

Process model of IT impacts on firm competitiveness based on application capability of information technology

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Abstract: To investigate the process of information technology (IT) impacts on firm competitiveness, an integrated process model of IT impacts on firm competitiveness is brought forward based on the process-oriented view, the resource-based view and the complementary resource view, which is comprised of an IT conversion process, an information system (IS) adoption process, an IS use process and a competition process. The application capability of IT plays the critical role, which determines the efficiency and effectiveness of the aforementioned four processes. The process model of IT impacts on firm competitiveness can also be used to explain why, under what situations and how IT can generate positive organizational outcomes, as well as theoretical bases for further empirical study.
Key words: application capability of IT; IT business value; process-oriented view; process model

In a turbulent environment, many firms turn to information technology (IT) in order to decrease product or service costs, to increase operation efficiency, to improve management and decision making, and to enhance firm competitiveness. However, the success ratio of IT applications is low compared to the enormous IT investments; for example, the figure is about 10% in China^[1]. To overcome the issue, both academicians and practitioners have studied it from different perspectives, including IS successes^[2-3], IT adoption^[4], IT impacts^[5-6], IT capability^[7-10] and IT business value^[11-12].

Although the streams of related researches are somewhat heterogeneous, they can function in an integrated way based on a process-oriented view. A process-oriented view is very powerful in explaining why, under what situations and how enhancements in firm competitiveness occur or fail due to information technology. The studies of Soh and Markus^[13], Melville et al.^[9], Peppard and Ward^[14], Pavlou and El Sawy^[15] are the most representative ones in this line.

In the literature, there are few models that deal with the whole process of IT investment affects on firm competitiveness from a capability perspective, especially the research considering environmental effects is even less. With these considerations as a point of departure, this paper aims to develop a new analytic model regarding the role of the environment from a capability perspective, which can be used to explain why, under what situations and how IT applications succeed or fail. To achieve our research objectives, the fol-

lowing three research questions are defined:

What is the whole IT application process from IT investment to firm competitiveness? Specifically, which main sub-processes can it be divided into?

Which capabilities are critical in the whole IT application process? Specifically, how do the application capabilities of IT ensure IS success, improve the IS adoption and enhance firm competitiveness?

What is the relationship between IT application processes and the IS lifecycle?

1 Theoretical Base

This paper draws on the multi-theory tenets of the resource-based view (RBV), the complementary resource view (CRV), and the process-oriented view (POV).

1.1 Resource-based view

Based on two propositions that resources are distributed heterogeneously across firms and this diversity can be retained over a long period of time, the RBV argues that the source of competitive advantage lies in valuable, rare, non-imitable, and non-substitutable resources^[16-17]. Mata et al.^[18] specified that the IT resource was a technical IT resource and a human IT resource. The single IS can be seen as an example of an IT resource providing a competitive advantage for the firm controlling it. For example, Wal-Mart can reduce its inventory costs with a purchase/inventory/distribution system.

1.2 Complementary resource view

According to Milgrom and Roberts, two activities (or factors) are complementary if the performance of one increases the benefits of the performance of the other^[19]. Besides IT investment, some complementary resources are also important inputs for IT application results, such as incentives to use a new system, top management commitment, business process reengineering, and an open organizational climate.

1.3 Process-oriented view

The variance-oriented view argues that the cause is necessary and sufficient to produce the desired effect; however, the POV emphasizes that causation consists of necessary conditions occurring in a particular sequence in which change and random events also play a role. So the POV is seen as a productive approach in explaining why, under what situations and how IT applications succeed or fail.

In this paper, we use the POV to bring forward the process model of IT impacts on firm competitiveness from a capability perspective: investigating the effects of the application capabilities of IT in every IT application process, and investigating the impacts of IT on business processes and or-

Received 2007-08-31.

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Foundation item: The National Natural Science Foundation of China (No. 70671024).

