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Managerial Assessments of E-Business Investment Opportunities: A Field Study

Anandhi Bharadwaj and Amrit Tiwana

Abstract—Managers charged with assessing investment opportunities for information technologies such as e-business projects face considerable uncertainty in their decision-making processes. Contemporary theories of the firm and the normative prescriptions thereof emphasize the potential for such investments to augment firm-level *knowledge* and *relational capabilities*. However, prior research has not examined the relative emphases that managers place on the knowledge and relational capability-augmenting characteristics of the e-business investments. In this paper, we develop a model to assess whether managerial evaluations of e-business investment opportunities are consistent with these normative and theoretical prescriptions. A test of the model using survey data on 485 project assessments by e-business managers suggests that managerial assessment and choice are guided by the criteria suggested by the knowledge and relational theories in evaluating potential e-business initiatives. Our results demonstrate that the ability of firms to exploit their intangible assets through such investments explicitly enter managerial calculus and provide new insights into the relative importance ascribed to these factors. The overarching insight is that managers ascribe relatively more weight to knowledge-based considerations than to relational considerations.

Index Terms—Conjoint design, decision making, e-business systems, emerging technologies, Internet software, knowledge-based theory, knowledge integration, project management, relational theory.

I. INTRODUCTION

NOVEL BUSINESS applications of the Internet continue to transform the competitive landscape of entire industries by facilitating complex coordination and exploitation of resources within and across firms [52]. Managers who are responsible for evaluating opportunities for investment in such “e-business” projects must often assess the potential rewards, while remaining wary of uncertainty and risk in their decision-making processes [34], [47]. We define e-business projects as projects associated with developing Internet-based business software applications. Industry analysts have predicted that e-business applications can facilitate the exploitation of intangible knowledge and relational assets such as intellectual

capital and customer relationships [49], [52].¹ Consequently, many contemporary organizations are realizing that new considerations must be brought to bear in assessing e-business investment decisions.

While normative prescriptions abound, what remains unclear is the extent to which managers who are in charge of selecting their firm’s portfolio of e-business projects actually apply such strategic considerations in project evaluation and selection. No research to date has actually investigated the cognitive processes of managers as they evaluate potential e-business projects, although managerial decision-making has been studied in other domains such as investment opportunity assessment and technology partnering [48], [58]. We address this understudied issue in this paper, guided by the following research questions.

- 1) How do managerial assessments of knowledge and relational capability contributions of prospective e-business projects influence their e-business project investment decisions?
- 2) What is the relative importance that managers ascribe to the key knowledge and relationship-enhancing capabilities of e-business projects?

Deeper understanding of the factors that executives bring to bear in assessing e-business project opportunities holds valuable theoretical and pragmatic insights for three reasons. First, e-business systems are complex, emerging technologies that can provide a wide range of functionality ranging from simple content presentation to dynamic personalization of information. However, the complexity of possible choices has led to a large variance in successfully selecting and implementing e-business systems across firms [5]. Understanding the mental filters that managers bring to bear in choosing one from a plethora of possible e-business projects can provide a deeper understanding of their guiding logic. Second, e-business systems are a relatively new genre of technologies for which robust frameworks and project evaluation models do not yet exist. Industry observers have argued that NPV or cost-benefit analyses are inadequate evaluation tools for assessing such projects because they affect firm operations in fundamental rather than incremental ways. Whether managerial assessment and choice are actually guided by the prospect of e-business project investments to augment

¹Such intangibles include brand equity [9], intellectual capital [55], organizational knowledge [10], and relationships with customers [27]. In these assessments, the potential for software applications to enhance firm-level capabilities for exploiting knowledge and relational resources must complement the cost-benefit assessments that have traditionally guided IT investments [3], [34], [44], [64]. Responses with substantial missing data were discarded, leaving 485 assessments for analyses.

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their firm's knowledge and relational capabilities, however, remains an open question. Third, executives' decision-making is influenced by their mental models derived from prior experience [21], [47], [63]. Therefore, eliciting the decision criteria actually used by them provides a basis for analyzing the extent to which managers are consistent with the normative prescriptions of contemporary knowledge and relational theories.

In this paper, we examine whether senior managers' assessments of e-business project opportunities are consistent with the theoretical perspectives of the knowledge-based and relational theories of the firm. The crux of these perspectives is that new investment opportunities should be guided by the extent to which they augment firm-level knowledge and relational capabilities [5], [44], [64]. We build on these perspectives to develop a theoretically grounded model that is tested using data on 485 e-business project evaluations collected from 36 managers responsible for evaluating e-business opportunities for their firms. Our results empirically determine the *relative weights* that senior executives assign to each factor in the model and estimate their predictive power in influencing an investment in a given e-business project. The results provide empirical support for the proposed model and show that managers go beyond simple financial criteria in assessing the attractiveness of investing in e-business projects. Specifically, we found, in the order of their importance, that managerial assessments of e-business investment opportunities were influenced most heavily by the availability of knowledge necessary to successfully accomplish the project, the ability of the proposed e-business project to strengthen ties with customers, and the degree to which it facilitated knowledge appropriation. Surprisingly, knowledge-sharing did not influence managerial assessments. The results further show that managers weigh knowledge-based considerations more heavily than relational considerations in their assessment of e-business investment opportunities.

The rest of this paper is organized as follows. In Section II, we use existing theory to guide the development of our hypotheses. In Section III, we describe the methodology, design, sampling approach, and data collection. Section IV presents the analysis and results, and Section V highlights the implications of the study for future research and practice.

