

# MODELS FOR MEASURING OF KNOWLEDGE MANAGEMENT AND E-BUSINESS SYSTEMS SUCCESS

## OTILIJA SEDLAK

ASSOCIATE PROFESSOR  
FACULTY OF ECONOMICS  
SUBOTICA, UNIVERSITY OF  
NOVI SAD  
SUBOTICA, SERBIA  
otilijas@ef.uns.ac.rs

## MARIJA ČILEG

FULL PROFESSOR  
FACULTY OF ECONOMICS  
SUBOTICA, UNIVERSITY OF  
NOVI SAD  
SUBOTICA, SERBIA  
mcileg@ef.uns.ac.rs

## TIBOR KIŠ

FULL PROFESSOR  
FACULTY OF ECONOMICS  
SUBOTICA, UNIVERSITY OF  
NOVI SAD  
SUBOTICA, SERBIA  
tkis@ef.uns.ac.rs

## IVANA ČIRIĆ

PHD STUDENT  
FACULTY OF ECONOMICS  
SUBOTICA, UNIVERSITY OF  
NOVI SAD  
SUBOTICA, SERBIA  
czoran@ef.uns.ac.rs

## ABSTRACT

The resulting model of the measurement of knowledge management system success is used to classify the abundant variables described in a large number of empirical studies and comprises six components. On the basis of some resources and on the basis of this literature review, the DeLone/McLean model for information system (IS) success measurement is selected and discussed. We also give a figure to show that the six categories are interrelated and describe a process view of knowledge management success, a series of constructs which include temporal and casual influences in determining success. The clear structuring of the measures and especially the interrelationships hypothesized in DeLone/McLean model have been subject to repeated criticism. Finally some critics are reviewed and developed of extensions to this model. We have extended the original DeLone/McLean model, respecified parts of the interrelationships, and even presented alternative models that follow an entirely different logic. The new model allows for a much more comprehensive analysis of independent factors influencing knowledge management system success and takes into account most of critique directed at the original DeLone/McLean model.

**KEYWORDS:** Knowledge Managemet, Quality, Competences, e-economy

## 1. INTRODUCTION

Skepticism about the value of e-business and information technology (IT) has been renewed recently, in part due to the gap between substantial firm spending on IT-particularly on Internet-related technologies-and the widespread perception about the lack of value of value from e-business.

Today more than ever, IS research face strong pressure to answer the question of whether and how e-business investments create business value. Although innovation diffusion represents a complex process, much of the existing research has focused on the adoption decision and on measures such as "intent to adopt" and "adopting versus nonadoption" (Fichman 2000). We need to view e-business diffusion as a multistage process that starts at adoption and extends to usage and value creation.

There is a lack of empirical evidence to gauge e-business usage and its impact on firm performance, partly because of the difficulty of developing measures and collecting data. A related issue is the lack of theory to guide empirical research. Although showing recent signs of advancement,

the linkage between theory and measures is still weak in the e-business literature. Clearly, there is a need for a theoretically rigorous and empirically relevant framework for examining the use and value of e-business in organizations.

Prior research argued that theories developed in the context of mature markets and industrialized economics need to be reexamined in the context of developing countries, because these countries may have very different economic and regulatory environments challenges the presumption of conceptual equivalence across cultural and economic barriers in management science research. We believe it is important to investigate whether innovation theories can be generalized and empirical findings are applicable in different economic contexts. To achieve this, we study e-business experience of organizations in developed and developing countries that might represent different stages of e-business transformation, for results in Vojvodina.

The gaps in the literature limit our understanding of the process of e-business innovation and consequently of e-business value. Key research questions that motivated our work are: (1) What framework can be used as a theoretical

basis for studying e-business use and value? (2) Within this theoretical framework, what factors can be identified as key antecedents of e-business use and value? (3) How would these factors vary across different economic environments like Vojvodina?

To better understand these issues, we developed a conceptual model for e-business use based on the technology-organization-environment (TOE) framework (Tornatzky and Fleischer 1990). We also analyzed e-business value creation, from a resource-based perspective, that stems from the unique characteristics of the Internet.