Citation: Wang Nianxin, Zhong Weijun, Mei Shu'e. Process model of IT impacts on firm competitiveness based on application capability of information technology [J]. Journal of Southeast University (English Edition), 2008, 24(1): 114 – 118.

ganizational capabilities.

2 Process Model Development

The objective of this paper is to develop a process model of IT impacts on firm competitiveness from the application capabilities in an IT perspective, which can be used to explain why, under what situations and how IT applications

succeed or fail. We extend the IT to create the business value model of Soh and Markus^[13]. Our model consists of four processes: The first model links IT investment to IT solutions, the second links IT solutions to IS; the third links IS to IT impacts, and the fourth links IT impacts to firm competitiveness (see Fig. 1).

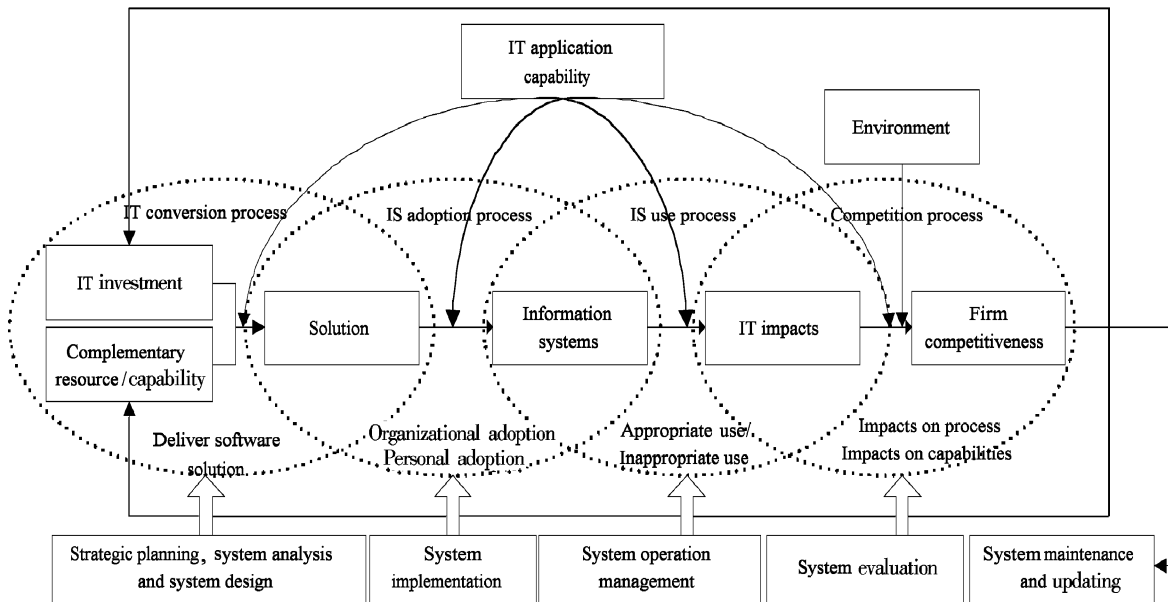


Fig. 1 A process model of IT impacting firm competitiveness based on application capability of IT

2.1 Application capability of IT

A capability is a firm's ability to carry out a concrete activity. The application capability of IT is the organizational ability to deliver an IS solution in a timely manner which is in accordance with evolving business needs and to improve firm competitiveness during the whole IT application process. The main functions of the application capability of IT include delivering IT solutions, ensuring IS success, IS appropriate use and increasing firm competitiveness.

The application capability of IT is one consisting of both complex and multidimensional organizational capabilities. It consists of IT investment conversion capabilities, IS adoption capabilities, IS use capabilities and IT management capabilities. From the perspective of an IS lifecycle, it includes activities such as system planning, system analysis and design, system implementation, system operation management, system evaluation, system maintenance and updating.

2.2 The first process: IT conversion process

An IT solution is a direct result of IT investment, but not all firms are able to convert their IT investments to IT solutions with the same efficiency and effectiveness. The conversion efficiency depends on a firm's level of application capability of IT. So the relationship between IT investment and IT solutions is mediated by the application capabilities of IT.