II. THEORY AND HYPOTHESES

A. Knowledge-Based Theory of the Firm

The knowledge-based theory of the firm views *knowledge* as the most strategically significant resource of the firm [19] and views the ability to create, distribute, share, and exploit knowledge as central to firm performance [30], [39]. Furthermore, firms are seen as distributed repositories of tacit and explicit knowledge [57], and heterogeneous knowledge bases are among the main determinants of sustained competitive advantage [65]. The prescriptive aspect of this theory stresses the importance of developing superior organizational capabilities for developing and exploiting knowledge resources.

Investments in e-business technologies facilitate key knowledge processes such as knowledge creation and exploitation

in several ways. E-business systems can be used to synthesize data from multiple but geographically dispersed sources to identify useful patterns. They can also facilitate the use of fragmented knowledge through collaborative platforms that enable boundary-spanning communication between a firm and its partners. Increasingly, firms are viewing e-business systems as mechanisms to digitize the application of business processes-related knowledge and to embed business rules in the software. In this section, we identify the key knowledge processes that are enabled by e-business systems and develop hypotheses linking managerial assessments to their perceptions of the influence of e-business systems on these key knowledge processes. Before we proceed, we must point out that although these knowledge processes are related, they are quite distinct from one another, and any e-business system might simultaneously enable one or more of these processes to a greater or a lesser extent. Our model development and subsequent testing is designed to examine the relative efficacies of these processes in influencing managerial assessment of e-business project attractiveness.

1) *Knowledge Creation*: Knowledge creation is defined as the process of development of knowledge at the firm level that previously did not exist [39]. New knowledge is created through novel combinations of existing explicit and tacit knowledge within and outside the firm through interactions above and beyond those facilitated by normal routines [28]. Empirical studies link knowledge creation through external sourcing with innovation and performance [4], [42]. E-business systems can facilitate knowledge creation by bringing together both dispersed and specialized internal and external knowledge. The expanded reach of information exchanged through these systems also increases its likelihood of interacting with individually held tacit knowledge and an increased potential for further knowledge to be created [39]. Case in point: online retailers dynamically customize their web site content and offerings using data on customers' navigational patterns and combine online data with customer data collected from other channels to create new insights about customer preferences and behaviors. Similarly, other e-business systems that increase the firm's knowledge about its suppliers (e.g., knowledge about supplier inventories and production plans) have been well documented in the literature [32]. Therefore, when IT managers evaluate e-business projects, they are likely to consider whether they will facilitate knowledge creation.² Therefore,

Hypothesis 1: Managerial perception of e-business project attractiveness will increase if the investment augments the knowledge creation ability of the firm.

²Not all e-business systems are likely to result in new knowledge creation. For example, when an online order processing system replaces an existing system based on telephony, the new system may be designed to capture the exact same data that was obtained previously through the telephone orders. In this case, while the firm may enhance operational efficiencies due to customer self-service, no new knowledge is likely to be created. However, if the same system was redesigned to capture additional data about the customer (such as products that the customer browsed through but did not purchase), then the system augments the firm's knowledge base by creating new knowledge that was previously unavailable to the firm.

2) *Knowledge Exploitation*: Knowledge exploitation is defined as the process of utilizing preexisting accumulated stocks of organizational knowledge and applying them in contexts different from the ones in which they were developed. The capability to exploit commercially existing stocks of knowledge serves as an important determinant of firm performance. Knowledge exploitation is often challenging in firms because knowledge is fragmented across organizational boundaries and organizational members may not know where the relevant knowledge is located within the firm. Moreover, the costs of accessing dispersed knowledge even within the firm can be high. E-business software applications can help overcome some of these knowledge management challenges in several ways: 1) by creating channels that lower the costs of searching for relevant knowledge; 2) by raising the accessibility of knowledge throughout the firm; and 3) by reducing the stickiness of unstructured knowledge through the use of rich multimedia channels.

For example, Siemens (a global engineering firm) implemented an Internet-based application called ShareNet that allows its 19 000 technical specialists to locate explicit knowledge (documents, reports, and presentations), as well as colleagues with specific expertise (tacit knowledge) in 190 countries for assistance with technical problems. This application facilitates exploitation of expertise and solutions across sales regions, projects, and markets, as well as facilitates knowledge sharing and integration (as discussed later). Similarly, an e-business portal application now allows American Airlines to exploit knowledge and expertise associated with travel reservations both within the firm and downstream channel members [6]. Another example of an e-business application is Microsoft's problem-solving database, which allows customers to search for solutions to problems with Microsoft products through its web site. This facilitates knowledge exploitation of prior problem-solving activities but does not facilitate knowledge sharing or knowledge creation. Therefore,

Hypothesis 2: Managerial perception of e-business project attractiveness will increase if the investment augments the knowledge exploitation ability of the firm.

3) *Knowledge Digitization*: Knowledge digitization refers to the extent to which organizational knowledge is codified and embedded in information systems such as rule-based and agent-based software. Although organizations rely on the knowledge that is held tacitly by individuals, human memory is fallible and subject to erosion and error [26]. Organizational memory is greatly facilitated through the explicit use of systems that capture and codify knowledge [26]. The process of knowledge digitization entails codification of tacit and explicit knowledge in software systems for easier application and reapplication.

Firms derive several benefits from the digitization of knowledge. First, knowledge embedded in digital systems can be applied consistently and without human intervention. Second, digitization insulates users from having to understand the underlying rules and makes such knowledge more accessible to individuals without the necessary skills to apply that knowledge. For example, the Tennessee Valley Authority's (TVA)

maintenance of its three nuclear power plants relies heavily on vendor manuals, schematics, and operating protocols [25]. TVA's web-enabled work-order system dynamically updates procedures and approval rules for new work orders, thereby increasing the consistency with which new process knowledge is applied. Thus, an e-business project that facilitates knowledge digitization can make specialized knowledge more readily accessible and more consistently reusable. Therefore,

Hypothesis 3: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to embed business rules and process knowledge in the software.