A host of variables, indicators and measures to assess the success of an IS:

- user (information) satisfaction of system acceptance,
- user engagement, user participation or user involvement,
- (perceived) information quality or system quality,
- perceived service quality: user satisfaction,
- usage of IS, usage to support specific tasks,
- task-technology fit,
- success of specialized IS: impact on individual, group or organizational performance, such as decision support systems, group (decision) support systems and group communication support systems, office systems, Creativity Support Systems, computer-mediated communication or End-User Computing.

DeLone and McLean went to the trouble of a comprehensive analysis of all the different streams of research about IS success and proposed an integrated model for information system success. This model is one of the most cited and empirically tested frameworks of IS success, in spite of many respectifications and extensions mostly in its original form, probably due to the fact that it is comparably well-defined, theoretically founded and yet simple and easily tailored to specific situations.

## 2. E-BUSINESS AND KNOWLEDGE MANAGEMENT

A theoretical model for e-business use needs to take into account factors that affect the propensity to use e-business, which is rooted in the specific technological, organizational, and environmental circumstances of an organization. The TOE framework identifies three aspects of a firm's context that influence the process by which it adopts, implements, and uses technological innovations: (a) *Technological context* describes both the existing technologies in use and new technologies relevant to the firm. (b) *Organizational context* refers to descriptive measures about the organization such as scope, size, and the amount of slack resources available internally. (c) *Environmental context* is the arena in which a firm conduct its business-its industry, competitors, and dealings with government.

There are three types of innovations: Type I innovations are technical innovations restricted to the IS functional

tasks (such as relational databases, CASE); Type II innovations apply IS to support administrative tasks of the business (such as financial, accounting, and payroll systems); and Type III innovations integrate IS with the core business where the whole business is potentially affected and the innovation may have strategic relevance to the firm. We consider e-business a Type III innovation, in the sense that e-business is often embedded in a firm's core business processes (e.g., making use of the open standard of the Internet protocol to streamline information sharing among various functional departments); e-business can extend basic business products and services (e.g., leveraging Internet-enabled two-way connectivity to offer real-time customer service); and e-business can streamline the integration with suppliers and customers.

E-business is a new Type III innovation and warrants investigation along with these innovations. In particular, the migration toward the Internet and the transformation of traditional processes require firms and their subunits to orchestrate the coevolutionary changes to their technologies in use, business processes, and value chain structures to successfully assimilate the Internet technologies into their e-business initiatives.

The TOE framework is appropriate for studying e-business usage. Based on the TOE framework, the use of e-business in organizations will be influenced by three types of antecedents: *technological* factors, *organizational* factors, and *environmental* factors.

The Internet is characterized by *open standard* (versus proprietary standard), *public network* (versus private network), and *broad connectivity* (back end and front end). These characteristics may have very different impacts on customer reach and richness of information. The global reach of the Internet enables cost-efficient means of reaching out to new markets, attracting new customers, and delivering products and services, as well as improving coordination with suppliers and business partners.

