

## Measuring Firm's Information Technology Capability

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**Abstract:** This study focuses on measuring firm's Information Technology (IT) capability using data collected from the survey results of 160 MBA students in Vietnam. The measurement scale identifies the elements that form information technology capability. The results provide evidence that information technology capability can be measured by four factors including IT human resource, IT infrastructure, IT partnership and IT effective use. This finding would be useful for future research requiring a measurement of information technology capability and could be of use to those managers wishing to improve information technology capability in their firms.

**Key words:** Information technology capability, IT capability, measurement model, infrastructure, improve, finding

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### INTRODUCTION

As Information Technology (IT) capability plays an important role, organisations who want to reap the benefits of IT need to foresee challenges and opportunities that changing environment will bring. Therefore, it is of great importance to understand what IT capability is, how to measure it and how IT capability interacts with other factors in organisations. This study will explore the issue and focuses on measuring firm's IT capability, using data in Vietnam.

#### Literature review and research hypothesis

**Definitions:** Theoretically, IT capability was firstly defined by Ross *et al.* (1996) as "the ability to control IT-related costs, deliver systems when needed and effect business objectives through IT implementations". In their argument, a highly competent IT staff, a strong partnering relationship between business and IT management and a reusable technology base are the three key IT assets that bring IT capabilities. In turn, IT capability will enhance an organisation's competitiveness. Later, Feeny and Willcocks (1998) identify the nine core capabilities that an organisation must maintain in organizations.

Then, Bharadwaj (2000) extended the traditional notion of organisational capabilities to an organisation's IT function by Amit and Schoemaker (1998) and defined IT capability as the ability to mobilise and deploy IT-based resources in combination or copresence with other resources and capabilities. Those IT-based resources are: IT infrastructure, human IT resources comprising technical and managerial IT skills and

intangible IT-enabled resources such as knowledge assets, customer orientation and synergy-the sharing of resources and capabilities across organisational divisions. As explained earlier, this research uses the capability definition of Amit and Schoemaker (1998). The IT capability definition by Bharadwaj (2000) will be adopted in the research.

Peppard and Ward (2004) resource, competence and capability are differentiated. They referred to competence as the "firm's capacity to deploy resources, usually in combination, using organisational processes to affect a desired end" (Peppard and Ward, 2004) which is the Amit and Schoemaker (1998) definition of capability. It also reflects what is called capability in the Andreu and Ciborra (1996) capability development model. While, Andreu and Ciborra (1996) described the development of organisational capability with core capability as the highest level, Peppard and Ward (2004) developed the IS capability model with its highest level as IS capability. Thus, IS capability in their model can be understood as IS core capability in organisations. So, IT and IS can be used interchangeable in IT/IS research. To avoid being confused among terminologies this research uses IT capability in general but IS capability and IT/IS competency when explicitly referred to by others.

**IT capability elements:** In the literature there are four main important elements of IT capability which are identified: IT human resources, IT infrastructure, IT partnership and IT effective use. The first three elements are the IT resources which are commonly discussed in the literature (Ross *et al.*, 1996; Bharadwaj, 2000; Peppard and Ward, 2004; Bhatt and Grover, 2005; Ravichandran and

Table 1: IT capability elements

IT capability components	Sub-dimensions	References
IT human resources	IT personnel skills	Ross <i>et al.</i> (1996), Feeny and Willcocks (1998), Bharadwaj <i>et al.</i> (1999), Bharadwaj (2000), Byrd and Turner (2001), Dehning and Stratopoulos (2003), Peppard and Ward (2004), Zhang <i>et al.</i> (2004), Bassellier and Benbasat (2004), Bhatt and Grover (2005), Ray <i>et al.</i> (2005) and Ravichandran and Lertwongsatien (2005)
	IT company knowledge	
IT infrastructure	Network and platform sophistication	Ross <i>et al.</i> (1996), Feeny and Willcocks (1998), Bharadwaj <i>et al.</i> (1999), Broadbenta <i>et al.</i> (1999), Bharadwaj (2000), Dehning and Stratopoulos (2003), Peppard and Ward (2004), Zhang <i>et al.</i> (2004), Bhatt and Grover (2005), Ray <i>et al.</i> (2005), Ravichandran and Lertwongsatien (2005) and Mithas <i>et al.</i> (2007)
	Data and core application sophistication	
IT partnership	Internal partnership	Ross <i>et al.</i> (1996), Feeny and Willcocks (1998), Bharadwaj <i>et al.</i> (1999), Heijden (2000), Peppard and Ward (2004), Zhang <i>et al.</i> (2004), Bassellier and Benbasat (2004), Bhatt and Grover (2005), Ray <i>et al.</i> (2005) and Ravichandran and Lertwongsatien (2005)
	External partnership	
IT effective use	Decision rationalisation	Doll and Torkzadeh (1998)
	Problem solving	Marchand (2005)
	Work integration	Peppard and Ward (2004)
	Customer support	