4) *Knowledge Integration*: Knowledge integration is defined as the coordinated, context-specific application of distributed individually-held specialist knowledge to collective activities in the firm [18], [40]. Even when firms own or have access to the relevant knowledge, it is their internal integrative capabilities that determine its use [59]. As fragmented knowledge vectors from one unit interact with other units, feedback, amplification, and recombination results in the integration into new knowledge that could not be derived independently [16]. Case in point: software development firms use web-based collaboration systems to develop systems using groups that are situated in geographically different time zones. Such environments allow ongoing integration of expertise inputs while maintaining the benefits of around-the-clock development. When e-business systems facilitate knowledge integration, they allow firms to secure numerous benefits such as cross-functional workflow and concurrent engineering [8], thereby enhancing problem solving [13]. In fact, Desanctis and Monge [11] show that divergent thinking tasks are completed more effectively electronically than face-to-face, suggesting that knowledge integration can be effectively achieved through electronic means. Therefore,

Hypothesis 4: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to integrate distributed knowledge.

5) *Knowledge Sharing*: Knowledge sharing is defined as the process of sharing specialized tacit and explicit knowledge across formal boundaries in the firm. While knowledge integration focuses on recombination/application and knowledge transfer on replication, sharing merely refers to raising awareness of specific knowledge in both the source and the recipient. Knowledge sharing can be impeded by several organizational factors based on the characteristics of the knowledge, the characteristics of the source, and the characteristics of the recipient [51]. Distributed e-business systems such as intranets can facilitate knowledge sharing by overcoming some of these impediments. For example, real-time videoconferencing and electronic chat rooms can facilitate sharing of sticky tacit expertise and know-how using text, voice, and video channels [43]. Internet-based rating systems can also be used to assess and evaluate knowledge sources and thereby increase source credibility. For example, eBay users rely on an Internet-based reputation aggregation system to share economic transaction

experiences with any given seller [2]. In summary, e-business projects can potentially lower the search and transfer costs of knowledge sharing. Therefore,

Hypothesis 5: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to share knowledge within the firm.

6) *Knowledge Appropriability:* A technology that facilitates knowledge sharing and application through codification also increases the risk of spillovers and leakage to competitors [45]. New and innovative technologies are often subject to rapid replication by competitors [53]. When a firm can create legal barriers to imitating an e-business opportunity, its returns can be fully appropriated by the firm [54]. One way in which firms can appropriate their investment in e-business systems is to create legal barriers to imitation through patenting. For example, Amazon.com's ability to patent its one-click purchasing system and Priceline.com's ability to patent its Internet-based reverse auction technology has helped minimize the threat of the blatant replication of the technologies by competitors. Other examples of knowledge appropriation include the attempt by universities to create web-based repositories of courses (electronic courseware) that become the intellectual property of the university rather than the individual that created it. Similarly, e-business projects that facilitate knowledge digitization (as discussed earlier) can simultaneously raise appropriability by embedding it in software, thus making knowledge spillovers to other firms less likely. While e-business systems have the potential to increase knowledge appropriability by firms, not all e-business systems, however, are likely to have this capability. Therefore,

Hypothesis 6: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to appropriate knowledge.

7) *Knowledge Gaps:* Our examination of e-business characteristics thus far has focused on the knowledge processes enabled by e-business projects and their relative attractiveness based on these characteristics. However, managerial assessment of system attractiveness is likely to depend not only on the projected benefits but also on the resources needed to accomplish the project [18], [57]. In keeping with our focus on knowledge aspects related to project assessment, here we consider only the knowledge skills needed to develop the project. An important consideration would thus be an evaluation of existing technical and business skills needed to successfully execute the project. For example, if implementation of an e-business system requires an entirely new skill set, the firm will face a considerably steep learning curve and is more likely to pursue alternative means of acquiring the technology, such as licensing or outright purchase of similar systems [53]. Thus, the direct costs and the opportunity costs of acquiring new skill sets internally will reduce the attractiveness of pursuing the e-business project opportunity. Therefore,

Hypothesis 7: Managerial perception of e-business project attractiveness will decrease if development of the

system requires entirely new skill sets that are not readily available within the firm.

B. Relational Theory of the Firm

According to the relational theory of the firm, the quality of a firm's relationships with its customers, suppliers, and business partners influences firm performance [12]. Relational capital—defined as the level of trust, reciprocity, and strength of ties that characterize the relationship between a firm and its partners [27]—is a central concept in this theoretical view.

E-business applications can facilitate the creation, strengthening, and exploitation of relational ties with customers and suppliers [5], [37]. Although the importance of developing relational capital with both customers and suppliers has been emphasized in the academic literature, in the present study, we limit our focus to examining the influence of e-business systems on customer-side relationships.

Managers are likely to weigh new e-business project opportunities based on their perceived impact on a firm's customer relationships for two reasons. First, customers are an important source of innovative insights, new product ideas, and new knowledge that is unlikely to be found within a firm [61]. Their willingness and ability to share such knowledge is influenced by the strength and quality of their relationships [29], [37]. Therefore, e-business projects can provide conduits for new knowledge from customers and competitors and increase awareness of customer problems. Firms, therefore, view e-business investments as mechanisms to develop relational capital both by strengthening customer ties and building customer trust.