### 2.2. E-Business Value and the Resource-Based Theory

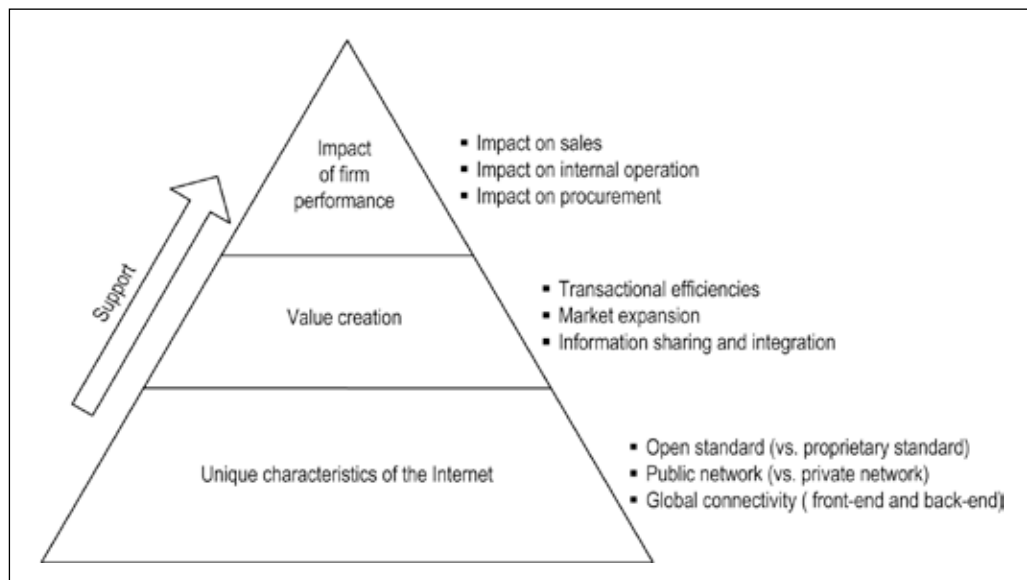
The resource based view (RBV) provides a theoretical basis for linking e-business use and value. Rooted in the strategic management literature, the RBV of the firm posits that firms create value by combining heterogeneous resources that are economically valuable, difficult to imitate, or imperfectly mobile across firms.

The value hierarchy depicts the unique characteristics of the Internet and how these characteristics enable value creation via e-business. In contrast to e-business, less connectivity, and a private network configuration – creates business value mainly through improving transactional efficiencies and reducing costs in procurement (Figure 1).

We examined the unique characteristics of the Internet and linked them in three ways through which e-business may create value-transactional efficiencies, market expansion, and information sharing. Combining them with the RBV, we developed an e-business value hierarchy, as shown in Figure 1. Open-standard information exchange can result in a more synchronized information flow will make mate-

rials move efficiently along the supply chain, thereby reducing the bullwhip effect. Such e-business value may lead to improved firm performance in sales, procurement, and internal operations, as shown in the top layer of the value hierarchy in Figure 1.

**Figure 1.** E-Business Value Hierarchy



### 3. BASIC ELEMENTS FOR DIFFUSION OF E-BUSINESS

**Technology Context.** The literature suggests that IS capabilities consist of infrastructure, human resources, and knowledge. Firms with a higher degree of technology competence tend to enjoy greater readiness to use e-business in their value chain processes. As a result, they would be more likely to achieve a greater extent of e-business usage. This leads to the following hypothesis.

*H1. Firms with greater technology competence are more likely to achieve a greater extent of e-business use.*

**Organization Context.** Firm size is commonly cited in innovation diffusion literature, yet different opinions exist as to the role that firm size plays in the process of innovation diffusion, due to the tension between resource availability and organizational inertia. On one hand, large firms generally possess slack resources that can facilitate implementation and usage. On the other hand, firm size is often associated with inertia; that is, large firms tend to be less agile and flexible than small firms. The possible structural inertia associated with large firms may slow down organizational usage and may therefore retard e-business value creation. Because our model has controlled for technological and financial resources that large firms may possess, the notion of structural inertia leads us to expect that large firm size may deter e-business usage and value

creation. This leads to the following hypothesis.

*H2. Controlling for resource availability effects, larger firms tend to achieve a lesser extent of e-business use.*

Firms conducting business in multiple markets have to manage demand uncertainty in all segments simultaneously, which requires a high degree of integration, flexibility and responsiveness in their information systems, as well as the broader information infrastructure linking the firm with its customers, trading partners, and distributors. As documented in the literature and consistent with our value hierarchy in Figure 1, e-business may help to create these capabilities within the firm and with its trading partners as a result of common standards, lower cost, and greater ease of implementation of Internet-based applications. In sum, retail companies that expand globally would have a greater incentive to use e-business to leverage their existing IT capabilities for a competitive advantage. This leads to the following hypothesis.

