2. Literature Review

2.1. The Issues of IT

In the field of information management, more and more researchers and practitioners have become involved in researching information technology management mainly as classified into several academic fields, such as the information system category, decision making resource, and the function of enterprises. These classifications all study the value and position of information technology. Therefore, in information management, a classical pyramid shape has described the function of information system, with the operational level at the bottom. At the top is the management level, and the strategic level as the point. According to the nature of the problem, system-assisted decision-making resources could be divided into structured, semi-structured, and unstructured problems. On the other hand, the information system supporting operators, managers, knowledge experts and executives also could be divided into groups of sales & marketing, finance & accounting, manufacturing and production, and human resources to distinguish the type and value by the functional areas.

Afterwards, Porter’s competitive forces model has been introduced by a lot of researchers to associate competitive advantage of enterprises with cost reduction, product type and business concentration, and to look for IT support. According to different competitive strategies, they let IT take on the role that it can and offer the value that it can. Otherwise, they depend on the structure of the competitive force model to study how IT supports enterprise to compete against traditional competitors and potential competitors, and to interact with suppliers and customers, or to achieve strategic alliances, keep the balance, and even change the competitive rules, in order to change the present position or to create a long-term advantage.

In addition, the structures of value chain and value web are often adopted by researchers to study the value and rules of IT, and every activity that is divided by the contribution of profit are all linked with each other to create value for enterprise in the structure.

In earlier days, developing IT systems could create or increase the competitive advantage for an organization, but owing to the fast duplicable characteristic of IT, this kind of advantage could not exist for a long time. As a result, the resources which had strategic value and were difficult to be copied could be the source of lasting competitiveness. In the literature of IT assessment, there are three kinds of analysis views as follows:

2.2. Views of IT Assessment

2.2.1. Resource-Oriented View

It is a classic strategy to treat IT investment as a resource. IT spending or investment is regarded as expenditure if that function can be duplicated easily and cannot constantly offer a competitive advantage. However, a resource-oriented view focuses on IT skills and its integration with IT investment into an organization, especially in terms of intangible benefits.

Pike et al. (2005) takes a resource-based view of the process in order to understand the dynamic value creation of resources in R&D organizations. Intangible resources are usually categorized into three main groups – human, organizational, and relational. Pike divided tangible resources into two groups – physical and monetary. He was of the opinion that resources themselves never create value. Resources are not just static assets, but dynamically interact with each other to be transformed into value. Using conceptual maps of the value shop he describes the interaction of processes and proposed that the basic triangle structure between human, relational, and organizational capital should be visible in any R&D organization.

Resource group	*Scope*	*Ownership*	*Control*
Human	Resources which are intrinsic to people such as their creativity, behavior, education and ability	By employees	By company
Organizational	Resources which the company has developed such as brand, image, IP, know-how, culture, systems & strategy	By company	By company
Relational	External resources which the company needs or which affect the company such as the suppliers, customers, regulators and partners	By the other party	By the other party
Physical	The company's land, buildings, IT, equipment, materials and products	By company	By company
Monetary	The company's cash or other financial assets which are equivalent to or can be converted to cash	By company	By company

Fig. 2.1: Resource categories

Source: Pike et al. (2005)

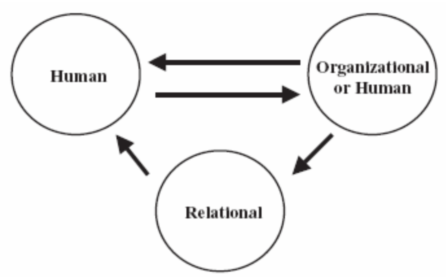

Fig. 2.2: R&D Dynamics

Source: Pike et al. (2005)

In order to identify key value drivers, especially intangible assets, Pike et al. (2005) first defined a minimum set of level one and level two resources which were distinct, complete and independent. Secondly, Pike et al. (2005) discussed how resources interact with each other and generated a conceptual map of resource deployment, called Navigator, and an influence space of resource effect, called Effector Plot. Using those diagrams, Pike could understand the resource identification and utilization in those R&D organizations.

