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RECOMBINANT KNOWLEDGE STRUCTURES AND MODELS OF E-BUSINESS INNOVATION: AN EMPIRICAL INVESTIGATION [RESEARCH IN PROGRESS]

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ABSTRACT

Using a knowledge-based theory of the firm within the larger framework of resource-based theory, this on-going study examines how firm knowledge structures are disrupted under different modes of innovation. Building further on innovation management theory, it is proposed that e-business innovation must be analysed at two related levels: the business model level and systems level. Irrespective of whether business innovations are radical, modular, incremental or architectural, it is suggested that e-business systems-level innovation is systemically architectural. Relationships between the two levels of innovation and the influence of knowledge assets are also discussed. A triangulated method-based approach, the multi-case site, and on-going progress is further reported.

1. INTRODUCTION

E-business is fundamentally transforming industry structures by enabling unprecendentedly networked business models facilitated by the Internet. The fundamental thesis of this ongoing study is that innovation in e-businesses can be theoretically understood by distinguishing between innovation in e-business models and innovation at the systems level. Innovation management theory and knowledge-based theory of the firm provide rich conceptual bases for exploring the relationship between business model innovation and IS innovation. Three research questions guide this study: (1) What are the relationships and complementarities between business model- and information system-level innovation in e-business? (2) How are knowledge structures altered in different modes of systems level and business model innovation? (3) How must firm knowledge be managed in such environments? This study hypothesizes that the ability to recognize the mode of innovation at both the business model and systems level is the precursor to the firm's ability to address any emergent e-business market opportunity.

1.1 E-Business

E-business is defined as Internet-mediated integration of business processes, applications, and information systems (Kalakota & Robinson, 1999). Until the emergence of e-business, IS has largely played a facilitative and relatively peripheral role in business, largely focusing on improving operational efficiencies, cost

structures, and effectiveness. Now, however, it would to fair to claim that e-business would not be possible if it were not for the information systems that facilitate it. The role of IS has become unprecedentedly central to e-business. The trade press estimates that e-business will account for as much as 37% of all transactions in some industries by 2003 (*Business Week*, June 9, 2000). Corresponding to this growth, spending on e-business software development is expected to grow to $78 billion over the same time frame.

Even though firms around the globe are rushing to build e-business systems, their rates of failure are alarmingly high. Failures have largely been blamed on poor execution and alignment of IS projects rather than on the failure of the technology to perform (Singh & Ambrose, 2000). The inability of firms to recognize the precise nature of an innovation can lead to "competency traps" (Levinthal, 1994), and can even create "negative competencies" (Ciborra, 1996). This study contends that innovation management provides the theoretical basis for mitigating risks of mindless reapplication of old approaches (Robey & Boudreau, 1999) that might be unsuited to the present e-business environment.

2. THEORETICAL FOUNDATIONS

This study uses the knowledge-based view of the firm (Grant, 1996a), within the larger framework of resource-based theory (Penrose, 1959). This theoretical base views firms as collections of productive intangible resources (such as relationships and knowledge) and tangible resources. Firms address market needs by opportunistically combining and integrating these resources in multitudous ways. Within this framework, innovation management theory is used to identify changes and requisite recombinations in knowledge structures in various modes of innovation. Consistent with the knowledge-integration view of the firm [6], the key capability of the firm is therefore its ability to integrate existing and new knowledge.

2.1 Models of Innovation in E-Business

Henderson and Clark (1990) suggest that innovations can be classified as incremental, radical, architectural, or modular on the basis of changes in (1) components and (2) linkages among those components (see Figure 1). Components are defined as core concepts and distinct, independent expert tasks, while the linkages among them to form a coherent whole defines the architecture. The distinction between components and their architectures assumes that the objects of study are inherently modular to some degree (Schilling, 2000) and consist of strong and weak ties linking relatively independent components. Collections of components constitute both business models and e-business information systems.

