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The Impacts of BTM Capability and CIO Role Effectiveness on Firms' Information Technology Assimilation: An Empirical Study

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THE IMPACTS OF BTM CAPABILITY AND CIO ROLE EFFECTIVENESS ON FIRMS' INFORMATION TECHNOLOGY ASSIMILATION: AN EMPIRICAL STUDY

Les impacts de la capacité à gérer les technologies d'affaires et de l'efficience du rôle du DSI sur l'assimilation des TI : une investigation empirique

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Abstract

This study presents a conceptual model to investigate the impacts of business technology management (BTM) capability and CIO role effectiveness on firms' information technology assimilation. A large-scale field survey was used as the methodology for this research. Global logistic enterprises of Taiwan and China were randomly selected for constituting a representative sample in this study. Using the partial least squares (PLS) method, the causal relationships among BTM capability, CIO role effectiveness, and firms' IT assimilation were verified. Also, the contribution of business technology and business management competencies on CIO role effectiveness was verified. The results of this study can provide practical implications for how firms can align, synchronize and converge IT and business management, thus ensuring better execution, risk control, and profitability.

Keywords: BTM capability, CIO role, IT assimilation

Résumé

Cette étude présente un modèle conceptuel visant à questionner les impacts de la capacité à gérer les technologies d'affaires et de l'efficience du rôle du DSI sur l'assimilation des technologies de l'information (TI) dans l'entreprise. Une investigation empirique à grande échelle a été mise en œuvre. Les résultats peuvent aider les firmes modernes à aligner, synchroniser, et faire converger les TI et la gestion de l'entreprise, assurant ainsi une meilleure exécution, un meilleur contrôle des risques, et une plus grande profitabilité des firmes modernes.

Introduction

Today, information and communication technologies (ICT) are ubiquitous and prevalent across the various functions and processes of contemporary business enterprises. The successful assimilation of information technology (IT) into business initiatives has been widely recognized to create business value, seed new market opportunities, facilitate

process innovation, and help shape the vision and strategy of business in order to gain competitive advantage (Wheeler 2002). Thus, understanding how to effectively strengthen business technology management (BTM) is a critical issue for top management teams (Hoque et al. 2006).

Since today's CIOs are accountable for envisioning, guiding, and implementing their firm's business and technology management practices, they are expected to effectively integrate IT functions and implement appropriate organizational structures, processes, and human skills to exploit IT as a strategic differentiator (Agarwal and Sambamurthy 2002). The effectiveness of senior IT executives may, thus, facilitate the BTM capabilities to shape and enable business goals. With the coming of the new Web-based era, the landscape of contemporary business contexts has been altered by significant transformations. There is an apparent need for studies that enhance our understanding of the multi-dimensional features of CIOs' roles and performance vis-à-vis firms' assimilation of IT. Researchers have made calls for more rigorous, theory-based empirical studies to advance our knowledge in the domain of CIO effectiveness (Karahanna and Watson 2006).

Since the title of the chief information officer (CIO) was initially coined, many issues regarding critical skills/knowledge (competencies), professional activities, and the roles of CIOs have been extensively discussed in IS literature (e.g., Chen and Preston 2007; Grover et al. 1993; Karimi et al. 1996; Karlsen et al. 2002; Ross and Feeny 2000). However, a comprehensive theoretical framework to explore and empirically examine these interrelated concepts is still lacking. What skills and/or knowledge are necessary for CIOs in today's business environment? How will such skills and knowledge help them effectively act as IT leaders in BTM practices? What will be the impact of BTM capability and CIO role effectiveness on firms' IT assimilation? Researchers have exerted relatively little theoretical effort on the development of causal relationships between CIOs' skills/knowledge and their role effectiveness. Systematic investigations of these relationships are also scarce. Reviews of IS literature reveal a lack of research that investigates how CIO role effectiveness will influence BTM capability. Also, few studies have addressed the emerging management concept of BTM capability and its impacts on firms' IT assimilation.

Attributing the inconclusiveness of this body of work to the separate nature of the discussions on BTM capability, CIOs' role effectiveness, and their required business technology and business management competencies, this study develops a theoretical framework and empirically examines the relationships among BTM capability, CIO role effectiveness and IT assimilation. Three questions form the focus of our inquiry: (1) How does BTM capability influence firms' ability to assimilate IT in their business strategies and value-chain activities? (2) How does CIO role effectiveness influence firms' BTM capability and the success in assimilating IT into their business strategies and value-chain activities? (3) What are the contributions of business technology and business management competencies toward improving CIO role effectiveness in modern firms? Utilizing data from a survey of CIOs and senior business executives in the global logistic firms of Taiwan and China, this study provides empirical grounding to these three questions.

Conceptual Development and Research Hypotheses

Several theoretical ideas underpin the conceptual development of a comprehensive framework of IT assimilation, BTM capability, and the investigation of the impact of business technology and business management competencies on CIO role effectiveness. First, drawing upon the theories of IT assimilation, the dimensions of successful assimilation of IT in supporting, shaping, and enabling firms' business strategies and value-chain activities are elucidated. Second, BTM, an emerging management science proposed by Hoque et al. (2006), serves as an initial foundation for examining the relationships among BTM capability and IT assimilation. Finally, the role-based performance theory proposed by Welbourne et al. (1998) and empowerment theory are used for developing a sound theoretical rationale for measuring CIO role effectiveness. These two theories also provide the support for investigating the influences of CIOs' ability to blend business and IT management skills/knowledge through their role effectiveness to influence BTM capability and IT assimilation.