In the IT conversion process, the application capabilities of IT may consist of five main activities: IT investment strategy formation, IT development strategy, business needs acquirement, logical system design, and physical system development.

From the IS lifecycle, the application capability of IT includes those activities such as system planning, system analysis and system design. The differences between the IT application process and the IS lifecycle lie in that the application capability of IT is a cross-function organization-wide capability; however, the IS development capability is a functional capability, so the application capability of IT emphasizes an organization-wide capability, and the steps in the lifecycle emphasize functions of IS units.

2.3 The second process: IS adoption process

The outcome of the IT conversion process is an IT solution to business needs. An IT solution can only be converted into the IS through an IT adoption process. An organizational embedding information system is the direct result of an IT adoption process, but not all firms can adopt IT solutions efficiently. The level of the IS adoption depends on the firm's level of application capability of IT. So the relationship between an IT solution and an IS success is mediated by the application capabilities of IT.

There are two kinds of IS adoption: one is organizational adoption; the other one is personal adoption. Organizational adoption refers to the activities of organizational structure transformation and business process reengineering. Personal adoption refers to the personal changes in ways of thinking and business operations.

From the IS lifecycle, the IS adoption process is defined as system implementation. Some critical success factors have been summarized in previous literature about IS implementation, such as top management commitment, open organizational climate, attitude towards transformation, staff training and exact basic data. The application capabilities of IT can

be neither more nor less than master and monitor the above critical success factors in the IS adoption process.

2.4 The third process: IS use process

Information systems are used for producing some positive impacts on business processes and organizational capabilities. Obviously, the IS cannot generate any valuable outcomes without appropriate use. The application capability of IT refers to the ability to use the IS appropriately in accordance with IS management policy and rules. So the relationship between the IS and IT impacts is mediated by the application capabilities of IT.

The IS use process consists of many daily management activities, such as operation rules establishment, data security protection, data backup and emergency disposal.

From the IS lifecycle, the IS use process may be similar to the IS operation management. The difference between the IT use process and the IS operation management lies in that the IS use process is organization-wide, and IS operation is unit-wide.

2.5 The fourth process: competition process

IT cannot lead to the enhancement of firm competitiveness directly, there is one mediating state called IT impact. IT generates positive outcomes indirectly through IT impacts.

IT has impacts on business processes. According to specifications about the business process of Mooney et al.^[12],

the business process can be classified into operational processes and management processes, and IT can have three separate but complementary effects on the operational processes and the management processes. Those three effects are automational, informational and transformational. The framework shown in Tab. 1 can be used for evaluating IT impacts on the business process.

Another option for evaluating IT impacts on business processes is Tallon and Kraemer's process-level IT impacts^[11], shown in Tab. 2, in which all the activities are made up of a value chain.

IT has impacts on organizational capability. IT influences firm performance through three significant organizational capabilities: agility, digital options and entrepreneurial alertness; and three strategic processes: capability-building, entrepreneurial action and co-evolutionary adoption^[20].

From an IS perspective, competition processes may be similar to the IS evaluation. Those impacts have most often been measured by some financial indicators such as ROA, ROS, OI/A and OI/S. These financial indicators cannot reflect all the IT impacts sufficiently. Firm competitiveness measured by these financial indicators are not decided by IT impacts. The environment plays a very important role, which will be described in the next section. So IT impacts should be evaluated from the process-level and the capability-level as well as from financial indicators.