1) *Customer Ties:* Strong ties with customers create substantial barriers for competitors because firms that cultivate them enjoy higher loyalty, retention, and responsiveness to new offerings [50]. E-business projects can provide opportunities to cultivate customer relational capital by restructuring the interfaces with customers and facilitating closer interactions with them [23]. Technologies such as profiling tools, site analysis, collaborative filtering, and online chat rooms are incorporated into e-business applications for promoting the development of online customer communities. These technologies are designed to enhance customer relationships by aggregating valuable customer information and managing collaboration with customers through an expanding loci of interaction with customers. Direct merchant LandsEnd provides an example of e-business project functionality that enhances customer ties. Customers can directly interact with sales representatives through the LandsEnd web site using text-based chat, interactive browsing with a customer service agent, and by creating personalized virtual models of themselves on which they can assess the fit of clothing. Therefore,

Hypothesis 8: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to strengthen customer ties.

2) *Customer Trust:* A substantial body of literature has examined the role of trust in social relationships and has found it to

be an important predictor of cooperative interactions [35]. High levels of consumer trust in the firm reduce the costs of transactions and increase customer loyalty [1], [50]. It also influences the willingness of customers to share knowledge with a firm [27], leading over time to generalized norms of cooperation. E-business investments can provide opportunities to build customer trust by increasing the transparency of *some* information to customers [52]. As an example of customer trust enhanced by an e-business application, consider eBay's implementation of the customer feedback rating system that allows every eBay customer to rate and to verify the reliability ratings of every other customer. This has engendered tremendous levels of customer trust and has led to increased loyalty to the firm [2]. Therefore,

Hypothesis 9: Managerial perception of e-business project attractiveness will increase if the investment augments the firm's ability to strengthen customer trust.

A priori hypotheses about the relative importance of various factors in the model are not proposed primarily because of scant empirical work on knowledge and relational theories of the firm. However, knowledge assets are recognized as a critical component of firm-level capabilities and relational assets are viewed in the literature as a vehicle for accessing distributed knowledge assets [36], [41]. We, therefore, expect that knowledge-based considerations will weigh more heavily than relational considerations in managerial assessments of e-business projects.

Hypothesis 10: Knowledge-based considerations will weigh more heavily than relational considerations in managerial assessments of the attractiveness of e-business project investment opportunities.

III. METHODOLOGY

A. Research Setting

We drew our sample from e-business managers at a large U.S. shipping and logistics conglomerate and its myriad business partners. The conglomerate has six loosely related lines of businesses that span logistics, financial services, new venture funding, and retail electronic commerce. 80% of its \$32 billion in revenues in 2000 were derived from an extensive network of business partners in a wide array of industries. We chose this context for three reasons. First, e-business projects encountered by these managers were promising stepping stones into new markets but were simultaneously threatened by evolving technologies, market shifts, and innovations. Managers were, therefore, likely to consider a variety of factors in judging their attractiveness to their firm. Second, our discussions with managers suggest that all the project characteristics in our study manifest themselves in e-business project contexts. Managers view the underlying open standards, the global reach of the Internet, and widespread adoption of Internet technology as potent opportunities to enhance the flow of knowledge and foster systemic relationships both within their organizations and with their business partners. Third, firms across all industries increasingly invest in e-business systems to improve the execution of business activities across individual firm boundaries.

B. Method

We used a policy capturing experiment, *a posteriori* judgment analysis technique common in cognitive psychology and managerial decision making [48] to determine if the strategic considerations expounded by the knowledge and relational theories are actually used by managers during e-business project assessment. The technique requires respondents to make a series of judgments based on a set of attributes from which the underlying structure of their cognitive models can be inferred. The design of policy capturing studies is theory-driven [20]; our design was grounded in knowledge and relational theories of organizing. The cues represent the independent variables that are manipulated simultaneously in different combinations. Based on each set of cues, respondents assign scores to the dependent variables. In this study, the cues were the nine theoretically-derived project attributes discussed in Section II, and the two dependent variables were e-business project attractiveness and willingness to recommend funding. Each project scenario therefore describes a project in terms of the levels of each of the project attributes and requires the respondent to assess its attractiveness to the firm and the likelihood that the respondent would recommend funding the project. The levels of project attributes in the scenario were high or low for each attribute [20].

Our choice of this research design was motivated by four considerations. First, our research questions required a design that allowed the respondents to evaluate the attractiveness of new e-business projects by *simultaneously* considering their knowledge and relational characteristics within the context of their firm, both of which are derived from existing theory. In general, policy capturing techniques are well suited for research questions that are guided by existing theory [20]. Second, the technique requires the respondents to perform a realistic task. Managers frequently consider various implications of their technology investment choices, especially in emerging technological contexts. For example, in the scenarios presented to managers, the likely effects of their choice on their firm's ability to better manage its knowledge assets (through knowledge creation, exploitation, digitization, integration, and sharing) and enhance its relational assets with customers were simultaneously evaluated. Third, this approach mitigates the threat of retrospection bias because it does not force managers to recall *ex post* the relevant factors and project characteristics that might have influenced their past decisions [38]. It is also less susceptible to social desirability bias because the scenarios presented are hypothetical. Fourth, the design facilitates evaluation of the relative importance of each variable without requiring the respondents to make tradeoffs on each independent variable directly [15], [62]. This information is derived from the respondents' judgments of the different scenarios. Although multiple attributes may significantly affect the dependent variable, they are unlikely to be equally important. Ordinary regression coefficients and their levels of significance indicate the extent to which the independent variables influence the dependent variable.