Theories of IT Assimilation

In today's Web-based business environment, a majority of modern companies have renovated their value chain activities and business strategies through the successful exploitation of business technology, so it is critical for them to recognize what factors are likely to promote heightened levels of IT assimilation (Armstrong and Sambamurthy 1999). Assimilation is an important construct in the causal chain of influence from the organizational adoption of an

information technology to the evidence of its impacts on business performance (Bharadwaj 2000; Chatterjee et al. 2002; Jarvenpaa and lves 1991; Purvis et al. 2001).

Theories of IT assimilation have drawn attention to facilitate organizational use of innovative business technologies once they have been implemented in organizations. Fichman and Kemerer (1999) suggest that most information technologies exhibit an "assimilation gap" (Fichman 2001). Lessons learned from prior literature regarding the assimilation of emerging information technologies, such as enterprise systems (Liang et al. 2007), electronic procurement innovations (Rai et al. 2006), web technologies (Chatterjee et al. 2002), and knowledge platform (Purvis et al. 2001) could be extended toward understanding how firms promote the assimilation of information technologies in the Web-based era.

Armstrong and Sambamurthy (1999) defined IT assimilation as the extent to which IT has been infused into specific business activities as well as how effectively IT is enabling the conduct of those activities relative to rivals. One of the dimensions of IT assimilation is the use of IT in the value-chain activities. Another dimension of IT assimilation refers to its use in competitive strategies such as being a low-cost producer, having manufacturing and operations flexibility, enhancing supplier or customer linkages, and enhancing or creating new products and services (Armstrong and Sambamurthy 1999; Chatterjee et al. 2002; Purvis et al. 2001). Drawing upon the above discussion, we define IT assimilation as the effective application of IT in supporting, shaping, and enabling firms' business strategies and value-chain activities in this study.

Willcocks and Feeny (2006) provide a good example to elucidate our conceptual model, as shown in Figure 1. Their longitudinal case research into an IT outsourcing at DuPont indicates that for a larger organization, business maturity in managing IT is an evolutionary process (passing through delivery, reorientation, and reorganization phases). For firms to succeed in IT exploitation (i.e., IT assimilation in our study) at different phases, their CIOs must have different emphasis in roles (i.e., CIO role effectiveness) and must develop different sets of IS capability (i.e., part of our BTM capability). For instance, in their post-2000 case studies, they found that DuPont (innovation from delivery phase to reorientation phase) emphasized the importance of retaining IT leadership (i.e., CIO role effectiveness) as well as the related concepts of BTM capability, including governance, technical architecture planning, and other IS capabilities to manage external sourcing in organizations with large-scale outsourcing arrangements. In addition, they indicate that the leadership of IT function requires distinctive mixes of business and interpersonal as well as technical skills/knowledge (i.e., business management and business technology competencies) in nearly all prominent CIO roles.

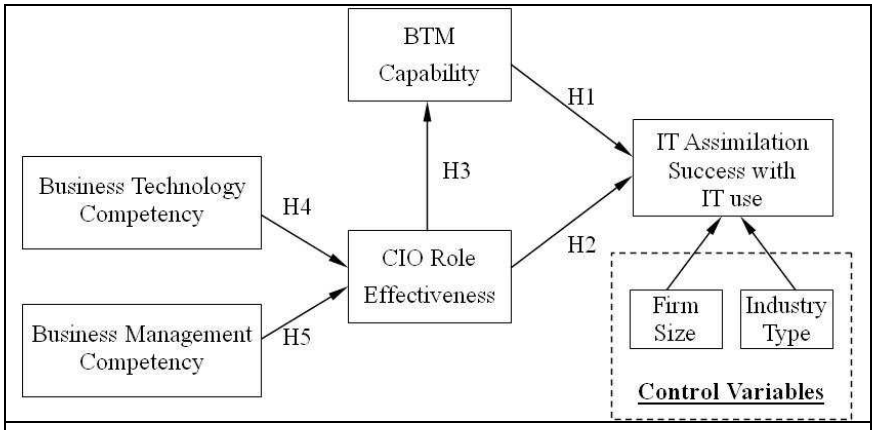

Figure 1. Conceptual model

Business Technology Management Capability

Willcocks and Feeny (2006) argued that "*a core IS capability is a capability needed to facilitate the exploitation of IT, measurable in terms of IT activities supported, and resulting business performance*" (p. 49). Hoque et al. (2006) proposed a capability framework of BTM to help firms effectively converge business and technology leadership, thus ensuring better execution, risk control, and profitability. Specifically, they argue that a BTM capability can be defined as firms' ability achieved by applying well-defined processes, appropriate organizational structures, information, and supporting technologies in one or more functional areas. The authors have listed 17 capabilities and

grouped them into four functional areas: governance and organization, managing technology investments, strategy and planning, and strategic enterprise architecture. As firms continue to seek strategic value from emerging technologies, they must specify the decision rights and accountability framework to encourage desirable behavior in the use of IT (Weill 2004; Weill and Ross 2004). Moreover, it is critical for firms to implement effective IT governance to support their strategies and institutionalize BTM practices effectively (Weill and Ross 2005; Weill and Vitale 2002; Willcocks et al. 2006). We anticipate that a firm with superior BTM capability would be more likely to successfully assimilate IT in supporting, shaping, and enabling its business strategies and value-chain activities. As a result, we proposed the following hypothesis:

H1: Higher levels of BTM capability will significantly enhance firms' IT assimilation.

CIO Role Effectiveness

Welbourne et al. (1998) argued that employee's performance evaluations should be associated with the salient role expectations in firms to determine which individual performance should be evaluated. By extending concepts from the role-based performance theory, Smaltz et al. (2006) argued that the measurement of CIO role performance should focus on the salient roles of CIOs and gauge the perceptual expectations of members in top management teams (TMT) regarding how well their CIOs perform those salient roles. They concluded that CIOs with superior business and strategic IT knowledge, interpersonal communication, and political savvy would perform better in their desired organizational roles.