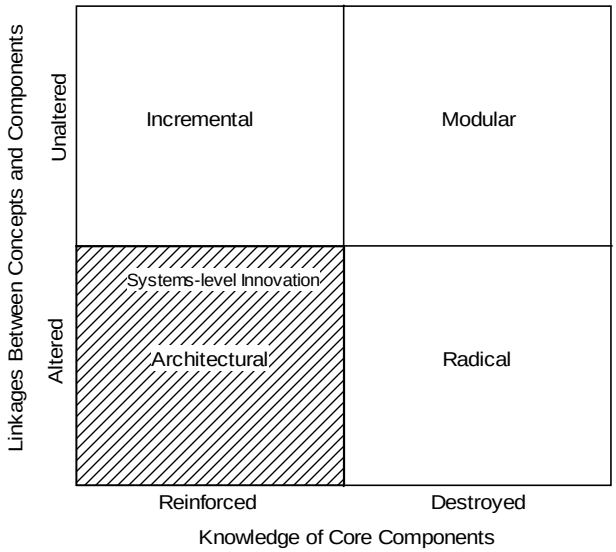

Figure 1: *Models of Business-Model and Systems-Level Innovation (based on [8]).*

Innovations can therefore be classified in one of four quadrants, although the demarcations among them are largely a matter of degree. We suggest that it is useful to distinguish between innovation at the business model level and that at the system level. Innovations in business models can destroy both knowledge of components and organizational architectures at the business-model level. Therefore, business model innovation may be modular, radical, architectural, or merely incremental.

2.2 Systems-Level Innovation Models in E-Business

This study contends that, irrespective of the innovation at the business-model level, systems-level innovation in e-business is largely architectural (the shaded area in Figure 1). Table 1 illustrates this point with some contemporary exemplars of e-business firms. Irrespective of their business models, these firms have largely relied on systems that recombine *existing technologies in novel ways*.

Innovation Mode	*Exemplars*	*Business Model*	*Facilitating Systems*
Radical	Application services	Rental software distributed through the Web	Digital software delivery on demand and with limited ownership
Modular	FedEX NYTimes.com Amazon.com	Web package tracking Digital wireless delivery Modular e-commerce	Tracking system front-end Content clipping software Modular replication of storefronts
Incremental	Kroger.com	Grocery coupons	Internet integration of coupon systems
Architectural	Windows WebGrocer.com	Windows Explorer Internet grocery delivery	Integration with Web browser Web-connected logistics systems

Table 1: *Case exemplars illustrating that systems-level innovation in e-business is largely architectural*

In each case described in Table 1, e-business models are largely radically or modularly innovative, yet the facilitating systems are architecturally innovative almost without exception. If systems-level innovation in e-business is architectural, then it is higher-level, systemic, and architectural knowledge that e-business must destroy. In other words, although component knowledge remains largely intact, it is the linkages among components that are destroyed in e-business. Given the knowledge intensive nature of traditional firms (Drucker, 1999), the innovation-model framework should be as applicable to production as it is to service firms (Eisenhardt & Tabrizi, 1995; Evangelista & Sirilli, 1998). The threats to IS development come, not from the nature of the innovation itself, but from the firm's inability to recognize that the systems needed to enable it are architecturally innovative. Firms and project teams have a false sense of security and mistakenly apply familiar, incrementally innovative IS approaches to these projects. The perils of continuing to apply old ways in the face of architecturally innovative changes has been recognized in the semiconductor industry (Henderson & Clark, 1990), the disk drive industry (Christensen, Suarez, & Utterback, 1998), pharmaceuticals research (Henderson & Cockburn, 1994), and in recent IS research (Robey & Boudreau, 1999).

3. KNOWLEDGE STRUCTURES AND RESOURCE RECOMBINATIONS

As e-business firms may face radically different innovations in competing business models, the changing nature in the underlying knowledge structures must be carefully considered in order to determine the type of response that the e-business opportunity necessitates. According to the formalized Penrosian view, firms can be viewed as collections of productive tangible and intangible resources (Wernerfelt, 1984). Of these, *knowledge* has been recognized as the most significant resource of all (Boisot, 1998; Burton-Jones, 1999; Tiwana, 2000); and the firm's ability to integrate this knowledge is its key differentiating capability (Grant, 1996b; Inkpen, 1998; Teece, 1998). In many respects, this knowledge-integration view implies that it is not the possession of knowledge that is of value to the firm but its integration and application.