1) *Development of Conjoint Decision Profiles:* Based on the theoretical considerations put forth in the earlier sec-

tion, we developed a series of hypothetical conjoint profiles that described each e-business opportunity in terms of nine attributes, each with two levels: 1) knowledge-creation ability; 2) knowledge exploitation ability; 3) knowledge digitizability; 4) knowledge integration ability; 5) knowledge sharing ability; 6) knowledge appropriability; 7) presence of knowledge gaps; 8) ability to improve customer ties; and 9) ability to improve customer trust. Each conjoint profile represents an individual project scenario with varying combinations of predictor attributes. The attributes of managers who responded to the survey were used to control for individual differences. Specifically, we controlled for how long the respondent had been with the firm (tenure), the number of years of e-business experience of the respondent, the number of e-business projects that he or she had previously evaluated, and the self-reported level of confidence in the overall assessments of all of the scenarios that were evaluated (a postexperimental control). Hair ([20, p. 580]) recommends ensuring that the conjoint profiles be realistic, as well as unambiguous. A pilot test conducted with a group of 13 MBA students in a leading part-time MBA program and a group of three academic experts confirmed the face validity of both the attribute and the levels and also helped improve the content validity, which is otherwise difficult to empirically assess [31]. Feedback from pilot test respondents was incorporated to refine the scenario wording and concept definitions [20]. This step ensured that the combinations of attributes presented in the project scenarios were realistic and that the attributes presented to the final set of respondents were unambiguous and clear. In this step, we also ensured that completing the questionnaire did not cognitively strain the respondents. On average, the respondents were able to complete their assessment of the 16 project scenarios in under 15 minutes.

Following a fractional factorial design, we developed sixteen conjoint scenarios (nine factors with two levels per factor) based on the formula for minimum number of scenarios put forth by Curry [7] and given by $N_s = (N_f * N_l) - (N_f + 1)$, where N_s = number of scenarios, N_f represents the number of factors, and N_l the number of levels per factor. Based on this formula, for this study the minimum number of scenarios needed was 11 ($10 * 2 - 10 + 1$). Curry [7] recommends then multiplying this minimum number by a factor of about 1.5 to 2, leading to 16 scenarios in our case. The actual scenarios were generated using the conjoint algorithm implemented in SPSS 11.0 following this approach.

We chose two-level predictors with values of “high” and “low” for three reasons. First, few other studies have examined how the knowledge and relational attributes of e-business projects shape managers’ perceptions of their attractiveness, and our primary goal was to determine the *existence* and *relative strengths* of those relationships. Second, given the tradeoff between the number of cues, cue-levels, and scenarios, use of two-level manipulations reduced the length of the survey to sixteen project scenarios per respondent. Third, two level manipulations reduced the cognitive burden of simultaneously evaluating multiple factors presented in each scenario. We

measured project attractiveness in two ways to increase the robustness of the results, first by directly asking the respondents about the project’s attractiveness and second by asking them about how willing they would be to recommend funding each project. Managers indicated the perceived attractiveness and willingness to fund each of the 16 prospective projects on a nine-point scale with end-point anchors “very attractive” to “very unattractive” based on the cues presented in each of the 16 project scenarios.

2) *Data Collection*: The e-business incubation center of the large US shipping and logistics conglomerate served as the access point for data collection. We obtained contact information for 52 e-business practice managers who were actively involved in making investment decisions for their firms. All of the firms in our sample partnered with this conglomerate in exploring e-business opportunities. Our key informants therefore meet the criteria of being knowledgeable about the context under study, which also mirrors a context that they personally experience [17]. We solicited participation of these managers via e-mail and provided each manager a personalized link to the web-based survey instrument. The instrument contained the instructions, definitions and explanations of the various attributes used in the scenarios, followed by the 16 e-business project scenarios. Each scenario had different combinations of project attributes, and each respondent assessed the dependent variables for each scenario. We received 36 usable sets of responses, each with 16 scenarios, for a response rate of about 71%. Our responding sample represented an expansive variety of e-business projects and managers in 29 different firms. In this sample, we had seven managers from various lines of business in the focal firm, two from another firm, and 27 managers from 27 other firms. Thus, we drew one manager from the majority of participating firms, ensuring sufficient generalizability of the results. The attribute levels for each of the 16 scenarios and a sample scenario are presented in the Appendix. The total usable number of projects evaluated was 485, which is the effective sample size for our analysis. On average, each respondent had previously evaluated 13 e-business projects (s.d. 21) and had about four years of e-business experience (s.d. 3.6 years).

IV. RESULTS

In conjoint analysis, the direction of the relationship between each independent variable and the dependent variable is indicated by its regression coefficient. Its statistical significance is indicated by its corresponding T-statistic. These significance tests are complemented by Hays’ [24] ω^2 (Omega-squared) that reflects the variance explained by each attribute and is used to assess the *relative importance* of each attribute ([33, p. 67]).³ Thus, beta values indicate the direction and ω^2 indicates the relative importance of each independent variable in the model.

³Hay’s [24] Omega-squared (ω^2) was calculated to assess the contribution of each independent variable and control variable to the explanatory power of the model. ω^2 serves as a measure of the proportion of variance in the dependent variable that is explained by the variation in each independent variable. The ω^2 values associated with each of the hypothesized factors for project attractiveness are shown in Table I. The results indicate the proportion of variance in the dependent variable that is explained by each project attribute.