CIOs should be good at prioritizing IT initiatives, building IT-driven business strategies and helping their business peers to supervise IT investments, prioritize business needs, and ensure effective use of critical IT assets (Weill and Ross and 2004; Weill 2004). They have to inform their business counterparts about potential opportunities for emerging IT applications, persuade them to provide business championship, and negotiate resources for IT initiatives (Smaltz et al. 2006). The effectiveness of CIOs in modern firms may play an important role in influencing the firms' success with IT use. Rapid evolution of IT-business partnerships, innovative business models, and emerging IT architectures present fresh challenges to the nature and professional activities of CIOs (Rau 2004). We anticipate that BTM processes are more likely to succeed when they are supported by appropriate organizational structures based on CIOs' clear understanding of roles, responsibilities, and decision rights. In that regard, the following hypotheses are proposed:

H2. Higher levels of CIO role effectiveness will significantly enhance firms' IT Assimilation.
H3. Higher levels of CIO role effectiveness will significantly enhance firms' BTM capability.

Business Technology and Business Management Competencies

As the core members of top management teams (TMT), CIOs often implement different organization functional areas in the business context. Therefore, it is important for them to develop a broad competency framework and not just one designed for their own technological specialties or a specific set of tasks. In this study, we constrain our taxonomy to those competency categories. These broad categories of skills and knowledge that form the overall competency are themselves inclusive of other categories of knowledge. Our proposed taxonomy is based on the integration and reorganization of the recommendations from different studies as represented in Table 1.

Table 1. Taxonomy of business technology and business management competencies

Taxonomy of business technology and business management competencies		Bassellier and Benbasat (2004)	Gorgone et al. (2002)	Reich and Benbasat (2000)	Robbins et al. (2001)
Business technology	IT infrastructure	-	IT infrastructure	IT infrastructure	IT infrastructure
	Business applications	-	Business applications	IT implementation success	Analytic and conceptual reasoning
	Business technology integration	IT-business integration	Organizational problem solving	Connections between business and IT planning	Technical integration
Business management	Business domain knowledge	Organization specific	Business functional area	Shared domain knowledge	Industry knowledge
	Interpersonal skills/knowledge	Interpersonal	Communication	Communication	Interpersonal & emotional intelligence
	Management practice	Management	Team-working Leaderships	Business management	Management practice

Empowerment Theory

As mentioned previously, another critical stream of theoretical works influencing the conceptual development of this study is referred to as the psychological empowerment perspective. Many empowerment theorists have identified empowerment as the construct of self-efficacy or self-determination/autonomy (e.g., Liden et al. 2000; Sprague and Hayes 2000). In line with them, competency is a belief that one possesses the skills and knowledge necessary to perform a job or task well and is analogous to agency beliefs, personal mastery, or effort-performance expectancy in one's capability to perform work activities with skills/knowledge (Rose 2007). Drawing upon the perspective of empowerment theory, an individual with a stronger sense of empowerment may be viewed by others in the workplace as more effective than those who experience a weaker sense of empowerment (Seibert et al. 2004). The concept of empowerment can serve as a sound theoretical base to structure CIOs' competency portfolios and facilitate them to effectively execute their professional activities and perform their job roles well.

Business Technology Competency and Its Influence on CIO Role Effectiveness

Business technology is the application of IT to deliver a business capability or automate a business operation (Hoque et al. 2006). Business technology can be properly exploited to produce anticipated business results by configuring, implementing, and applying various kinds of IT applications. The skills/knowledge pertaining to business technology competency possessed by CIOs can allow them to effectively configure, implement, apply, and evaluate IT to establish enterprise-wide IT infrastructure, initiate various sorts of business applications, and integrate IT functions with critical business processes in order to deliver a business capability or automate a business operation (Bharadwaj 2000; Rai et al. 2006; Weill and Vitale 2002). Thus, three dimensions of skills/knowledge emerge in the category of business technology competency in this study:

- **IT infrastructure skills/knowledge:** The dimension of IT infrastructure skills/knowledge encompasses the ability of a CIO to configure, implement, apply, and evaluate the existing and emerging information and communication technologies in order to construct an integrated and reliable IT infrastructure (Broadbent et al. 1999; Weill and Vitale 2002).
- **Business applications skills/knowledge:** Business applications skills/knowledge refers to the ability of a CIO to apply an integrated set of reliable IT infrastructure components, services, or functions available to achieve various business objectives. These objectives include supporting both existing applications and new initiatives, connecting different business functional units in the value chain, and linking to suppliers, customers, and strategic allies in its complicated supply network (Weill and Vitale 2002).
- **Business technology integration skills/knowledge:** Business technology integration refers to the ability of a CIO to visualize the ways in which various kinds of technologies can contribute to the organization's performance and help to provide synergies between IT and organization's performance (Burke and Menachemi 2004; Hoque et al. 2006).

Sambamurthy and Zmud (1996) found CIOs' ability to envision likely business impacts of current and emerging ITs as instrumental to IT assimilation. CIOs with high level of knowledge of business technology can better advise their top management teams about IT issues such as appropriate technologies to invest in, the timing of those investment choices, and the level of investments. We anticipate that CIOs with superior business technology competency will achieve a higher level of effectiveness at performing the roles of IT leaders in firms. Therefore, the following hypothesis is proposed:

H4. Higher levels of business technology competency of CIOs will enhance their role effectiveness.