Using a resource-oriented view, Pike et al. (2005) created the Navigator, as seen in the below figures. Pike et al. (2005) considered the company resources as being used ineffectively and inefficiently. Pike suggested that the firm concentrate on both knowledge input and results output with the external world, especially customers and suppliers. The firm was heavily dependent on management for direction. In order to increase sustainability and reduce dependence on individuals, Pike et al. (2005) suggested that the firm address the issue of management quality and usability, such as putting in place a research management system.

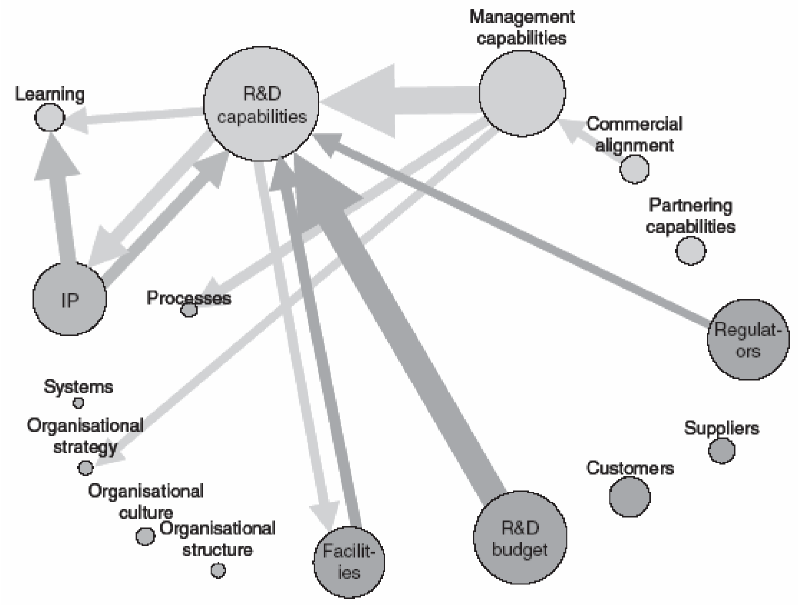

Fig. 2.3: Navigator (PharmaWorld)
Source: Pike et al. (2005)