TABLE I
RESULTS

Model Variables	Expected Direction	Project Attractiveness				Project Funding			
		Standardized Beta Coefficient (T-value)	p value	Omega squared (ω^2)	Relative Importance	Standardized Beta Coefficient (T-value)	p value	Omega squared (ω^2)	Relative Importance
Knowledge creation (H1)	+	0.137*** (3.24)	.001	0.019	4	0.13** (3.03)	.004	0.017	4
Knowledge exploitation (H2)	+	0.86* (2.04)	.041	0.008	7	0.06 (1.41)	.149	—	—
Knowledge digitization (H3)	+	0.122** (2.89)	.004	0.015	5	0.105** (2.46)	.018	0.011	6
Knowledge integration (H4)	+	0.120** (2.85)	.005	0.012	6	0.107** (2.50)	.026	0.010	7
Knowledge sharing (H5)	+	0.065 (1.54)	.124	—	—	0.08 (1.88)	.087	—	—
Knowledge appropriation (H6)	+	0.153*** (3.62)	.000	0.022	3	0.144*** (3.36)	.002	0.020	2
Knowledge gaps (H7)	-	-0.185*** (4.40)	.000	0.032	1	-0.180*** (4.19)	.000	0.030	1
Customer Ties (H8)	+	0.172*** (4.08)	.000	0.028	2	0.116** (2.70)	.012	0.013	5
Customer Trust (H9)	+	0.130** (3.10)	.002	0.015	5	0.145*** (3.38)	.002	0.019	3
Control variables									
Tenure in firm	-	-0.071 (-1.13)		—		-0.09 (-1.55)	.121	—	
E-business experience	+	0.25*** (3.41)		0.034		0.307*** (4.14)	.000	0.038	
Number of e-business projects previously evaluated	-	-0.369*** (-6.31)		0.055		-0.428*** (-7.19)	.000	0.071	
Confidence in evaluations	+	0.107* (2.25)		0.015		-0.01 (-0.23)	.821	—	
Adjusted R²		23.9%				21.7%			

***p ≤ 0.001; **p ≤ 0.01; *p ≤ 0.05
2-tailed T-tests were used.
N = 485 e-business project assessments.

TABLE II
SUPERATTRIBUTE ANALYSIS FOR KNOWLEDGE AND RELATIONAL SUPERATTRIBUTES

Model Superattribute	Project Attractiveness			Project Funding		
	Standardized Beta Coefficient (t-value)	p value	Omega squared (ω^2)	Standardized Beta Coefficient (t-value)	p value	Omega squared (ω^2)
KNOWLEDGE _{superattribute}	0.323*** (7.40)	.000	.104	0.300*** (6.77)	.000	.090
RELATIONAL _{superattribute}	0.204*** (4.68)	.000	.042	0.178*** (4.01)	.000	.032
Control variables						
Tenure in firm	-0.071 (-1.13)	.257	—	-0.10 (-1.56)	.119	—
E-business experience	0.25*** (3.42)	.001	.034	0.307*** (4.16)	.000	.038
Number of e-business projects previously evaluated	-0.369*** (-6.32)	.000	.055	-0.428*** (-7.23)	.000	.071
Confidence in evaluations	0.107* (2.25)	.025	.015	-0.01 (-0.23)	.820	—

***p ≤ 0.001; **p ≤ 0.01; *p ≤ 0.05
2-tailed T-tests were used.

Table I summarizes the regression coefficients for each factor, its statistical significance, and its relative importance measure ω^2 for each of the two dependent variables. The relative importance of each predictor variable is also summarized for both dependent variables in Table I (and discussed in the next section). As expected, the results are consistent with the hypotheses across both dependent variables, although with two exceptions: knowledge sharing was not significant in both models and neither was knowledge exploitation in the project funding model, though it was significant in the project attractiveness model. Although the hypotheses are unidirectional, more conservative two-tailed T-tests were used to assess statistical significance.

The results indicate that managers ascribe the highest weights to knowledge creation, knowledge appropriation, the existing level of knowledge relative to the new opportunity (knowledge gaps), customer ties, and customer trust (H1 and H6–H9) in

assessing *both* dependent variables. Other factors that were also significant for evaluating relative project attractiveness were knowledge exploitation (H2), knowledge digitization (H3), and knowledge integration (H4), while knowledge sharing (H5) was not significant. When funding was used as the dependent variable, knowledge digitization (H3) was significant, whereas knowledge exploitation and knowledge sharing was not significant. The relative importance of each variable is discussed in the next section.

To test Hypothesis 10, which predicted that knowledge factors weigh more heavily in managerial assessments than relational factors, we conducted superattribute analyses to assess how the composite knowledge and relational factors based on the knowledge and relational theories influenced managerial assessments. *Superattributes* are composed of multiple attributes in a conjoint design and partially address the robustness

of the conjoint model [20]. The objective was twofold: 1) to assess the robustness of the results and 2) to assess the model at the broader theory-base level rather than at the individual theoretically derived attribute level. Following the approach recommended by Hair *et al.* ([20, p. 576]), we next created two superattributes. The two superattributes were created by computing separate composite variable scores for all knowledge and both relational project attributes. These were based on the two theoretical categories of e-business project attributes *vis-à-vis* KNOWLEDGE_{superattribute} and RELATIONAL_{superattribute} superattributes. We repeated the analyzes by substituting the two superattributes in the regression equation, the results of which are summarized in Table II. The results suggest that both knowledge considerations and relational considerations positively influence managers' assessments of the attractiveness of potential e-business projects. The superattribute analyzes are therefore highly consistent with the finer-grained analyzes presented in Table I. A comparison of the ω^2 values associated with KNOWLEDGE_{superattribute} and RELATIONAL_{superattribute} suggests that knowledge-based considerations weigh more heavily than relational considerations in managerial assessments of e-business investment opportunities, supporting Hypothesis 10.

