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TOWARDS A THEORY OF ARCHITECTURAL KNOWLEDGE INTEGRATION CAPABILITY: A TEST OF AN EMPIRICAL MODEL IN E-BUSINESS PROJECT TEAMS [RESEARCH IN PROGRESS]

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ABSTRACT

Knowledge is now recognized as the key differentiating resource among firms. The ability to integrate widely held knowledge to derive new products and services constitutes a meta-capability from which streams new and of innovative capabilities continually emerge. This paper reports on an on-going study that empirically operationalizes new measures, and tests and validates a model of team-level knowledge integration capability in fast paced, knowledge intensive, dynamic e-business project teams. Relationships and complementarities among structural intangibles such as relational capital, cultural orientation, and absorptive capacity of teams and their ability to integrate component knowledge into project-specific architectural knowledge are empirically tested.

1. INTRODUCTION

Penrose (1959) recognized over four decades ago that it is not the firm's resources but the services that those resources render that are of value to the firm. Knowledge-based assets are now widely recognized as a key competitive resource in firms (Drucker, 1999). It is in the use, integration, and application of resources that value lies. This on-going empirical study extends recent work on the Knowledge-Based Theory of the Firm. In the context of architecturally-disruptive, knowledge-intensive e-business project teams, an initial theoretical model for team-level knowledge integration is proposed, tested, and validated. Such teams are not only knowledge intensive, but also interdisciplinary, dynamic, temporary, and operate at higher "clockspeeds" than traditional IS organizations (Mendelson & Pillai, 1998). Structural antecedents of knowledge integration capability (KIC) such as relational capital, team culture, and absorptive capacity are theoretically and empirically related. This stream of research that has hitherto been largely anecdotally or qualitatively researched. New measures for knowledge integration capability that are operationalized as part of this study will hopefully stimulate further empirical work.

The paper begins with a brief review of the theory base that it seeks to extend. This is followed by an analysis of the study's e-business context, and the motivating reasons underlying this choice. Next, the research model, constructs, and their operationalization are discussed. Finally, ongoing data collection, analysis, and expected contributions are discussed.

2. THEORY BASES

IS project management has been studied using a variety of theoretical lenses. Project management has been studied using agency theory (Eisenhardt, 1989), as found in studies of project risk (Keil, Cule, Lyytinen, & Schmidt, 1998), from a transaction-cost perspective (Poppo & Zenger, 1998), and more recently using Resource-Based Theory (Bharadwaj, 2000). Transaction-cost economics have largely focused on viewing firms as mechanisms for reducing transaction costs relative to markets, while agency theory has focused on agency-agent conflicts. The resource-based perspective used here offers a highly complementary perspective that can increase the overall explanatory power of IS management theories.

2.1 Resource-Based Theory

Resource-based Theory (RBT) views firms as collections of productive tangible and intangible resources that can be combined to derive new products and services (Wernerfelt, 1984). Key among the tangible resources are the firm's knowledge and relationship assets. Relationship-based assets provide access to other resources such as complementary knowledge and other tangible resources that the firm can combine with its own. Relationship-based assets can exist at various levels: with customers, with partners, and with suppliers. The value of these resources lies in the *services* that these resources render rather than in the resources themselves (Penrose, 1959).

2.2 Knowledge-Integration Theory of the Firm

Recognizing the significance of knowledge as a key productive resource, a knowledge-integration View of the firm has emerged in recent theory (Grant, 1996). This view suggests that the key capability of firms is their ability to integrate knowledge. In this context, it is appropriate to distinguish between two types of knowledge: component knowledge and architectural knowledge. Component knowledge refers the to knowledge underlying distinct components, specialized areas of expert tasks, and elements of larger systems (Henderson & Clark, 1990). How these components are integrated and inter-linked to form a coherent whole system represents architectural knowledge. As discussed in the next section, e-business systems innovation is largely architectural. In architectural innovations, the linkages between knowledge components are destroyed while component knowledge itself remains largely unchanged (Henderson & Clark, 1990; Henderson & Cockburn, 1994). This study therefore suggests that firms that are able to reintegrate component knowledge into relevant architectural knowledge are those that will enjoy superior performance. Consequently, antecedents of architectural knowledge integration capability (KIC) are empirically examined.

