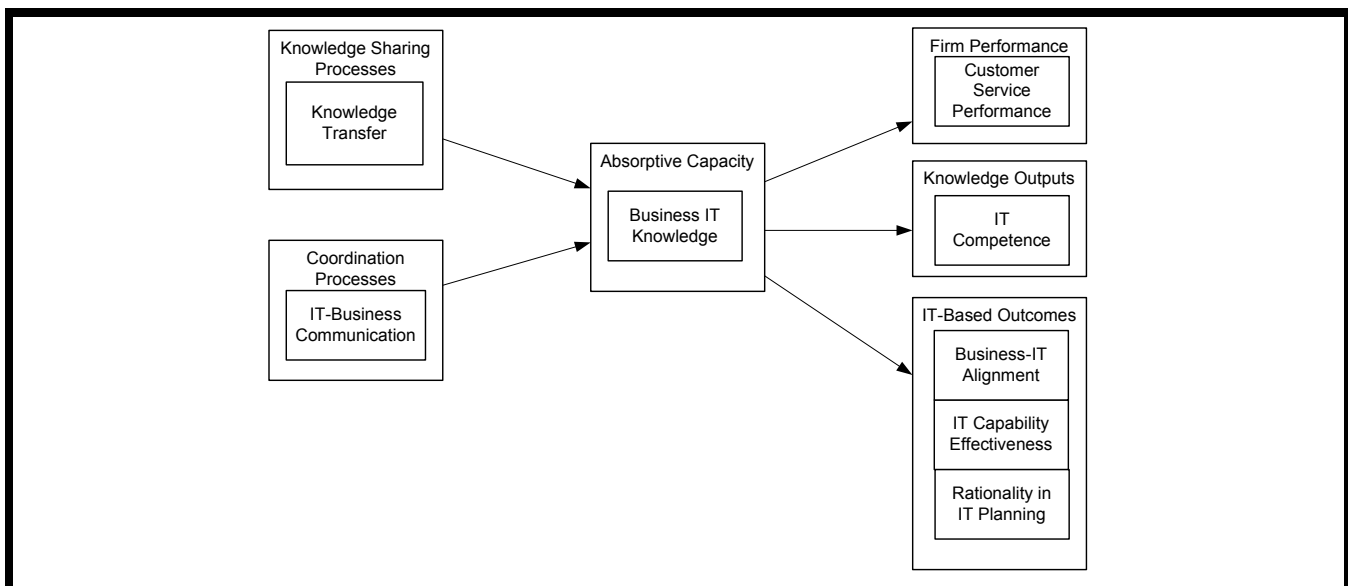


Figure B1. Business-IT Knowledge

Business-IT knowledge is a subset of a firm's absorptive capacity. Knowledge transfer and business-IT communication enhance business-IT knowledge. Consequences of business-IT knowledge include customer service performance, IT competence, business-IT alignment, IT capability effectiveness, and rationality in IT planning.