V. DISCUSSION

The objective of this study was to understand the factors influencing managerial assessment of e-business project investment opportunities, particularly, in the theoretical context of the knowledge and relational theories of the firm. Our goal was to test whether managerial assessments of e-business investment opportunities are influenced by considerations of augmenting firm-level capabilities to develop and exploit knowledge and relational resources. We developed a model informed by the knowledge and relational theories of the firm and tested this model using data on 485 project evaluations collected from 36 managers responsible for e-business initiatives in 29 firms. Our results provide strong support for our overarching hypothesis that the ability of e-business project investments to enhance knowledge and relational capabilities enters the decision calculus of managers both in terms of perceived attractiveness and their intention to fund e-business projects. The results in Table II further suggest that managers place more weight on knowledge-augmenting capabilities relative to relational capabilities in their assessments. Overall, our findings suggest a strong correspondence between the prescriptions of these theories and observed managerial decision-making patterns.

The relative importance of each project characteristic in influencing the attractiveness and the likelihood of funding a project is indicated by its ω^2 value. Knowledge gaps—whether a firm has the knowledge necessary to accomplish the project—emerged as the most important factor in predicting its attractiveness to the firm. Thus managers are likely to view an e-business investment opportunity as being less attractive if they perceive that their organization lacks the necessary

expertise to successfully accomplish the project. The second most important factor in predicting project attractiveness was the ability of the project to strengthen ties with customers. This finding is consistent with the emerging relational view in which customers are seen as providing not only a stream of revenues but also ideas, expertise, and knowledge that the firm can incorporate in refining its product and service offerings [37], [60]. In a similar vein, strong ties with customers also lower the costs of acquiring valuable knowledge from them [22]. An example of this is Amazon.com, where the system allows customers to rate products, review products, as well as receive customized product recommendations based on their past purchasing patterns. The third most important driver was whether the investment will enhance the capacity of the firm to appropriate and safeguard its knowledge. Managers are thus acutely aware that e-business investments are vulnerable to imitation by competitors and hence appropriability of the investments through mechanisms such as patent protection are extremely important, although in practice it may be much harder to achieve. The fourth most important factor was whether the e-business project investment would enhance the knowledge creation ability of the firm. This finding is consistent with the knowledge-based theory of the firm that views knowledge creation as an important ingredient in the market performance of firms [39]. The next important predictor of managerial attractiveness was whether the e-business investment would enhance customer trust. Although technology-mediated trust ranks lower than other factors in the model, it allows firms to enjoy substantial price premiums and competitive advantage relative to other firms with customers [2]. Related knowledge capabilities were also significant in influencing managerial assessments. In their order of importance, these were knowledge digitization, or the ability of the firm to embed knowledge in software and, thus, enhance its ability to consistently apply it to business processes; knowledge integration, through which distributed knowledge is brought to bear on organizational activities; and knowledge exploitation.

A single exception to our expectations about the underlying knowledge considerations that drive e-business opportunity assessment was that managers did not seem to consider as critical the ability of an e-business project to increase the firm's knowledge sharing ability. A plausible explanation for this is that several organizational factors, such as incentives for sharing and an organizational culture that promotes sharing, need to be in place before e-business systems can effect change. It is likely that managers, perceiving the underlying organizational dynamics, did not weigh this factor heavily during e-business project selection. Alternatively, other internal knowledge sharing systems such as e-mail and discussion databases (e.g., Lotus Notes) may already be available in other information systems, and therefore knowledge sharing capability was not regarded as a strategic consideration in e-business systems. The pattern of results is similar when product funding is used as a dependent variable, with the exception of knowledge exploitation, which does not appear to influence the likelihood that managers will actually

fund the project. An interpretation for this difference is that managers might be inclined to weigh only the factors that are more readily measured and thus not consider knowledge exploitation in their funding decisions because of the difficulty in observing and measuring knowledge exploitation.

A. Contributions to Research

The key research objective of the study was to assess the extent to which practicing managers considered the theoretical factors suggested by the knowledge and relational theories of the firm in their assessment of e-business projects. The theory section of the paper argued the important factors associated with these two theoretical bases and hypothesized that these considerations would implicitly enter the managerial calculus in evaluating potential opportunities. The results from our study show that: 1) managers go beyond simple cost-benefit analyses in considering how IT investments enhance firm-level capabilities [3], [34], [44], [64] and 2) while both knowledge considerations and relational considerations positively influence managers' assessments of the attractiveness of potential e-business projects, we find that managers ascribe more weight to knowledge-based attributes than relational attributes.

With growing academic interest in the knowledge and relational theories of the firm, and the simultaneous recognition that e-business investments can significantly contribute to developing knowledge and relational assets for the firm, this exploratory study has sought to bring to the forefront factors that should be important to executives as they make these types of evaluations. Our study, thus, serves to integrate the theoretical perspectives offered by knowledge and relational considerations and an examination of how these factors implicitly guide investment choices in e-business projects.

B. Limitations

The study suffers from some of the inherent limitations of the conjoint analysis technique. One such limitation is the use of hypothetical scenarios for project selection, rather than evaluations of actual e-business project opportunities. Furthermore, an orthogonal cue set has the potential to generate spurious scenarios (i.e., one that simply does not exist in the evaluator's experience). However, our pretests indicated that all scenarios used in the study were realistic. Since our respondent pool was drawn from a single large conglomerate's business partners, caution should be observed in broadly generalizing the findings. Although the respondents belonged to a variety of different firms that partnered with the conglomerate, their association with a powerful focal business partner might introduce bias. Finally, our study relied on a restricted set of project attributes that were drawn from existing theory. Future work should consider other

criteria (including simultaneous consideration of cost and efficiency considerations) that might influence managers' assessments of e-business project opportunities.