Business Management Competency and Its Influence on CIO Role Effectiveness

CIOs' business knowledge is critical for them to understand their firms' competitive advantages and business strategies. Armstrong and Sambamurthy (1999) describe CIOs' business knowledge as an awareness of relationships between the organization and its stakeholders, the firm's means of competing in the marketplace, and its rivals' competitive moves. Effective CIOs simply must possess a broad business perspective to understand the business priorities, opportunities, and needs for the strategic use of IT. In this study, business management competency reflects an understanding of the business in all its dimensions which will influence their approach in delivering IT solutions to firms' value chain activities and business strategies. Drawing from prior research on business

management skills/knowledge (e.g., Bassellier and Benbaset 2004; Feeny and Willcock 1998; Garman and Johnson 2006), we deduced three dimensions of skills/knowledge that represent CIOs' business management competency:

- **Business domain knowledge:** It stands for CIOs' understanding of the holistic organizational settings in which IT is deployed and of the connections between IT and their organizations. This knowledge represents the competency of CIOs to see the big picture of IT exploited in their organizations and to make a link between different divisions and tasks, ensuring that benefits are realized from the potential fit between IT and the specific organizational setting (Bassellier and Benbasat 2004).
- **Interpersonal skills/knowledge:** Interpersonal skills/knowledge refers to the competency of CIOs to motivate other people, articulate visions and preferences and communicate them to others, handle negotiations with other people, and manage conflicts. As top IT leaders for information service delivery and change agents, CIOs are increasingly asked to develop overall strategies and tactics for creating broad-based understanding and act as exceptional team players and effective, jargon-free communicators throughout the organization (Bashein and Markus 1997; Feeny and Willcocks 2004).
- **Management practice skills/knowledge:** Management practice skills/knowledge taps into the abilities related to the execution of business management practices. This dimension of skills/knowledge refers to the competency of a CIO to act as a technology-leader in dealing with organizational renovation and risk management (Hersher 2003). Longest (1998) argued for the importance of management skills/knowledge for IT leaders in motivating other people, articulating visions and preferences, and managing changes and risks.

Top IT leaders with a superior business management competency will be able to understand the business priorities, opportunities, and needs for the strategic exploitation of IT (Broadbent et al. 1999; Westerman and Weill 2004). McKenney et al. (1995) illustrate how firms were able to create the successes of IT innovation only through a marriage of appropriate IT and business knowledge. Higher levels of IS and business unit knowledge have generally been found to enhance firms' IT assimilation (Armstrong and Sambamurthy 1999). They will be in a better position to align IT with key business processes, maximize the business value of IT, and promote IT-based business innovation (Agarwal and Sambamurthy 2002; Curley 2005; Hoque et al. 2006). Despite the fact that not all CIOs are likely to have developed each one of these dimensions well, we anticipate that CIOs who have generally excelled in all three of these dimensions are likely to be more effective in performing their roles. Therefore, we propose that:

H5: Higher levels of business management competency of CIOs will enhance their role effectiveness.

Control Variables

Larger-size companies may have more slack resources required for experimenting with emerging technologies, engaging in risk taking and experimentation, bearing critical failures, tolerating the costs of implementing innovations, proactively seeking the opportunities to innovate with technologies, purchasing expensive innovations and withstanding adoption failures and, as a result, a greater capacity for assimilating innovations and technologies (Rogers 1983; Liang 2007). We anticipate that larger organizations have greater success with assimilating IT into their value-chain activities and business strategies. In this study, the numbers of employees and revenues of firms were adopted as two measures of organizational size. Besides, the type of industry was used as another important control variable that would affect the level of IT assimilation. Although IT may provide innovative opportunities for firms to conduct many of their value chain activities and business strategies, the extent of potential may be different between the manufacturing, service-oriented and/or other industries (Chatterjee et al. 2001).

Research Methodology

Sample and Procedure

The empirical data were gathered through a large-scale field survey of firms in Taiwan and China. The unit of analysis is the firm, with the assimilation of information technologies into its business strategies and value chain activities being the phenomenon of inquiry. Organizations are purposively selected from the high-tech companies with a formal MIS department and having global logistics functions or processes. Drawing from the databases of China Credit Information Service Ltd., the most authoritative business investigatory apparatus in Taiwan and Strait Exchange Foundation, a non-profit organization that officially represents Taiwan government to gather statistics and

help firms of Taiwan doing business in China. Although the majority of these companies have migrated and built their factories in Mainland China or South-east Asia, their headquarters are still located in Taiwan and China. CIOs in these firms are more likely to act as the eight salient roles as proposed in this study. Finally, 968 companies are purposively selected to constitute a representative sample in this study.

The perceptual data for this study were collected through questionnaires. Two sets of questionnaires were mailed to the CEOs or TMT members. One questionnaire named (TMT Questionnaire) gathered data about IT assimilation, their CIO role effectiveness, and business technology and business management competencies from the CEOs or TMT members. The other questionnaire (CIO Questionnaire) assessed the levels of competencies in business technology and business management and firms' BTM capability and was completed by CIOs in the same firms. The CEOs or TMT members were asked to pass the second set of questionnaires to their CIOs to ensure the responses provided by different sources of informants and to minimize the extent of common method variance bias.