*H3. Firms with greater international scope are more likely to achieve a greater extent of e-business use.*

Financial resources constitute another important factor recognized in the innovation literature. In this study, we tailor this factor to financial resources specially committed to e-business. Implementing e-business requires investment in hardware, software, system integration, and employee training. Sufficient financial resources dedicated to e-business helps companies to obtain these necessary resources and develop them into superior e-business functionalities. Thus, firms



with greater financial commitment are more likely to achieve successful e-business implementation and thus tend to achieve a greater extent of usage. Hence, we have the following hypothesis.

*H4. Firms with greater financial commitment are more likely to achieve a greater extent of e-business use.*

**Environment Context.** Competitive pressure refers to the degree of pressure that the company feels from competitors within the industry. The use of e-business may induce changes of industry structure through disintermediation and reintermediation, offer new means of competing and altering competition rules through lock-in, electronic integration, and brick-and-click synergy. Thus, competitive pressure plays a significant role in pushing firms toward using e-business.

*H5. Firms facing higher competitive pressure are more likely to achieve a greater extent of e-business use.*

Regulatory support is another critical environmental factor that tends to affect innovation diffusion. This concept is similar to government policy theorized to affect IT diffusion in Umanath and Campbell (1994) and empirically tested in Dasgupta et al. (1999). The latter found that companies operating in an environment where government policies are restrictive have low IT adoption.

*H6. Firms facing higher regulatory support are more likely to achieve a greater extent of e-business use.*

**Linkage from E-Business Use to E-Business Value.** We draw on the RBV to explain the connection between usage and value. RBV suggests that the greater the extent of IT use, the greater the likelihood that organizations will create IT capabilities that are rare, inimitable, valuable, and sustainable, thereby contributing to value creation (along with organizational compliments). Through deeper usage in organizations, IT creates asset specificity, which provides a competitive advantage. A classic model for general IS success developed by DeLone and McLean (1992) suggested that there tends to be a strong link between system use and system impact.

*H7. Firms with greater e-business use are more likely to generate higher e-business value.*

**E-Business Value.** The ultimate goal of using e-business is to improve the business performance of the organization. As shown in the value hierarchy of Figure 1, e-business helps companies develop appropriate functionalities to leverage the Internet's characteristics. E-business functionalities are categorized into two groups: front-end functionality and back-end integration. Back-end integration helps firms achieve technology integration and enables information sharing within the firm and along the value chain. Thus, one would expect that superior front-end functionality

and back-end integration help firms improve business performance. This leads to the following hypothesis.

*H8. Greater e-business capabilities, including both front-end functionality and back-end integration, are positively associated with higher e-business value.*

Although both have the potential to create e-business value, front-end functionality and back-end integration may vary in importance, as suggested by the resource-based theory. Front-end functionality is public and open on the Internet, and thus could be easily observed and imitated by competitors. As a result, front-end functionality could become commodity-like as more competitors adopt e-business. In comparison, the process of back-end integration is far more difficult to imitate, because its success requires quality complementary resources. In addition, the integration process is often tailored to a firm's strategic context and woven into the organization's fabric, which is not transparent to competitors. Therefore, we propose the following hypothesis.

*H9. Back-end integration will have a stronger impact on e-business value than front-end functionality.*

**International Effects: Differences between Developed and Developing Countries.** Given that the Internet is an open platform with global connectivity, we believe it is important to incorporate an international dimension in this study.

*H10. The strength of the antecedents of e-business use and value will differ for developed and developing countries.*

## 4. MEASUREMENT MODEL

The development of the measurement model included successive stages of theoretical modeling, statistical testing, and refinement (Straub 1989). Measurement items were developed on the basis of a comprehensive review of the literature as well as expert opinion. We then tested multi-indicator constructs using confirmatory factor analysis (CFA)<sup>1</sup>. Based on the assessment of CFA, the measurement model was further refined and then fitted again.

Several constructs deserve further explanation. First, technology competence is instrumented not only by physical technologies, but also by IT human resources that possess the knowledge and skills to implement e-business. Such a design is consistent with the theoretical rationale discussed. Our study used the major items in the first three dimensions to instrument front-end functionality, and the fourth dimension corresponded to our back-end integration.