Lertwongsatien, 2005). The last element-IT effective use reflects how effectively those resources are mobilised and used in supporting operational and business processes in organisations (Peppard and Ward, 2004; Marchand, 2005). Table 1 shows IT capability elements and some main references of research in IT capability-related area. Each of these four elements is reviewed in this study. Table 1 shows the comparison with other three components of IT capability, the last component-IT effective use has not been well researched in the literature.

The research hypothesis is proposed as follows: IT capability could be measured by four factors including IT human resources, IT infrastructure, IT partnership and IT effective use.

**IT human resources:** Generally, human resources in organisations include the training, experience, relationships and insights of their employees (Barney, 1991). Ross *et al.* (1996) argued that the important characteristic of a valuable IT human resource is IT staff who consistently solve business problems and address business opportunities through information technology. With the combination of training, experience and focused leadership, IT staff accumulate firm-relevant IT knowledge and competence. The IT human resources are important inputs in the development of IT capability (Ravichandran and Lertwongsatien, 2005). The critical dimensions of IT human resources are: IT personnel skills and IT company knowledge.

**IT personnel skills:** This includes technical skills, including business experience (Ross *et al.*, 1996; Bharadwaj, 2000; Bhatt and Grover, 2005; Ravichandran and Lertwongsatien, 2005) and managerial skills (Mata *et al.*, 1995; Bharadwaj, 2000). Technical skills comprise programming, systems analysis and design and competencies in emerging technologies while managerial skills include the effective management of IT functions,

coordination and interaction with user community and project management and leadership skills. The technical and managerial skills evolve through history and learning by doing over time (Katz, 2002; Bhatt and Grover, 2005). Therefore, they are heterogeneous across firms. From the RBV approach they are difficult to acquire to observe and imitate. They can be seen as sources of sustained competitive advantage (Bharadwaj, 2000).

**IT company knowledge:** Besides, technical and managerial skills, company knowledge of IT people plays a critical role for the IT department to deliver business required services and for developing IT capability. The understanding of business processes, routines, procedures and policies ensures the IT department delivers the right services at the right time to business and other functions in organisations. In addition, deep understanding of the organisation's culture and norms is necessary to develop working routines that fit and meet the organisational context in which IT department works and delivers services. Those working routines are important elements in the development of organisational capability in general and IT capability in particular (Nelson and Winter, 1982; Andreu and Ciborra, 1996).

**IT infrastructure:** IT infrastructure comprises computers, communication technologies and the shareable technical platforms and database (Ross *et al.*, 1996; Weill *et al.*, 1996). It is a set of shared technology resources that provides a foundation enabling present and future business applications (Earl, 1989; Duncan, 1995).

A flexible and reusable IT infrastructure is an intangible and important aspect of IT infrastructure. It can provide the technical platform, services and specialist resources needed to respond quickly to required business changes, new process designs or business initiatives (Peppard and Ward, 2004). It makes the integration of new technologies with existing ones easier thus, allowing firms

to have cutting-edge technology capabilities quickly and cost effectively (Ravichandran and Lertwongsatien, 2005). Thus, it has a positive relationship with firm's competitive advantage (Byrd and Turner, 2001). IT infrastructure flexibility has two dimensions: network and platform sophistication and data and core application sophistication. Platform readiness enables firms to provide faster, more cost effective IT solutions to end users while reusable data and applications can speed up application delivery.

**IT partnership:** Managing IT and delivering business value is a set of knowledge-based activities with a complex and multidimensional set of tasks and processes, incorporating many different and interdependent types of knowledge from different people with different background and experience in different business functions in organisations (Peppard and Ward, 2004). Thus, a close relationship between IT people and business people at all levels is needed in both formal processes and informal working relationships (Ross *et al.*, 1996; Chan, 2002). This relationship reflects the ability of the IT unit to understand business needs and create partnership with business units to work together to meet business's needs and exploit new opportunities (Bhatt and Grover, 2005). For the IT unit to deliver its services effectively to its customers (both internally and externally) an effective partnership is required both between the IT unit and business units and between the IT unit and its external partners like customers, vendors, service providers, etc. (Feeny and Willcocks, 1998; Ravichandran and Lertwongsatien, 2005). The IT partnership element has two dimensions: IT internal partnership and IT external partnership.