The initial survey was mailed in March, 2008 and a postcard reminder was sent to non-responders in the first week of April, 2008. At this moment in time, we have received responses from 121 companies, representing a response rate of 12.5% of the initial sample. However, of the 121 companies, 97 companies provided paired responses, 13 companies provided the senior IS/IT executives only and 11 companies provided the TMT members only. To test the consistency of the responses, correlations were computed on key constructs for those firms where paired responses were received. These correlations were significant for the four constructs: IT assimilation in business strategies and value-chain activities; business technology competency and business management competency of CIOs ($p < 0.01$). The potential non-response bias was assessed by comparing the early versus late respondents that were weighed on industry type, revenue, and number of employees. None of the t-statistics was statistically significant ($p > 0.05$, two-tail tests), thereby suggesting that non-response bias may not exist. As the characteristics of the respondents shown in Table 2, the titles borne by the respondents varied from company to company. While General Manager, Senior Manager and President were the most common positions of personnel that responded to the TMT-Questionnaire, IT/IS Manager, MIS/IT Director, and Senior IT Manager most commonly responded to CIO-Questionnaire.

Table 2. Characteristics of the Respondents

TMT-Questionnaire (N=97)	Freq.	%
Chief executive officer	9	9.3%
General manager	23	23.4%
Chief financial officer	5	5.6%
Executive vice president	8	8.4%
President	17	17.8%
Senior manager	21	21.5%
Sales director	5	4.7%
Finance director	6	6.5%
Other	3	2.8%
CIO-Questionnaire (N=97)	**Freq.**	**%**
CIO	8	8.2%
IT executive president	11	11.3%
Vice president	13	13.4%
IT/IS manager	18	18.6%
MIS/IT director	20	20.6%
Senior IT manager	23	23.7%
Other	4	4.1%

Industry type	Freq.	%
Manufacturing	70	72.2 %
Service-orientation	27	27.8 %
Number of employees	**Freq.**	**%**
1~50	10	10.3%
50~100	10	10.3%
100~500	32	33.0%
500~1000	6	6.2%
1000	39	40.2%
Revenue (NT$ Million)	**Freq.**	**%**
1~50	6	6.2%
50~100	5	5.2%
100~1000	29	29.9%
1000~5000	17	17.5%
5000~10000	15	15.5%
>10000	25	25.8%

Measurement Development

A cross-sectional survey was used as the research methodology. The starting point for measurement development involved reviews of the empirical and theoretical literature. In order to generate a sample of items, items that fit the construct definitions of the current study were identified. Once the initial list of measurement items was generated, an iterative interview process involving interviews with a small group of academic and industrial experts was conducted to refine the item list. The interviews were recorded to improve the quality of data collected. From this, the researchers gauged the clarity of the scale items, assessed whether the list of items could effectively capture the phenomenon desired by the researchers, and verified that related concepts were not omitted. This process was continued until no further modifications to the questionnaire were necessary. Feedback from the interview processes served as the basis for correcting, refining, and enhancing the experimental scales.

After completing the development of the constructs and their related scale items, several pretests were conducted with a small group of respondents to ensure the completeness and appropriateness of the scale items. Since there are 20 sub-constructs included in the five major constructs in the proposed model, the goal was to have a smaller number of items per construct while maintaining sufficient measurement properties. In addition, the basic qualitative criterion concerning construct validity and content validity could then be assured in this stage. Content validity implies that the instrument considers all aspects of the construct being measured. It should be determined by specifying the domain of the construct, generating items that exhaust the domain, and subsequently purifying the resulting scale to produce a measure which is content or face valid and reliable (Churchill 1979). All measures were reviewed by a panel of 12 academic and professional experts to ensure content validity through the calculation of content validity ratios on each scale item. Table 3 summarizes the operationalized definitions of latent variables and example measures of the survey instrument administered in this study.

Table 3. Operationalization of the Major Constructs and Example Scale Items

Construct	Respondent	Operationalized definitions and example scale items	References
IT assimilation	TMT/CIO	The degree to which a firm can effectively apply IT in supporting, shaping, and enabling firms' business strategies and value-chain activities. ▪ Example scale items (1: Not successful at all ~ 5: Very successful): *Q. How do you evaluate your firm's performance in applying IT to support each of the business strategies/value chain activities relative to other firms in your own industry?* *A. Business strategies* *1. being a low-cost producer* *2. having manufacturing/operations flexibility* *3. enhancing supplier/customer linkages…*	Armstrong and Sambamurthy (1999); Chatterjee et al. (2002); Purvis et al. (2001)
BTM capability	CIO	The degree to which a firm can effectively apply well-defined processes and appropriate organizational structures, information, and supporting technologies in four BTM functional areas to drive the organization closer to the goal of business and technology unification. ▪ Example scale items (1: Very poorly ~ 5: Very well): *Q: Relative to other firms in your industry, please indicate how well developed are the following capabilities in your firms?* *GO1: Vision about the strategic role of IT* *MT1: To develop enterprise project and asset portfolios* *SP1. To articulate required business capabilities* *SE1: To achieve target architectures and maintain standards.*	Hoque et al. (2006); Weill (2004); Weill and Ross (2004); Weill and Ross (2005); Weill and Vitale (2002)
CIO role effectiveness	TMT	The extents of outcome expectations perceived by TMT members on their CIOs' role performance to act in a multiplicity of salient roles including business visionary/strategist, business system thinker, value configurer, entrepreneur, infrastructure builder, organizational designer, relationship builder, and informed buyer. ▪ Example scale items (1: Not meeting expectations ~ 5: Outstanding): *Q: Please indicate your CIO's performance on the following role items* *BV1: getting involved intimately in shaping the vision, mission and goal of the organization.* *BT1: thinking through new business models concerning the issues of cost structures, pricing, and channel conflict.* *VC1: developing/maintaining metrics that reflect the value of IT to the organization.*	Feeny and Willcocks (1998); Grover et al. (1993); Ross and Feeny (2000); Smaltz et al. (2006); Willcocks et al. (2006)
Business technology competency	TMT/CIO	The levels of skills/knowledge possessed that enable him or her to configure, implement, apply, and evaluate IT to establish the enterprise-wide IT infrastructure, initiate various sorts of business applications, and integrate IT functions with critical business processes in order to deliver a business capability or automate a business operation. ▪ Example scale items (1: Very low ~ 5: Very high): *Q: Please indicate your CIO's/your level of the following skills/knowledge items:* *TI1: To purchase software to ensure that applications are meeting the needs of the organization.* *BA1: identifying and testing new technologies for business purposes.* *TP1: understanding how to integrate IS and new work flow of the organization.*	Broadbent et al. (1999); Weill and Vitale (2002); Weill et al. (2002); Burke and Menachemi (2004)
Business management competency	TMT/CIO	The level of skills/knowledge possessed that enables them to understand the business domain-specific knowledge, speak the language of business, and interact with their business partners in other business divisions. ▪ Example scale items (1: Very low ~ 5: Very high): *Q: Please indicate your CIO's/your level of the following skills/knowledge items:* *BD1: understanding the overall performance of the organization as a whole.* *IP1: communicating with people at different levels of the organization* *MP1: understanding the existing practices for the management of change in the organization.*	Agarwal and Sambamurthy (2002); Bassellier and Benbaset (2004); Curley (2005); Hersher (2003)