<sup>1</sup>For the purpose of testing the robustness of our measurement model, we also ran exploratory factor analysis on all indicators. Principal component analysis with equamax rotation yielded a consistent grouping with CFA.

**Table 1:** Measurement Model: Factor Loadings, Reliability, and Convergent Validity

Measurement Model: Factor Loadings, Reliability, and Convergent Validity			
Constructs (reliability)	Indicators	Loadings	Convergent validity (t-start)
Technology competence (0.81)	TC1	0.79***	46.76
	TC2	0.79***	37.10
	TC3	0.71***	24.90
International scope (0.81)	FS1	0.64***	36.65
	FS2	0.86***	160.80
	FS3	0.78***	52.66
Financial commitment to e-business (0.83)	FR1	0.86***	29.07
	FR2	0.82***	15.84
Competitive pressure (0.86)	CP1	0.87***	74.04
	CP2	0.87***	73.89
Regulatory support (0,80)	RE1	0.68***	21.30
	RE2	0.69***	24.87
	RE3	0.71***	22.91
	RE4	0.74***	30.76
Back-end integration (0.86)	BI1	0.87***	80.53
	BI2	0.86***	79.54
E-business use (0.78)	EU1	0.64***	18.44
	EU2	0.50***	6.67
	EU3	0.46***	4.85
	EU4	0.83***	35.95
	EU5	0.75***	13.55
Front-end functionality (0.80)	FF1	0.63***	15.92
	FF2	0.65***	25.76
	FF3	0.67***	26.00
	FF4	0.72***	24.31
	FF5	0.68***	20.46
Impact on sales (0.88)	IS1	0.86***	76.46
	IS2	0.84***	51.62
	IS3	0.81***	41.92
Impact on internal operations (0.90)	IIO1	0.89***	81.85
	IIO2	0.91***	123.42
Impact on procurement (0.87)	IP1	0.85***	50.11
	IP2	0.85***	74.50
	IP3	0.79***	37.90
* $p < 0.10$ ; ** $p < 0.05$ ; *** $p < 0.01$ . Insignificant factors are dropped (FS4 and FS5).			

To empirically assess the constructs theorized above, we conducted CFA using structural equation modeling. We assessed construct reliability, convergent validity, discriminant validity, and validity of the second-order construct. The measurement properties are reported in Table 1.

(1) *Construct Reliability*: Construct reliability measures the degree to which items are free from random error and therefore yield consistent results. In our measurement model (Table 1), all constructs have a composite reliability over the cutoff of 0.70, as suggested by Straub (1989).

(2) *Convergent Validity and Discriminant Validity*: Convergent validity assesses the consistency across multiple operation. As shown in Table 1, all estimated standard loadings are significant ( $p < 0.01$ ), suggesting good convergent validity. To assess the discriminant validity-the extent to which different constructs diverge from one another-we used Fornell and Larcker's (1981) criteria: average variance extracted for each construct should be greater than the squared correlation between constructs.

**Table 2:** Measurement Model: Second-Order Construct

Table 2 Measurement Model: Second-Order Construct				
Second-order construct	First-order construct	Loading	t-stat	Composite reliability
E-business value	Impact on sales	0.865***	77.68	0.88
	Impact on internal operation	0.805***	44.08	
	Impact on procurement	0.844***	55.52	
* p < 0.10; ** p < 0.05; *** p < 0.01				

(3)*Validity of the Second-Order Construct:* Table 2 shows the estimation of the second-order construct, e-business value. The paths from the second-order construct to the three first-order factors are significant and of high magnitude, greater than the suggested cutoff of 0.7. Our model has a very high T ratio of 0.99, implying that the relationship among first-order constructs is sufficiently captured by the second-order construct. Therefore, on both theoretical and empirical grounds, the conceptualization of e-business value as a higher-order, multidimensional construct seems justified. In summary, our measurement model satisfies various reliability and validity criteria. Thus, constructs developed by this measurement model could be used to test the conceptual model and the associated hypotheses proposed earlier.