**IT effective use:** There is no inherent value of technology by itself. Only people can unlock its value by actually using it effectively. This can be taken place in business and management processes and requires knowledge and skills from within organisational functions and processes (Peppard and Ward, 2004). Very early, Zmud (1979) stated that the management information system success ultimately depends on how well the information system has supported decision making. Because a system that does not help people perform their jobs is not likely to be received favourably thus it will receives a low level of usage in spite of careful implementation efforts (Robey, 1979). By defining management information systems more precisely as an integrated, user-machine system for providing information to support operations, management and decision making functions in an organisation, Davis (1974) agreed that the objective of

IT/IS is to providing information to support other functions in organisations. Later, Davis *et al.* (1989) argued that computer systems cannot improve organisational performance if they are not used.

But using technology itself has two aspects: using the technology "use machine" by Davenport (1994)'s word and working with information (Marchand *et al.*, 2000; Peppard and Ward, 2004). It is argued that to get more business benefits, managers should not focus strictly on technology but on human psychology aspects which are how people in their organisations actually acquire, share and make use of information (Davenport, 1994). Goodhue and Thompson (1995) argued that for information technology to have a positive impact on performance, it must be utilised and must be a good fit with the tasks it supports. They measured the "task-technology fit" by using eight factors: quality of data, locatability, authorisation, compatibility, production timeliness, systems reliability, ease of use/training and relationship with users.

Now a days, organisations are concerned increasingly with making more effective use of information technology because it is considered as a major determinant of competitive advantage and even personal competency (Doll and Torkzadeh, 1998). There can be different criteria for measuring the usage of information technology in the implementation period and after-implementation period. In the former phase, due to implementation systems focusing, the more usage may be considered desirable. In post-implementation phase, system improvement efforts focus on reducing the cost and improving the effectiveness of the usage thus, utilising IT more effectively to perform organisational relevant functions and goals (Doll and Torkzadeh, 1998).

How extensively IT is used in a work context to perform organisational functions determines how effectively it is used in an organisation (Doll and Torkzadeh, 1998). In their study, Doll and Torkzadeh (1998) built a system use constructs, based on Hirschhorn and Farduhar (1985) cited in Doll and Torkzadeh (1998). There are three functions of IT utilisation which are decision support, customer service and work integration with their five components. Its functions and components are defined in Table 2.

Doll and Torkzadeh (1998) developed detailed measurement scales for IT use construct and tested them using a pilot study to refine these scales and then a survey study was used.

The approach used by Doll and Torkzadeh (1998) in developing the IT use construct is conceptually suitable to the view of IT effective use process suggested by

Table 2: Components of IT use

IT functions	Components	Definitions
Decision support	Problem solving	The extent that information technology is used to analyse cause and effect relationships (i.e., to make sense out of data)
	Decision rationalization	The extent that information is used to improve the decision making processes or explain/justify the reasons for decisions
Work integration	Horizontal integration	The extent that information is used to coordinate work activities with others in one's work group
	Vertical integration	The extent that information is used to plan one's own work, monitor performance and communicate vertically to coordinate one's work with superiors and subordinates
Customer service	Customer service	The extent that information is used to service people. The people serviced by the application may be internal to the organisation or external customers

Adapted by Doll and Torkzadeh (1998)

Peppard and Ward (2004). It focuses on how effectively IT is used to support operations, management and decision making functions in an organisation. However, since Ross *et al.* (1996) emphasised one of the three important dimensions of IT human resources is the problem-solving orientation, it might be a good idea to separate problem solving from decision rationalisation dimension for measuring the IT effective use construct later.

## MATERIALS AND METHODS

A questionnaire was developed based on research from literature review with some small modifications for the questionnaire to be suitable with Vietnam context. The structure of the questionnaire survey includes two parts: Part 1 with demographic information, Part 2: about four dimensions of IT capability. A seven-point Likert-type scale was applied to measure items used in the questionnaire developed for this study.

In Part 2: Questions 1-10 (Section 4a) measure IT human resources in two dimensions: company knowledge of IT personnel and IT personnel skills. Section 4b with 8 questions asked about IT infrastructure in two aspects: network and platform sophistication and data and core applications sophistication. IT partnership with its two dimensions: internal partnership and external partnership were measured by Section 4c with 8 questions. Question items for these three factors were based on Ravichandran and Lertwongsatien (2005) research. Section 4d measured four dimensions of organisation-wide IT effective use by 18 questions. Question items for this factor were based on Doll and Torkzadeh (1998) research.

Besides, relevant background information of respondents was collected. Four questions are asked about the position of respondents in the organisation, number of years worked in the company and their qualifications.