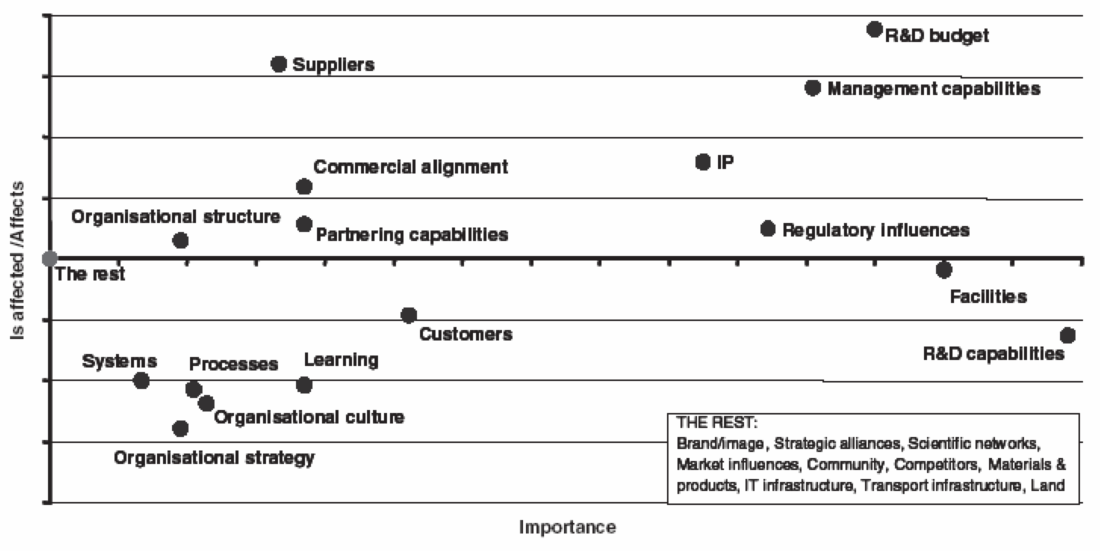

Fig. 2.4: Effector plot (PharmaWorld)
Source: Pike et al. (2005)

2.2.2. Capability-Oriented View

The financial performance of a firm is more related to IT asset management than the level of organizational IT spending. Diverse problems associated with IT assessment have been widely reported. When the purpose of IT investments is to improve operational efficiency, many traditional methods of evaluation may be suitable. However, if managers need to consider the wider strategic implications of IT investment, they should be concerned about their responsibility, vision, and future benefits.

Irani (2002) proposed an idea called concept justification. The traditional investment justification process centers on the details of direct project costs. Concept-based justification, however, requires a more persuasive approach to understand IT investments in the real world. This approach is likely to be sought by those with executive responsibilities, and it aligns the project proposal with the medium/long-term strategic and financial business plan of the company. It can also be expanded to operational employees. In other words, this approach can be used to communicate with project directors, senior management or operational stakeholders who surround the adoption of new technology.

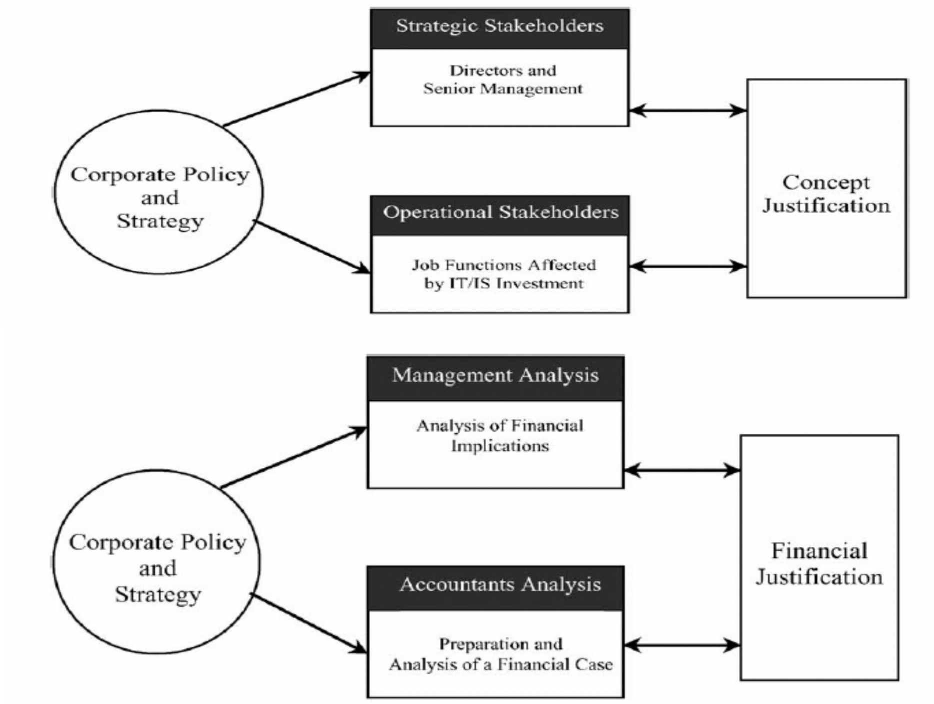

Fig. 2.5: Concept & financial justification stakeholders
Source: Irani (2002)

Irani (2002) takes the MRPII, the second generation system for raw materials, as an example. This is an ERP predecessor and one of the key modules of ERP. In bellowing figures, the MRPII's benefit, for the whole life cycle, can be divided into strategic, tactical and operational benefits. Each part can be divided into financial, non-financial and intangible. (1). Strategic benefits depend on the growth of revenue, successful modules, and the increasing market rate. (2). Tactical benefits depend on factors like the flexibility of production, quality promotion, open discussion and integration of enterprise functions. These would not be considered in assessment methods related to operational and financial affairs. (3). Intangible benefits include the flexibility of reporting structures, quantity of online communication, network ordering and purchasing, and reduction of manpower.