Data Analysis and Results

The analytical strategy in this study is a two-phase approach. First, in the phase of measurement development, the psychometric properties of all scales were assessed through confirmatory factor analyses. Next, in the phase of model validation, the structural relationships of the conceptual framework were examined. Considering that our research model contains a large number of latent constructs and that we have a relatively small sample size, the partial least squares (PLS) method was applied for data analysis. Unlike a covariance-based structural equation modeling method such as LISREL and AMOS, PLS technique utilizes a component-based approach for estimation purposes (Löhmoller 1989), and can handle formative constructs (Chin et al. 2003). In general, PLS places minimal restrictions on measurement scales, sample size, and residual distributions. This approach is more suitable for explaining complex causal relationships as it avoids the problems of inadmissible solutions and factor indeterminacy (Fornell and Bookstein 1982).

To minimize the extent of common method variance bias, CIOs were asked to answer the questions in business management and business technology competencies, BTM capability, and IT assimilation. The TMT members were asked to answer the questions in CIO role effectiveness and IT assimilation. As far as the competencies are concerned, it is reasonable to believe that others' assessments of one's competence may be fraught with the difficulty for someone to figure out how much an individual accurately knows. Hence, no matter how competencies are measured, by the individual or by someone else, it is not possible to alleviate measurement concerns completely (Bassellier and Benbasat 2004). For CIO role effectiveness measures, we would argue that TMT members can provide more objective answers than CIOs themselves. Because CIOs are often responsible and involved in firm's BTM practice relative to competition, they might be a better source to give a good judgment on firm's BTM capability measures than TMT members. In addition, to be more "neutral" in the responses about IT assimilation, the averaged answers of both CIOs and TMT members were used for model testing and analysis.

Measurement Model

The measurement model was analyzed through PLS-Graph 3.0. The assessments of item loadings, reliability, convergent validity, and discriminant validity were performed for the latent constructs through a confirmatory factor analysis (CFA). Reflective items should be unidimensional in their representation of the latent variable, and therefore correlated with each other. Factor loadings of scale items should be above 0.707, showing that over half of the variance is captured by the constructs (Hair et al. 1998; Straub et al. 2004). As shown in Table 4, the analysis for the initial set of all scale items showed that the four items have loadings below the recommended value of 0.707 (i.e., BS8 with a loading of 0.65, VC3 with a loading of 0.66, and SP6 with a loading of 0.66). These three items were discarded from the subsequent analyses in order to achieve a high level of reliability and validity.

Table 4. Factor Loadings and Reliability Coefficients of Constructs

Construct	Sub-construct	Data Used	Indicator	Loadings	Reliability (AVE/α)
IT assimilation	Business strategies	Average (TMT, CIO)	BS1-8	0.65(BS8)~0.86	0.93 (0.58 / 0.89)
	Value chain activities		VC1-6	0.66(VC3)~0.83	0.90 (0.56 / 0.84)
BTM capability	Governance and organization	CIO	GO1-7	0.83~0.92	0.96 (0.78 / 0.95)
	Managing technology investments		MBT1-5	0.80~0.90	0.93 (0.74 / 0.91)
	Strategy and planning		SP1-8	0.66(SP6)~0.86	0.93 (0.61 / 0.91)
	Strategic enterprise architecture		SEA1-10	0.73~0.86	0.95 (0.67 / 0.94)
CIO role effectiveness	Business visionary	TMT	BV1-4	0.81~0.87	0.90 (0.70 / 0.85)
	Business system thinker		BST1-3	0.80~0.87	0.88 (0.71 / 0.79)
	Value configurer		VA1-4	0.77~0.87	0.89 (0.67 / 0.83)
	Entrepreneur		EN1-4	0.74~0.90	0.91 (0.71 / 0.86)
	Infrastructure builder		IB1-6	0.74~0.89	0.92 (0.65 / 0.89)
	Organizational designer		OD1-4	0.75~0.87	0.88 (0.66 / 0.82)
	Relationship builder		RB1-4	0.79~0.88	0.90 (0.70 / 0.86)
	Informed buyer		IB1-5	0.80~0.90	0.92 (0.71 / 0.90)
Business technology competency	IT infrastructures	CIO	ITI1-8	0.75~0.89	0.95 (0.69 / 0.93)
	Business applications		BA1-6	0.71~0.86	0.91 (0.64 / 0.89)
	Business technology integration		BTI1-6	0.84~0.90	0.95 (0.75 / 0.93)
Business management competency	Business domain knowledge	CIO	BDK1-7	0.81~0.87	0.95 (0.72 / 0.93)
	Interpersonal skills		IP1-7	0.79~0.86	0.94 (0.70 / 0.93)
	Management practice knowledge		MP1-5	0.78~0.89	0.92 (0.71 / 0.90)