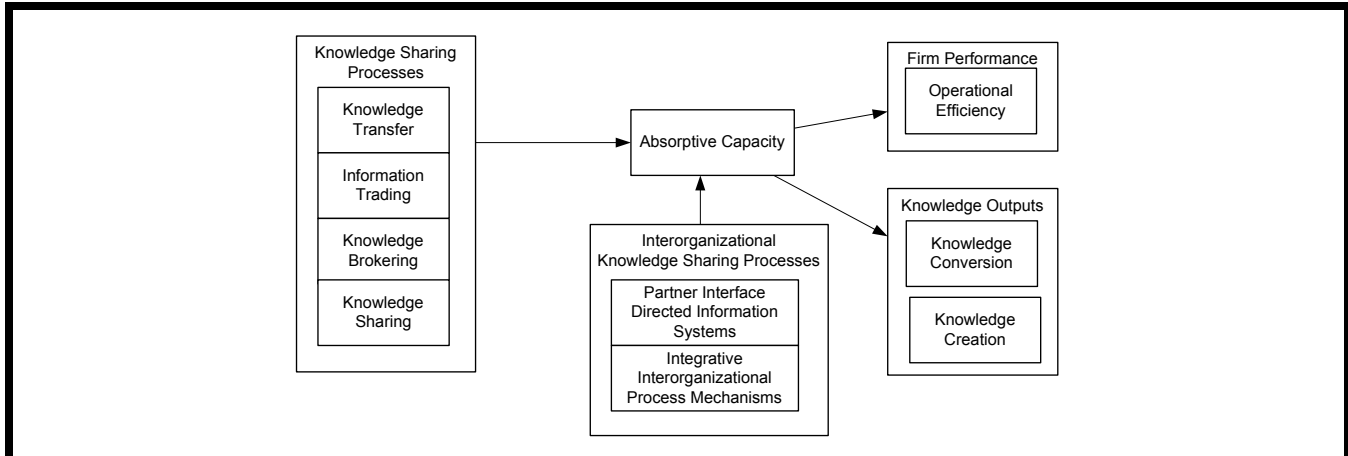


Figure B2. Knowledge Transfer

For our *knowledge transfer* theme, several knowledge sharing processes influence absorptive capacity. In particular, knowledge transfer, information trading, knowledge brokering, and knowledge sharing impact absorptive capacity. At the interorganizational level, partner interface directed information systems and integrative interorganizational process mechanisms enhance absorptive capacity. Higher levels of absorptive capacity result in operational efficiency, knowledge conversion, and knowledge creation.

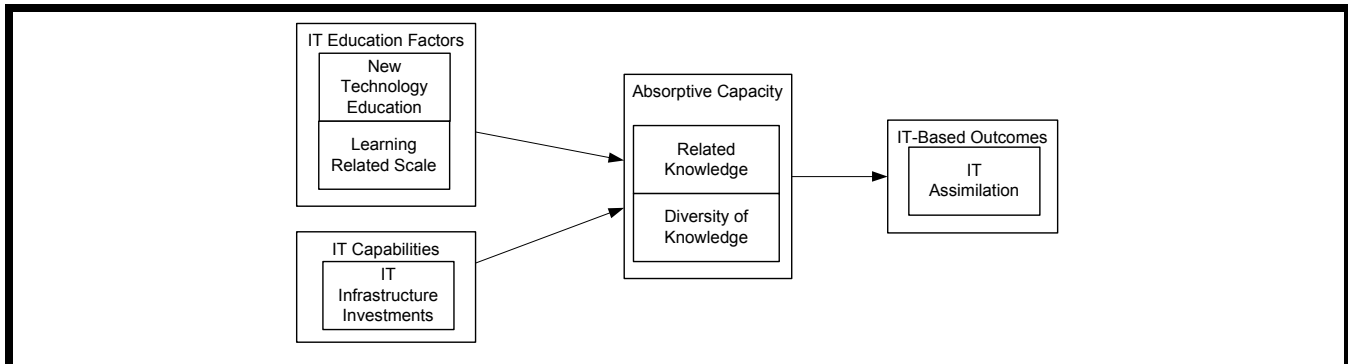


Figure B3. IT Assimilation

Our findings from *IT assimilation* research show that learning related scale, investments in new technology education, and IT infrastructure investments increase absorptive capacity. Related knowledge and diversity of knowledge (i.e., absorptive capacity as knowledge base) facilitate the assimilation of complex IT innovations.

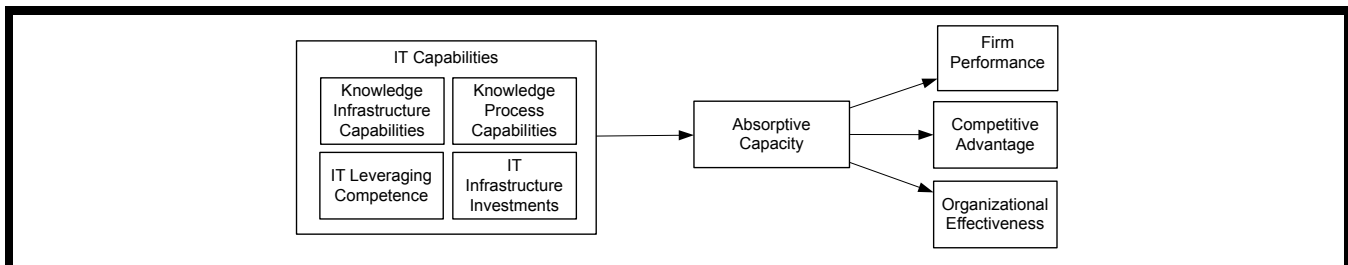


Figure B4. IT Business Value

Finally, our *IT business value* theme reveals several antecedents to absorptive capacity, such as knowledge infrastructure capabilities, knowledge process capabilities, IT leveraging competence, and IT infrastructure investments. Consequences of absorptive capacity include competitive advantage, organizational effectiveness, and firm performance.

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