2.3 Towards a Team-level Knowledge-Integration Theory

Individuals—not firms—create, store, and manage tacit knowledge, expertise, and know-how (Nonaka, 1994). Firms merely provide the context for knowledge management, in groups of such individuals. Knowledge integration occurs *only at the group level* whereas only institutionalization occurs at the firm level [9, 12, 14]. Therefore, the proposed substantive theory underlying the model being tested in this study suggests that three intangible assets/resources must be *co-present* within the structural context of project teams for knowledge integration to occur: (1) they must have *access* to requisite, complementary knowledge components, (2) they must be *willing* to integrate those knowledge components into higher-level, project specific architectural knowledge, and (3) they must be *able* to integrate them. As described in Section 4, these are represented as relational capital, team-level cultural commitment to learning, and component absorptive capacity. Further, these will collectively and synergistically determine the project team's ability to integrate component knowledge into architectural knowledge–-"knowledge integration capability".

3. E-BUSINESS—THE CONTEXT

The chosen context of this study is e-business because the relationships and effects suggested are likely to be more pronounced in the highly dynamic and competitive environments found in e-business undertakings. E-business, as used here, is defined as Internet-mediated integration of business processes, applications, and information systems (Kalakota & Robinson, 1999; Tiwana, 2000). E-business typically spans multiple internal and external units across which business processes and activities are coordinated. For business-to-consumer e-businesses, these may span suppliers, logistics, shippers, marketing, and IS.

3.1 E-Business Project Execution as Architectural Knowledge Reintegration

This study focuses on teams that implement systems that facilitate e-business. Because e-business systems rely on reconfiguring existing technologies in novel ways, such projects are considered architectural innovations. These study views e-business information systems largely as configurational or architectural innovations, even when the underlying business model that they support is modularly or radically innovative. The hallmark of architectural innovations is that they destroy the existing knowledge of the linkages among specialized knowledge components ("architectural knowledge") while leaving the knowledge underlying those components ("component knowledge") largely intact (Henderson & Clark, 1990; Henderson & Cockburn, 1994). For example, Amazon.com used existing Web and database technologies, combined with marketing strategies, and integrated them in a novel way to facilitate Internet-facilitated sale of physical goods. Likewise, Dell and Cisco combined known logistics theory and Internet-based software to link and coordinate complex supply chains on their back-end. Even with non-physical goods, firms such as MP3.com, Beyond.com, and Elsevier Science BV have integrated existing multimedia technologies to deliver respectively music, software, and research papers digitally. Although the business models underlying the aforementioned firms may be modularly or even radically innovative, systems-level innovations are largely configurational in nature (Gallouj & Weinstein, 1997; Rycroft & Kash, 1999).

3.2 Project Execution Teams

Firms have increasingly begun to rely on project teams to execute complex, time-sensitive projects (Miles, Snow, Mathews, Miles, & Coleman, 1997). Teams enable firms to span traditional functional boundaries and provide an organizational form in which both efficiency and flexibility of knowledge integration are high (De Boer, Van den Bosch, & Volberda, 1999). Figure 1 illustrates a simplified form of a systems-implementation team assembled within a larger business unit web and interfirm network.

Individual members are drawn from different business units and areas of expertise both internal and external to the firm. Each member therefore has a unique business unit affiliation, and represents (though possibly overlapping) requisite component knowledge. All relevant knowledge components must be integrated into project specific architectural knowledge that accurately represents a coherent, systemic whole. According to knowledge integration theory, the higher the ability to integrate its members' component knowledge into project-specific architectural knowledge, the more superior the team's performance should be. It is the antecedent determinants of such knowledge integration capability that this study empirically examines.