Then, the CFA technique was applied again for all of the latent constructs in the research model. Finally, all constructs in the measurement model exhibited good internal consistency as evidenced by their composite reliability scores. The composite reliability coefficients of all constructs in the proposed conceptual framework are more than adequate, ranging from 0.88 to 0.96. Further, to assess discriminant validity, (1) indicators should load more strongly on their corresponding construct than on other constructs in the model and (2) the square root of the average variance extracted (AVE) should be larger than the inter-construct correlations (Chin 1998). The percent of variance captured by a construct is given by its average variance extracted (AVE). First, factor analytical techniques using SPSS were applied to aggregate factor scores for all of the latent constructs in the model. Then, PLS method was applied again to evaluate discriminant validity of the major constructs of the conceptual framework. As the results shown in the Table 5, all constructs meet this requirement. Finally, the reliability coefficients are all above the suggested minimum of 0.7 (Hair et al. 1998); all constructs display adequate reliability and discriminant validity. Thus, the convergent and discriminant validity of all constructs in the proposed conceptual framework can be firmly assured.

Table 5. Descriptive Statistics and Inter-Correlations among Major Constructs

Construct	Composite reliability	BS	VC	BTM	CRE	BT	BM
IT assimilation- Business strategies (BS)	0.933	0.82					
IT assimilation- Value chain activities (VC)	0.908	0.72	0.82				
BTM capability (BTM)	0.976	0.48	0.35	0.76			
CIO role effectiveness (CRE)	0.960	0.57	0.57	0.48	0.87		
Business technology competency (BT)	0.967	0.48	0.52	0.42	0.45	0.77	
Business management competency (BM)	0.950	0.50	0.50	0.44	0.46	0.70	0.71

**Diagonal elements are the square roots of average variance extracted (AVE).*

Hypothesis Testing

Since we have both formative (e.g., business technology and business management competencies) and reflective (e.g., CIO role effectiveness, BTM capability and IT assimilation) second-order constructs in the conceptual model, the structural model was also validated by the PLS technique. T-statistics and standard errors were generated by applying the bootstrapping procedure with 200 samples. In the PLS structural model analysis, path coefficients can be interpreted as standardized beta weights in a regression analysis. The path coefficients and explained variances for the conceptual model in this study are shown in Figure 2. As can be seen from Figure 2, the paths linking from BTM capability and CIO role effectiveness to IT assimilation represent the total impacts on firms' assimilation of information technologies in shaping value chain activities and business strategies. The results provide strong empirical evidence for the nomological validity of all latent constructs and the effects on IT assimilation. The estimate of 54.7 % on the construct of IT assimilation ($R^2 = 0.547$) for these paths provides good support for the hypothesized impact of BTM capability and CIO role effectiveness on IT assimilation. The estimate of 22.4 % on the construct of BTM capability ($R^2 = 0.224$) denotes that CIO role effectiveness significantly influences a firm's BTM capability. Moreover, CIO role effectiveness is also apparently influenced by the skills/knowledge levels of business technology and business management competencies. The R^2 value of 0.242 demonstrates that the two competencies explain a good amount of the variance in CIO role effectiveness. An F test is further applied to test the significance of the effect size of the overall model. All of the dependent variables are significant ($p<0.01$). Therefore, as a whole, the model has strong explanatory power for the constructs of CIO role effectiveness, BTM capability, and of IT assimilation.

The results of PLS analysis provide support for both of the hypotheses H1 and H2. Thus, we find that BTM capability and CIO role effectiveness do influence firms' assimilation of information technologies in their value chain activities and business strategies. On the other hand, the analysis results also provide support for the hypothesis, H3, effectively drawn from CIO role effectiveness to BTM capability. Further, hypotheses H4 and H5 are also supported. As a whole, the research model has significant explanatory power. The significant path coefficients, effect size, and the value of the R^2 reinforce our confidence in the results of hypotheses testing and provide support for the nomological network of the proposed model.