C. Directions for Future Research

Three avenues for future research present fertile ground for extending this study's findings. First, this study offers some exploratory insights into the decisional factors that affect managerial choice of e-business projects. Additional research employing qualitative research methods would be useful to glean the mental representations executives actually use in evaluating e-business technology opportunities. Simultaneous inclusion of both traditional benefits (such as cost and efficiency) and intangible benefits (such as those examined here) can, in future work, allow assessment of the relative emphasis that managers place on them. Another avenue for future research is to examine the validity of the study's findings across other emerging technology contexts besides Internet technologies. With the rapid shifts in the information technology landscapes, it is imperative to examine if the knowledge and relational considerations examined in this study also play a role in other emerging technological contexts. The phenomenon of how managers make judgments about other types of emerging technologies remains an important but highly understudied area of research. Finally, real-options theory can be used as a powerful lens to examine whether managers view investments in emerging information technologies from a knowledge and relational perspective as creating future strategic and operational options for their firms [14].

VI. CONCLUSION

As emerging e-business technologies provide new avenues for innovation, placing the right bets on projects that compete for limited firm resources is a key strategic consideration. On one hand, managers trained in traditional ROI assessment approaches risk being too conservative in charting the future of their firm's course, and, on the other hand, applying untested normative prescriptions can create a dangerous illusion of optimism. This study tested the theoretical perspectives of the knowledge and relational theories of the firm that propose that firms increasingly consider the potential for developing their knowledge and relational asset portfolios through investments in emerging e-business project opportunities. The results offer new insights about the relative importance that managers ascribe to an e-business project's contribution to their firm's capabilities for creating, sharing, integrating, appropriating, digitizing, and exploiting its knowledge resources and relational assets. This work is a stepping stone toward understanding firm-level assessments of emerging e-business technologies over their yet-unfolding course of evolution.

APPENDIX

Attributes, levels, and definitions

E-business Project Attributes	Levels	Definition
Knowledge creation	Low/High	The e-business system provides capabilities to create new knowledge such as improved customer knowledge and supplier knowledge.
Knowledge exploitation	Low/High	The e-business system provides capabilities to exploit existing knowledge such as ability to customized product offers for customers.
Knowledge digitization	Low/High	The e-business system provides capabilities to capture the firm's decision rules or business practices in the software such as firm-specific scheduling algorithms.
Knowledge integration	Low/High	The e-business system provides capabilities to integrate knowledge from different sources such as knowledge about competitor's offers with firm's product offerings.
Knowledge sharing	Low/High	The e-business system provides capabilities for sharing knowledge across departments within the firm and with business partners, suppliers, and customers.
Knowledge appropriation	Low/High	The e-business system can be patented.
Knowledge gaps	Low/High	Developing the e-business system requires technical and business skills that are not readily available within the firm.
Customer Ties	Low/High	The e-business system provides capabilities to enhance the number and quality of interactions with customers such as well-designed customer interfaces.
Customer Trust	Low/High	The e-business system provides capabilities to enhance customer trust in the firm.

E-business Project Attribute Levels for the 16 Scenarios

E-business Scenario	Knowledge creation	Knowledge exploitation	Knowledge digitization	Knowledge integration	Knowledge sharing	Knowledge appropriation	Knowledge gaps	Customer Ties	Customer Trust
1	High	High	High	Low	Low	High	High	Low	Low
2	High	High	Low	High	Low	Low	High	High	Low
3	High	High	High	Low	High	High	Low	High	Low
4	Low	High	High	Low	High	Low	High	High	High
5	Low	Low	Low	Low	High	Low	High	High	Low
6	High	Low	Low	Low	High	High	Low	High	High
7	High	Low	High	High	High	Low	Low	Low	High
8	Low	High	Low	High	High	High	High	Low	High
9	High	Low	High	High	Low	Low	High	High	High
10	Low	Low	High	High	High	High	High	Low	Low
11	High	High	Low	High	High	Low	Low	Low	Low
12	Low	High	Low	High	Low	High	Low	High	High
13	High	Low	Low	Low	Low	High	High	Low	High
14	Low	Low	High	High	Low	High	Low	High	Low
15	Low	Low	Low	Low	Low	Low	Low	Low	Low
16	Low	High	High	Low	Low	Low	Low	Low	High

Sample Conjoint Scenario

The respondents were provided background information on the study and the definitions of each of the nine e-business project attributes. They were asked to respond to the survey keeping their own firm in mind. Then they were presented the sixteen scenarios such as the sample scenario in the table below. Each scenario had different combinations of project attribute levels. Based on the information provided in the scenario, they were asked to respond to the following two dependent variable assessments.

Sample E-business Project Scenario

The extent to which this project can enhance knowledge creation in the firm is	High
The extent to which this project can enhance knowledge exploitation in the firm is	High
The extent to which this project can enhance knowledge digitization in the firm is	High
The extent to which this project can enhance knowledge integration in the firm is	Low
The extent to which this project can enhance knowledge sharing in the firm is	Low
The extent to which this resulting system can be patented is	High
The extent to which completing this project requires new technical and business skills that are not readily available in the firm	High
The extent to which this project can improve the quality of interactions with customers is	Low
The extent to which this project can enhance knowledge creation in the firm is	Low

1. Please rate the attractiveness of this e-Business project to your firm.

Very Unattractive	1	2	3	4	5	6	7	8	9	Very Attractive
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2. What is the probability that you would recommend this project for immediate funding?

Low probability	1	2	3	4	5	6	7	8	9	High Probability
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