At the end of the questionnaire, there are places for respondents to fill in their contacts if they wish to. A short instruction on how to deliver the questionnaire and a thank you notice were addressed.

A questionnaire survey was created to collect empirical data from MBA classes in some universities in Hanoi. Hardcopy questionnaires were sent to universities's MBA students at their classes (about 200 students at site). Finally, 163 responses were received. Of which, 160 responses can be used for further study after data screening which represents about 80% response rate.

## RESULTS AND DISCUSSION

This research used confirmatory factor analysis to refine the initial measures of each construct and test for the internal consistency of scales for IT capability constructs.

As mentioned previously, most of the questions in the questionnaire for IT capability constructs are taken from previous studies with some modifications. Thus, each construct of the model is tested using one factor congeneric model before doing the hypothesis test. From the results of the tests, IT human resources now have 7 items IT infrastructure has 5 items; IT partnership has 7 items and IT effective use has 13 items. Detailed items are in the Appendix 1.

Because, the four factors of IT capability are interrelated, it is important to assess their discriminant validity. Large correlations between latent constructs, say >0.80 or 0.90, suggest a lack of discriminant validity (Smith *et al.*, 2005). Discriminant validity between these three factors was also checked through the structure coefficients which are in "all implied (for all variables) correlations" table in AMOS output.

An inspection of the coefficients for all four constructs shows a clear distinction between the items comprising the respective factors and the remaining items. The four factors are considered to have discriminant validity.

The hypothesis in this study is dealt with by using the model shown in Fig. 1. The model tests the measurement model of IT capability (IT human

Table 3: Standardised regression and fit estimates of the IT capability model

Standardised regression weights	Estimate	CR	p	Variance extracted	Variable reliability
Infra-ITcap	0.618			0.616	0.382
Human-ITcap	0.812	6.439	***	0.237	0.659
Partner-ITcap	0.635	5.763	***	0.492	0.403
IT use-ITcap	0.692	6.100	***	0.274	0.479
				Recommended value	Results
Reliability-cronbach alpha				$\alpha > 0.70$	0.773
Chi-square					9.710
Degree of Freedom (DF)					2.000
p				$p > 0.05$ (at $\alpha = 0.05$ level)	0.008/0.136
Normed Chi-square (CMIN/df)				$1 < \chi^2/df < 3$	4.855
Root Mean Square Residual (RMR)				$< 0.05$	0.033
Root Mean Square Error of Approximation (RMSEA)				RMSEA $< 0.08$	0.167
Goodness of Fit Index (GFI)				$\sim 0.9$	0.965
Adjusted Goodness of Fit Index (AGFI)				$\sim 0.9$	0.825
Normed Fit Index (NFI)				$> 0.8$	0.940
Tucker-Lewis Index (TLI)				$\sim 0.9$	0.851
Comparative Fit Index (CFI)				$\sim 0.9$	0.950

Summary results from AMOS 7.0 output for this study

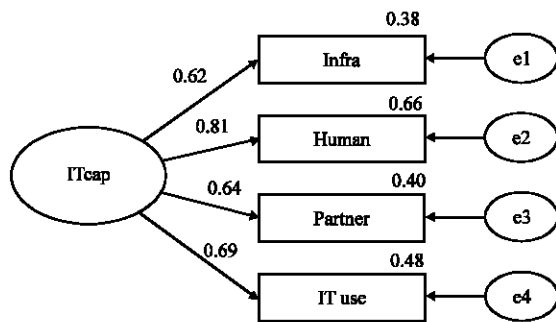


Fig. 1: One factor congeneric model of IT capability; Developed by the researcher for this research

resources-Human, IT infrastructure-Infra, IT partnership-Partner and IT effective use-IT use). The results of the measurement model are shown in Fig. 1 and summarised in Table 3.

From Table 3, we can see that the Cronbach coefficient alpha for the IT capability one factor congeneric model is high (0.773), indicating that the variables are a good measure of IT capability. The standardised regression weight and variable reliability for each variable was  $> 0.6$  and  $0.3$ , respectively. That means this model was a good measurement model for IT capability with evidence of convergent validity. In addition, all goodness of fit indices GFI, AGFI, NFI, TLI, CFI, RMR, except RMSEA and CMIN/df were within acceptable levels. The p-value was originally at  $0.008$  but increased to  $0.136$  after bootstrapping, indicating that the model fitted the data well.