Empirical tests are on the Integrated Model of E-Business Use and Value.

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## 5. ANALYSIS AND INTERPRETATIONS

We tested the conceptual model by structural equation modeling using both the full sample and the sample split between developed and developing countries. Although theory and prior research led us to expect differences, we did not know a priori that there would be differences between the full and split samples; therefore, we needed to do the analysis for both. It also enabled us to relate our finding to the broader IT literature.

The strong statistical power enhanced our confidence in the result of hypotheses testing, which is based on the examination of the standardized paths shown in Figure 2. For e-business use, five of six TOE factors-technology competence, size, financial commitment, competitive pressure, and regulatory support- have significant paths leading to the dependent construct. Size has a negative path, while the other factors have positive paths. The path associated with international scope is positive but statistically insignificant ( $p > 0.10$ ).

E-business value is also shown to have significantly positive associations with front-end functionality and back-end integration. Hence, Hypothesis 8 is supported. To test hypothesis 9, we compared the standardized path from front-end functionality to e-business value with standardized path from back-end integration to e-business value. Back-end integration is found to have much higher magnitude than front-end functionality (0.239\*\*\* versus 0.141\*\*\*). Thus, Hypothesis

9 is supported.

*Within the TOE framework, technology competence, financial commitment, competitive pressure, and regulatory support are found to have significant influence on the extent of e-business use. Among these, technology competence appears to be strongest factor.*

As indicated by their significant and positive paths in Figure 2, firms with higher levels of technology competence tend to achieve greater extent of e-business use, as do firms facing competitive pressure and regulatory support. Among all the TOE factors, technology competence is the most significant factor, as indicated by its path loadings and significance levels ( $p < 0.01$ ), followed by regulatory support. Within the organizational context, our study reveals a negative effect of firm size on e-business use. While it has been commonly believed that large firms have more slack resources for committing required investments, our results show that large firms are also burdened by structural inertia, possibly due to fragmented legacy systems and entrenched organizational structures. Our model has controlled for technological and financial resources, and thus the net effect of firm size in our model might be dominated by structure inertia. These results suggest that the proposed research model in Figure 2 is a useful theoretical framework for explaining factors that affect the use of e-business by companies.

*2. The linkage from e-business use to e-business value is found to be significant, suggesting that use would be a "missing link" if not included.*

As theorized earlier, firms with higher e-business use tend to achieve greater value from e-business use. Our results from both the full sample and the split sample consistently show a significant and positive linkage from e-business use to e-business value. This means that higher degrees of e-business use are associated with improved business performance. This also confirms the earlier postulation that actual use may be the "missing link" to IT payoff. This significant linkage also supports our research design, in which use and value are evaluated together in one model.

*3. Both front-end functionality and back-end integration contribute to value creation of e-business.*

Using a large dataset, our analysis has identified two ways in which e-business creates value-front-end functionality and back-end integration. This finding is supported by the significant and positive linkages from front-end functionality and back-end integration to e-business value. Front-end functionalities help firms provide timely information to customers, facilitate personalization and account management, expand existing channels, and improve transactional efficiencies; back-end integration enables technology integration within the organization and facilitates information sharing with suppliers and business partners. As a result, these two types of e-business capabilities help firms improve performance by affecting intermediate achievements such as customer intimacy in the front end and operational excellence in the back end; both are critical for firms to achieve performance improvement.

*4. The importance of two factors-competitive pressure and regulatory support-differs across developed versus developing countries. This finding confirms that economic environment shape e-business use.*