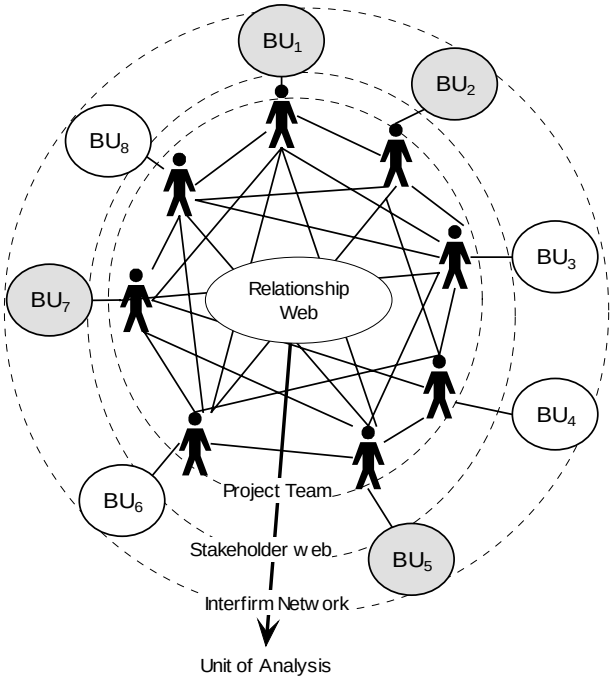

Figure 1: *An e-business project team as a business unit relationship network*

4. THE RESEARCH MODEL

The research model for this study (Figure 2) suggests that three complementary factors that constitute a project team's structural context influence KIC: relational capital, cultural learning orientation, and component absorptive capacity. A team's structural context therefore defines the context in which a project team is assembled with participants from various business units, each carrying unique and partially overlapping component knowledge. Each factor is operationalized as a latent construct and measured using several manifest, reflective variables, as described in a subsequent section.

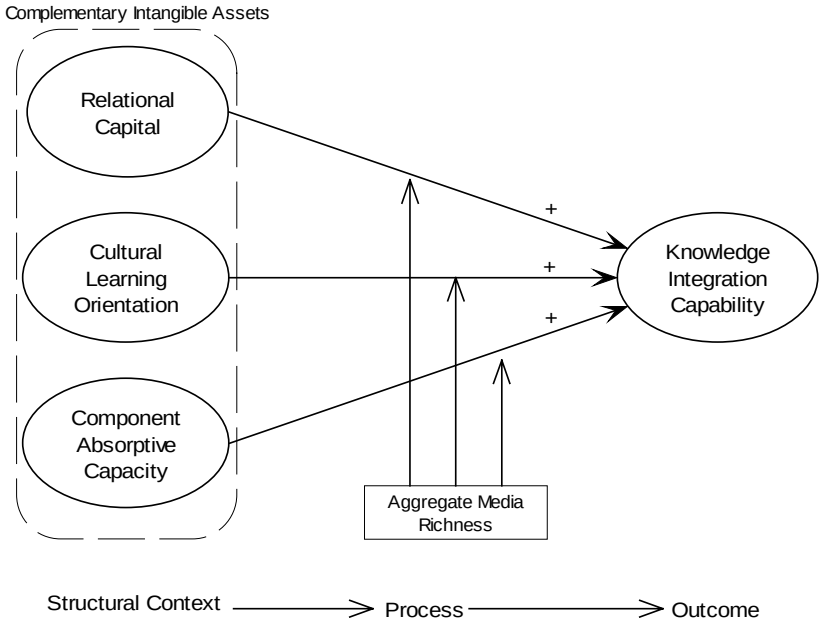

Figure 2: *The research model*

4.1 Relational Capital

To be able to integrate component knowledge into higher-level architectural knowledge, team members must be *able to access* relevant knowledge components. Relational assets largely govern such access. Relational capital is defined as the proximity of interaction, trust, and level of reciprocity among various business units (Kale, Singh, & Perlmutter, 2000). Relational capital therefore empirically measures the intangible asset/resource of relationships. This construct is measured using individual members' perceptions that reflect back to their parent business units, as has been often done in earlier IS studies of trust (Gulati, 1995). Higher levels of relational capital are expected to increase the scope of knowledge that is accessible to the team; therefore, it increases the degree of knowledge integration (Grant, 1995, 1996). This leads to the first hypothesis:

Hypothesis 1: Relational capital is positively and directly related to knowledge integration capability.