Tab. 1 Framework of Mooney et al. for evaluating IT impacts on business process

Process	Automational effects	Informational effects	Transformational effects
Operation process	Labor costs	Utilization	Product and service innovation
	Reliability	Wastage	Cycle times
	Throughput	Operational flexibility	Customer relationships
	Inventory costs	Responsiveness	
	Efficiency	Quality	
Management process	Administrative expense	Effectiveness	Competitive flexibility
	Control	Decision quality	Competitive capability
	Reporting	Resource usage	Organizational form
	Routinization	Empowerment	
		Creativity	

Tab. 2 Tallon and Kraemer's process-level IT impacts

Process	Key impacts
Planning and supporting	Enhance decision making outcomes
	Improve communication and coordination
	Facilitate design of new and improved processes
Supplier relationships	Coordinate supplier linkages to reduce search costs
	Facilitate closer ties with suppliers through EDI
	Enable closer monitoring of quality and improved delivery techniques
Production and operations	Enhance manufacturing techniques through CAD
	Create economies of scale
	Increase labor productivity through automation
Product and service enhancement	Facilitate the development of new products and services
	Enable products and services to be differentiated
	Improve product and service quality
Sales and marketing support	Enable a corporation to identify and serve new market segments
	Track market trends and respond to them
	Monitor the effectiveness of pricing strategies
Customer relationships	Establish, sustain and improve relationships with customers
	Offer improved levels of customer service
	Improve customer responsiveness

2.6 Firm competitiveness and environment

The final outcome of the IT investment is the enhancement of firm competitiveness. Firm competitiveness is composed of organizational capabilities and business processes. Organizational capabilities include R&D capability, production and manufacturing capability, and marketing capability. Business processes consist of the operation process and the management process. So the enhancement of firm competitiveness is improved business processes and increased organizational capabilities. In fact, customers cannot perceive one firm's competitiveness through business processes and organizational capabilities done but through the firm's products and/or service in the market. So the external characteristics of firm competitiveness refer to firm performance. However, firm competitiveness consists of only the necessary conditions of firm performance, the depth and breadth of the relationships depend heavily on environmental conditions.

The contemporary environment is characterized by global competition, knowledge intensity, deregulation, volatility, and blurred industrial boundaries. Such turbulent, dynamic and hostile environments cause increased uncertainty, heightened volatility and hyper-competition. Yet the IT strategy is just a beginning in incorporating competitive dynamics, particularly regarding the sustainability of advantages. In fact, firms cannot forecast the changes in products, suppliers, customers, and technologies in the contemporary environment. Environments can cause failure of information technology so that IT cannot generate any positive outcomes except vast IT expenditure.

What's more, our process model is a closed loop. The decline (or trends) in firm competitiveness can be seen as another new beginning for IT investment which is similar to system maintenance and system updating. For example, before the early 1990s, most manufacturing enterprises relied on MRP II to monitor their internal resources. With the turbulent environment at that time, the competition between enterprises had turned to the competition between supply chains; the MIS in enterprises had changed from MRP II to ERP which can control all the resource distributions in the whole supply chain.

3 Discussion and Conclusions

The process-oriented analytic model of IT application capabilities is very powerful in explaining why, under what situations and how IT applications succeed or fail. Our process model differs from the IT creating the business value model of Soh and Markus in four significant ways:

1) The definition of the application capabilities of IT is brought forward to IT application success or failure in the whole IT application process.

2) The IT application process is decomposed into four sub-processes from which the process of IT application can be better understood.

3) The variance of environments is added in our model, which can be used for investigating the environmental effects of the IT application process.

4) The relationship between the four IT application processes and every step of the IS lifecycle is brought forward to increase our understanding and improve the success ratio of

IT applications.

This process model of IT impacts on firm competitiveness based on the application capability of IT may have some potential and practical limitations. For example, the process model does not take industry characteristics into consideration. In spite of the limitations of this research, the proposed process model serves as a theoretical foundation for further empirical study.