Scree plot and scale reliability are also checked in SPSS. The results indicate that each of the four factors: IT infrastructure, IT human resources, IT partnership and IT

effective use is uni-dimensional. They are together a good measure of the IT capability. Together they explain  $60.6\%$  of the variance of IT capability (SPSS output table of "total variance explained" with these four factors (all had eigenvalues  $> 1$ ) provided  $60.6\%$  of extraction sums of square loadings). So, hypothesis  $H_1$  (IT capability can be measured by four factors: IT human resources, IT infrastructure, IT partnership and IT effective use) is supported by the data.

## CONCLUSION

The finding from this research empirically confirms the suggested theory that IT human resources, the relationship between IT and business people in organisations, IT effective use and IT infrastructure are good measures of IT capability. These four factors can explain up to about  $60\%$  of the variance of IT capability.

Of the four dimensions, IT effective use is the attribute having been least researched in the literature. With the viewpoint that the use of IT should be assessed based on its helpfulness to the working processes in organisations based not only on how much or how long IT is used (Zmud, 1979) this study uses the Doll and Torkzadeh (1998)'s measurements of IT effective use to assess the effectiveness of IT use in organisations. Although, the measurements themselves are taken from previous research, the application of them on a new context for a different purpose is a new contribution in this field.

In summary, the finding of this research supports the hypothesis that IT capability can be measured by four

factors: IT human resources, IT partnership, IT effective use and IT infrastructure. It adds to the literature showing that IT capability is not only related to IT resources such as human resources, IT partnership and IT infrastructure but also related to how effective organisations are in using IT. This measurement model can be used to assess the degree of IT capability in organisations.

This research makes important contributions to the understanding of IT capability. First, it provides evidence that IT capability is a multidimensional construct, including four dimensions. It confirms that IT capability does not only refer to the IT resources (such as human resources, infrastructure and relationship between IT and business people) but also refers to how these resources are combined and used effectively for organisational objectives and for working operations in organisations.

Second, this study not only investigates the components of IT capability but also measures it empirically with detailed measurement scales which reflect these four dimensions of IT capability. It would be useful for other research which requires measurement model of IT capability. Moreover, knowing that IT capability has four important factors IT human resources, IT infrastructure, IT partnership and IT effective use helps managers in understanding and measuring IT capability while trying to build and improve it.

## LIMITATIONS

One limitation of this study is that the questionnaire was answered by MBA students who are working at companies. It would be better for future studies to consider research designs that allow data collection from multiple respondents within a company.

**Further research:** Further research is needed to validate and generalise the findings to broader settings. The research could be replicated in other contexts such as in different areas and in different industries.

## APPENDIX

### Appendix 1: IT capability measurement items

#### IT human resources:

- Our IT staff has very good technical knowledge; they are one of the best technical groups an IT department could have
- Our IT staff has the ability to quickly learn and apply new technologies as they become available
- Our IT staff has the skills and knowledge to manage IT projects in the current business environment
- Our IT staff has the ability to work closely with customers and maintain productive user or client relationship
- Our IT staff understands our organisation's procedures and policies very well

- Our IT staff is aware of the core beliefs and values of our organisation
- Our IT staff knows who are responsible for important task in this organisation

#### IT infrastructure:

- The technology infrastructure needed to electronically link our business units is present and in place today
- The technology infrastructure needed to electronically link our firm with external business partners (i.e., key customer, suppliers, alliances) is present and in place today
- The technology infrastructure needed for current business operations is present and in place today
- Corporate data is currently sharable across business units and organisational boundaries
- We have standardised the various components of our technology infrastructure (i.e., hardware, network and database)

#### IT partnership:

- Critical information and knowledge that affect IT projects are shared freely between our business units and IT department
- Our IT department and business units understand the working environment of each other very well
- There is high degree of trust between our IT department and business units
- The goals and plans for IT projects are jointly developed by both the IT department and business units
- We seldom have conflicts with our IT vendors and service providers
- We can rely on our IT vendors and service providers to respond to our IT needs in a timely and effective manner
- We have long-term partnerships with our key IT vendors and service providers

#### Organisation-wide IT effective usage:

- Our staff use IT systems to decide how to best approach a problem
- Our staff use IT systems to help them think through problems
- Our staff use IT systems to help them explain and justify their decisions
- Our staff use IT systems to rationalise their decisions
- Our staff use IT systems to make the decision process more rational
- Our staff use IT systems to improve the effectiveness and efficiency of the decision process
- Our staff use IT systems to communicate and exchange information with other people in their work group
- Our staff use IT systems to communicate and exchange information with people who report to them
- Our staff use IT systems to communicate and exchange information with people they report to
- Our staff use IT systems to serve internal and/or external customers
- Our staff use IT systems to improve the quality of customer service
- Our staff use IT systems to more creatively serve customers
- Our staff use IT systems to exchange information with internal and/or external customers

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