Based on this knowledge-integration theory of the firm, this study hypothesizes that firms that are able to build knowledge integration capability in turbulent, architecturally-destructive business environments such as e-business will enjoy superior competitive and financial performance. In effect, firms are viewed as

collections of intangible assets, specifically knowledge and relationship assets. Measures of these assets are empirically operationalized at the component and architectural levels, and at the customer, supply-chain, and interfirm network levels. As firms build both stocks *and* flows of these assets, they gain access to tangible assets by means of their relational assets. This decreasing dependence on tangible assets has been recently observed in the semiconductor industry where several newer firms that design microprocessor devices do not own the facilities for actually producing them. All production is handled by specialized manufacturing firms ("foundries") in certain East Asian countries, primarily on the basis on long-term market relationships ("relational assets"). The feasibility of coordinating these complex, globally-distributed manufacturing activities has been largely facilitated by the use e-business systems (see www.microprocessorwatch.com).

3.1 Complementarities between IS and Business-Model Knowledge Structures

Recognizing that the mode of innovation must be separately identified at the business-model and systems level, Figure 2 illustrates the linkages between the two as mediated by recombinant knowledge structures.

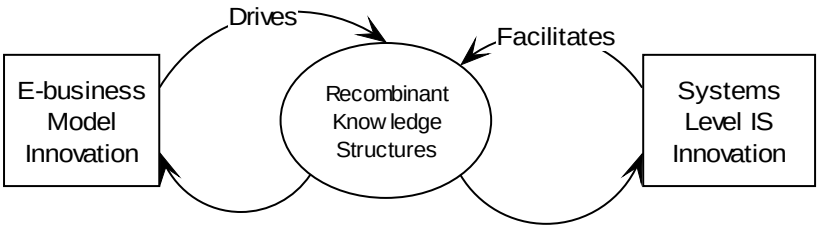

Figure 2: *Relationships between Business-Model and Systems-Level E-business Innovation*

The nature of innovation within the business model drives innovation in the systems needed to enable that model. Depending on whether the business model is incrementally, architecturally, modularly, or radically innovative, the requirements of relevant systems can be determined. Given these requirements, systems-level innovation facilitates building capabilities to execute this business model. As argued above, the largely architectural nature of IS innovation in e-business implies that firms must be able to recombine systems-component knowledge in new and novel ways. The more capable a firm is of facilitating such integration and recombination, the more likely it is to exhibit superior performance in the long run.

This study further suggests viewing firms' assimilation of component-knowledge assets and relationship assets as creating *platforms* for launching new product and service offerings. By recombining component knowledge internal to the firm, and component knowledge accessible through its relationship-based assets, new architectural knowledge can be created to deliver matched market offerings. This is similar in spirit to the concept of the platform organizational structure proposed by Ciborra (1996).

4. RESEARCH METHODOLOGY

Data collection is underway for testing the aforementioned relationships among business model and IS knowledge structures in an e-business context. Approximately 26-30 e-business projects in a leading U.S. e-business conglomerate (revenues in the US$26 billion range) are being studied. A cross-case analysis method is being used to collect data in two ways: (1) questionnaire-based empirical data from members within the firm and (2) qualitative multi-case data using interviews with members, managers, and customers of the firm (Yin, 1993, 1994). Data from these two sources will be first tested empirically to determine support for the linkages suggested here and then triangulated across cases (Dubin, 1976; Webster & Starbuck, 1988; Weick, 1995). Further support for whether knowledge structures within an IS context are truly architecturally destabilized will be gained through interviews with IS developers who build these systems. By using a multiple-informants approach for both quantitative data and qualitative data, a more accurate depiction of individual cases will be possible (Creswell, 1994; Morgan & Smircich, 1980).

4.1 Expected Contributions

The following contributions are expected from this study. The knowledge-based theory of the firm will be empirically operationalized in an e-business context. The distinction between business-model and IS innovation will be better articulated. The relationship between the two will help guide managerial decision making by better informing them of the interdependencies between them. Finally, by articulating shifts in knowledge structures under architectural modes of innovation and supporting them with case-based data, further guidance will be provided to managers for managing firm-level IS knowledge. It is also hoped that the current skepticism about the applicability of existing IS theory to the so-called "New Economy" will be dispelled to some degree.

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