References

- [1] Lu Xinyuan, Zhang Jinlong, Chen Tao. The investigative analysis and research of enterprise informatization and risk management [J]. *Science Research Management*, 2006, **27** (5): 77–86. (in Chinese)
- [2] Delone William H, Mclean Ephraim. Information systems success: the quest for the dependent variable [J]. *Information Systems Research*, 1992, **3**(1): 60–95.
- [3] Delone William H, Mclean Ephraim. The Delone and Mclean model of information systems success [J]. *Journal of Management Information Systems*, 2003, **19**(4): 9–30.
- [4] Jasperson J, Carter P E, Zmud R W. A comprehensive conceptualization of post-adoption behaviors associated with information technology enabled work systems [J]. *MIS Quarterly*, 2005, **29**(3): 525–557.
- [5] Zhong Weijun, Mei Shu'e. A method for analyzing impact of information systems technology on competitive domain of firms [J]. *Journal of Management Science in China*, 1998, **1** (2): 37–43. (in Chinese)
- [6] Shin N. The impact of information technology on the financial performance of diversified firms [J]. *Decision Support Systems*, 2006, **41**(4): 698–707.
- [7] Bharadwaj A S. A resource-based perspective on information technology capability and firm performance: an empirical investigation [J]. *MIS Quarterly*, 2000, **24**(1): 169–196.
- [8] Santhanam R, Hartono E. Issues in linking information technology capability to firm performance [J]. *MIS Quarterly*, 2003, **27**(1): 125–153.
- [9] Melville N, Kraemer K, Gurbaxani V. Information technology and organizational performance: an integrative model of IT business value [J]. *MIS Quarterly*, 2004, **28**(2): 283–322.
- [10] Bhatt G D, Grover V. Types of information technology capabilities and their role in competitive advantage: an empirical study [J]. *Journal of Management Information Systems*, 2005, **22**(2): 253–277.
- [11] Tallon P P, Kraemer K L, Gurbaxani V. Executives' perceptions of the business value of information technology: a process-oriented approach [J]. *Journal of Management Information Systems*, 2000, **16**(4): 145–173.
- [12] Mooney J, Gurbaxani V, Kraemer K L. A process oriented framework for assessing the business value of information technology [J]. *The Data Base for Advances in Information Systems*, 1996, **27**(2): 68–81.
- [13] Soh C, Markus L. How IT creates business value: a process theory synthesis[C]//*Proceedings of the 16th Annual International Conference on Information Systems*. Amsterdam: Association for Information Systems, 1995: 29–41.
- [14] Peppard J, Ward J. Beyond strategic information systems: towards an IS capability [J]. *Journal of Strategic Information Systems*, 2004, **13**(2): 167–194.
- [15] Pavlou P, El Sawy O. From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development [J]. *Information Systems Research*, 2006, **17**(3): 198–227.

- [16] Wernerfelt B. A resource-based view of the firm [J]. *Strategic Management Journal*, 1984, **5**(2): 171 – 180.
- [17] Barney J B. Firm resource and sustained competitive advantage [J]. *Journal of Management*, 1991, **17**(1): 99 – 120.
- [18] Mata F J, Fuerst W L, Barney J B. Information technology and sustained competitive advantage: a resource-based analysis [J]. *MIS Quarterly*, 1995, **19**(4): 487 – 505.
- [19] Milgrom P, Roberts J. The economics of modern manufacturing: technology, strategy, and organization [J]. *American Economic Review*, 1990, **80**(3): 511 – 528.
- [20] Sambamurthy V, Bharadwaj A, Grover V. Shaping agility through digital options: reconceptualizing the role of information technology in contemporary firms [J]. *MIS Quarterly*, 2003, **27**(2): 237 – 263.

基于信息技术应用能力的信息技术影响企业竞争力的过程模型

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摘要:为揭示信息技术影响企业竞争力的过程黑箱,基于过程观、资源观和互补资源观提出了信息技术影响企业竞争力的过程模型.该模型包括信息技术转换过程、信息系统采纳过程、信息系统使用过程和竞争过程等4个阶段,其中信息技术应用能力扮演了一个关键角色,它是决定4个过程效率和效能的组织能力.基于信息技术应用能力的信息技术影响企业竞争力的过程模型用于解释信息技术为什么、在什么条件下以及如何增强企业竞争力,该模型为进一步实证研究奠定了理论基础.

关键词:信息技术应用能力;信息技术业务价值;过程观;过程模型

中图分类号:F270