This result might be explained as follows. First, competitive pressure is statistically significant for developed but not for developing part of the country. Such a difference could be explained by the distinct market environments of developed and developing part of the country. Prior research has shown that information asymmetry exists in less-developed markets, and market imperfections and inefficiencies may weaken the pressure from competitors. In developed area of the country, however, markets have evolved into mature stages over time, characterized by more transparent information flow and more stable legal frameworks and government policies. Therefore, firms in developed countries can obtain more information about competitors, e-business development, which may force them to adopt e-business to avoid competitive decline. Second, although the path loadings of regulatory support appear to be significant in both subsamples, more sophisticated analysis (group analysis) reveals that it is relatively more important in developing countries. This

finding is related to the above discussion, that markets in most developing part of country are characterized by information asymmetry and immature institutional structure. As a result, government regulation (e.g., legal protection of online transactions), or the lack thereof, tends to be a greater force in developing countries. In light of these varying behaviors across the two subsamples, we have learned the significant role that economic environments play in shaping the extent of e-business use. This finding further confirms the usefulness of the proposed conceptual model for studying e-business, as economic environment is an important factor within the TOE framework.

These results have several important implications for management. First, they offer a useful framework for managers to assess the *technological* conditions under which e-business is launched to better pursue business value. It is important to build up technology competence includes tangible technologies, intangible managerial skills, and human resources. Further, IT managers have struggled for ways to create value from Internet technologies. Our study sheds light on ways to realize value from e-business-greater breadth and depth of use, customer-facing Web functionalities on the front end, and tight integration on the back end.

In particular, our empirical results highlight the importance of *back-end integration* among various back-office databases and enterprise systems, and information sharing with business partners. Our analysis has identified this as a major source of e-business value. It will become even more important as e-business develops into deeper stages, as suggested by the results that the significant of back-end integration is more pronounced in developed countries that seem to be at deeper stages of e-business development. These findings could serve as useful guidelines for firms to develop their e-business capabilities. This is especially important in the retail industry, where firms have been building various legacy systems and using multiple IT platform over the years.

Furthermore, managers need to assess the appropriateness of e-business to certain *organizational* characteristics (e.g., size scope), as suggested by our empirical findings. This implies that potential value of e-business investment could be affected by structural differences. Effective e-business programs rely on necessary organizational reconfiguration and business processes reengineering. As Internet technologies diffuse and become necessities, these organizational capabilities and structural differences will be even more critical. In particular, managers in retail firms with a wider scope should pursue e-business usage more proactively, given the greater potential to achieve benefits from e-business. This implication should be of special interest for retailers seeking global expansion into different regions and market segments. Such expansion means that retailers would face greater coordination tasks and could leverage e-business initiatives to facilitate coordination and achieve resource integration. Finally, our study also offers implications for *policy* makers. Regulatory support has emerged as an important factor for e-business use and value. This is even more important for de-



veloping countries. During our study, companies frequently cited significant obstacles to doing e-business, including inadequate legal protection for online transactions, unclear business laws, and security and privacy concerns. While this was important for all countries, it was a much more significant factor for developing countries. It also pointed to the need for establishing a broad legal and institutional framework that supports e-business. Governments, therefore, could accelerate the diffusion of e-business by establishing supportive business laws to make the Internet a trustworthy business platform (e.g., dealing with transaction fraud, promoting credit card use). This is particularly important at early stages of e-business development in an economy. Technological innovations are considered the primary driver of improvements in industrial productivity. Yet if promising innovations cannot be widely deployed, then the benefits resulting from their invention will be curtailed.

## 6. CONCLUSIONS

Grounded in the innovation diffusion literature and the resource-based theory, this study has theoretically developed and empirically evaluated an integrative research model in-

corporating technological, organizational, and environmental factors, for assessing e-business use and value at the firm level. While these issues were typically studied separately in the literature, our results suggest that usage and value are closely link, indicating that this unified perspective helps us gain a more holistic picture of the postadoption diffusion and consequence of e-business. To realize e-business value, firms need to facilitate the usage of e-business in various value chain activities.

For e-business use, our study has examined six factors, within the TOE framework, as drivers of e-business use. Some of these factors play different roles across different economic environments. This finding shows that, while e-business is a global phenomenon, its use is moderated by local environments. For e-business value, our study has demonstrated that the extent of e-business use and e-business capabilities, both front-end functionalities and back-end integration, contribute to value creation of e-business, but back-end integration has a much stronger impact.

In summary, this study has developed an integrative theoretical framework for assessing e-business use and value, beyond initial adoption.

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