4.2 Cultural Learning Orientation

Given that team members are able to access knowledge components through high levels of relational capital, they must be *willing to integrate* it into architectural knowledge. Such willingness is measured in terms of the team's culture and the extent to which it encourages learning and knowledge sharing across participating business units. This cultural learning orientation is measured using a multi-item measure that assesses it at the level of the team. It is noteworthy that cultures of parent organizations might not be convergent with that of teams that span them. Especially in e-business projects, trade press reports have frequently observed how managers are willing to allow more leeway to project teams because these projects are considered crucial to long-term survival (Yourdon, 2000). This leads to the next hypothesis:

Hypothesis 2: Cultural learning orientation is positively and directly related to a project team's knowledge integration capability.

4.3 Component Absorptive Capacity

Provided that teams can access relevant component knowledge through relational linkages and are willing to use it, they must also be *able to use* it. To be able to integrate other members' component knowledge, members must share some common ground and possess some shared knowledge to be able to relate to other members. To capture this aspect of KIC, we introduce the construct of component absorptive capacity. This is defined as the team's collective ability to recognize, interpret, and value its members' and external component knowledge. This leads to the final hypothesis:

Hypothesis 3: Component-absorptive capacity is positively and directly related to the project team's knowledge integration capability.

This operationalization of absorptive capacity refines earlier definitions of absorptive capacity that: (1) fail to specify a stable unit of analysis (Zahra & George, 2000), (2) failed to distinguish between component and architectural knowledge, and (3) define it inconsistently at individual, unit, and firm levels (Van den Bosch, Volberda, & Boer, 1999). Correspondingly, a new team-level measure is derived using factor analysis of items derived from previous studies (Szulanski, 1996; Van den Bosch et al., 1999). Additionally, the moderating effects of aggregate media richness (defined as the total richness of *all* electronic and non-electronic knowledge sharing channels used by the team) are also tested, but not described here for brevity.

5. DATA COLLECTION AND ANALYSIS

Data are being collected in a large U.S. e-business. About 130 project managers, e-business developers, and senior managers are being surveyed using an empirical, field-based questionnaire. Existing measures for relational capital have been adapted from Kale et. al (Kale et al., 2000) and for cultural-learning orientation

from Sinkula et. al (Sinkula, Bawker, & Noordewier, 1997). New measures are under development for component-absorptive capacity, based on theoretical descriptions from Szulanski (1996). Likewise, a new measure is being developed for the knowledge integration capability construct, based on exploratory factor analysis of 38 items identified from the knowledge management literature. Initial pretests and principal-component rotation have already revealed a stable, four item measure for knowledge-integration capability. All new measures will undergo three additional rounds of pre- and pilot testing before the "actual" data are collected. Actual data will be aggregated across all respondents for each team to create team-level scores for each construct. Structural equation modeling (Maruyama, 1998) will be used to test the final model, using the partial-least-squares (PLS) procedure (Chin, 1998).

6. EXPECTED CONTRIBUTIONS

Although knowledge is recognized as one of the key assets of New Economy firms, this stream of research has largely been speculatively theoretical and qualitative. This study represents an early attempt to formalize and test empirically knowledge-integration theory. Five key contributions are expected from this study: (1) validation of the proposed theoretical model and supporting substantive theory, (2) operationalization of measures for knowledge integration capability and component-absorptive capacity, (3) the relative import of cultural factors, relational alliances, and team constitution to knowledge-integration-capability formation, (4) the moderating role played by IT enablers and knowledge sharing channels, and (5) team-level, rather than individual- or firm-level, operationalization of this knowledge-integration theory (where knowledge integration actually occurs). This on-going study is also expected to lay further groundwork for a planned longitudinal replication of this model in settings other than e-business. It is also hoped that this work will help formalize and validate the amorphous body of recent research on valuable but little validated knowledge-based theories of the firm, as well as motivate further empirical IS research on knowledge management.

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