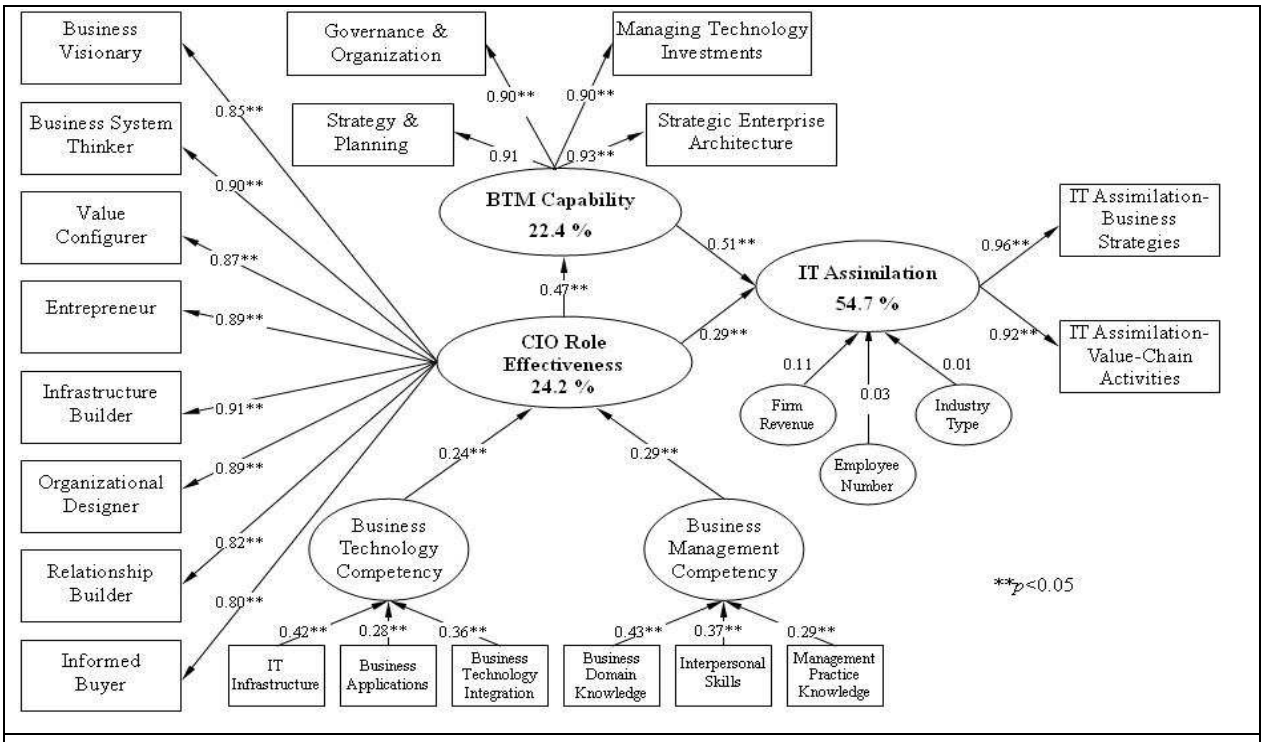

Figure 2. PLS Results

Discussion and Implications

As more and more enterprises seek to create business value, seed new market opportunities, facilitate process innovation, and help shape business strategy through the success of information technologies, there is a need to understand what factors are likely to promote heightened levels of IT assimilation. Drawing upon prior theory and research, we examined the impacts of two critical factors upon the organization level of IT assimilation in shaping value chain activities and business strategies in modern firms: CIO role effectiveness and BTM capability. In addition, our study validated the influences of business technology and business management competencies on CIO role effectiveness. Based on the perspective of empowerment theory, we discovered that the two categories of skills/knowledge (i.e., business technology and business management competencies) are important for nurturing higher levels of CIO role effectiveness. By adopting the approach of role-based performance theory proposed by Welbourne et al. (1998), the impact of CIO role effectiveness was also found to be critical in encouraging the IT assimilation and BTM capability. Further, our research found that higher levels of BTM capability are significant in promoting IT assimilation in value chain activities. Consequently, we argued that the requisite expertise and authority for higher levels of IT assimilation in business strategies are distributed across firms.

From the viewpoint of managerial implications, our research findings testify to the importance of BTM capability and top IT leaders' effectiveness together as portfolios in enhancing IT assimilation; a detailed understanding and use of a portfolio of BTM capability would be beneficial for promoting firms' IT assimilation. Our findings also have important implications for managers involved in efforts to introduce information technologies into their firms. They reinforce the importance of institutional factors such as top IT management championship and BTM capability on the heightened levels of technology assimilation. These findings testify to the responsibility of senior IS executives in heightening their firms' success in technology assimilation. While numerous advocates have prescribed such a collective responsibility as a normative guideline, our research provides empirical support for this prescription. Beyond studying senior IT management effectiveness, we also demonstrate the importance of articulating BTM capability to facilitate the assimilation of information technologies. Another important implication of our research is the finding that CIOs' business technology and business management competencies are both essential for enhancing their role effectiveness.

Although our study provided interesting insights into the BTM capability and CIO role effectiveness and their impact on IT assimilation, it has several limitations that also represent opportunities for future research. First, a potential limitation of our study is its cross-sectional design. Since implementing IT takes years, there is usually a multiple year delay. The potential concern on time delay is lacking in the research design of the study. The responses to our IT assimilation questions are likely to be the result of actions in this past. Thus, it would be interesting to use a longitudinal design to examine the cyclical reference relationships among the identified research variables. Second, considering the logistical difficulties of collecting longitudinal data from senior IT executives, a more feasible strategy would be to focus on a few companies and to gather data over a period of time. Such data could be collected through in-depth personal interviews and case analyses. Third, other potential extensions of this study would include examining the effects of other contextual factors on the assimilation of information technologies. As mentioned earlier, apart from organization-specific factors, there are other contextual factors (e.g., technological, user, and firms' innovative characteristics) that could influence the extent of assimilation of IT. Finally, objective measures of performance or IT assimilation are missing in our study; however, it is hoped that the future studies can explore the possibility of including some objective measures (e.g., financial performance) to compare our empirical results.

Conclusion

The issues regarding business management and business management competencies, CIO role performance, BTM capability, and IT assimilation have been extensively discussed separately or partially interrelated in IS literature. Our findings indicate that they are highly correlated. Seeing high levels of BTM and CIO role effectiveness as a way to enhancing IT assimilation is beneficial when CIO's possesses high levels of business management and business management competencies. Specially, with higher levels of business technology and business management competencies, CIOs also have higher effectiveness in acting multiple salient roles to facilitate firms' success use of IT. As more contemporary enterprises seek to transform their value chain activities and business strategies through the success of information technologies, it is critical to understand what factors are likely to promote heightened levels of IT assimilation. Our work provides judicious knowledge to researchers and practitioners interested in learning how firms can facilitate more effective transformations to today's Web-based business environments and adds to the body of knowledge on firm's IT assimilation. We hope that our theoretical perspective and findings will stimulate and encourage more research into this important phenomenon.

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