Taxonomy of benefits considered as part of cost/benefit/value analysis

Classification of MRPII benefits	Financial	Non-financial	Partly/totally intangible
Strategic benefits			
Improved growth and success	✓	✓	✓
Leader in new technology			✓
Improved market share	✓		
Market leadership	✓	✓	✓
Enhanced competitive advantage	✓	✓	✓
Tactical benefits			
Improved flexibility	✓	✓	✓
Improved response to changes		✓	
Improved product quality	✓	✓	✓
Improved organizational teamwork			✓
Promotes concept of open culture			✓
Improved integration with other business functions			✓
Increased productivity	✓		
Increased plant efficiency	✓		
Reduced delivery lead-times		✓	
Reduced manufacturing lead-times		✓	
Improved capacity planning	✓	✓	✓
Improved stability of MPS		✓	
Improved data management		✓	✓
Improved manufacturing control		✓	✓
Improved accuracy of decisions	✓	✓	✓
Operational benefits			
Reduced raw material inventory	✓		
Reduced levels of WIP	✓		
Reduced labor costs	✓		
Reduced manufacturing costs	✓		
Increased throughput	✓		
Improved data availability and reporting structure			✓
Improved communication through 'on-line' order progressing			✓
Improved product tractability			✓
Formalized procedures with accountability and responsibility			✓
Improved schedule adherence	✓	✓	✓

Fig. 2.6: Taxonomy of benefits considered as part of cost/benefit/value analysis

Source: Irani (2002)

Taxonomy of costs considered as part of bespoke cost/benefit analysis

Classification of MRPII costs	MRPII cost factor	Financial	Partly/totally intangible
Indirect human costs			
Cost of ownership: system support	Vendor support/trouble shooting costs	✓	
Management/staff resource	Integrating computerized production planning and control into work practices	✓	✓
Management time	Devising, approving and amending IT and manufacturing strategies	✓	
Management effort and dedication	Exploring the potential of the system for example linking and integrating new systems together, e.g. CAM, DNC, CIM	✓	✓
Employee time	Detailing, approving and amending the computerization of product BOMs	✓	
Employee training	Being trained to manipulate vendor software and training others	✓	
Employee motivation	Interest in computerized production planning and control reduces as time passes		✓
Changes in salaries	Pay increases based on improved employee flexibility	✓	
Staff turnover	Increases in interview costs, induction costs, training costs based in the need for skilled human resource	✓	
Indirect organizational costs			
Productivity losses and organizational impact	Developing and adapting to new systems, procedures and guidelines	✓	✓
Strains on resource	Maximizing the potential of the new technology through integrating information flows and increasing information availability		✓
Business process reengineering	The re-design of organizational functions, processes and reporting structures	✓	✓
Security software protection	The continuous need to upgrade security software to overcome hacking and other external attacks —viruses: this cost was seen as increasing and never ending with the need for many upgrades	✓	
Security breaches	Loss of time and the need to recover data and morale: there is also the cost of litigation threats from suppliers and customers, fraud, data theft, loss of productivity and system damage and corporate trust		✓
Organizational re-structuring	Covert resistance to change		✓

Fig. 2.7: Taxonomy of costs considered as part of bespoke cost/benefit analysis

Source: Irani (2002)

2.2.3. Management-Oriented View

In a great deal of research, the independent variables are inconsistent. It is very hard to identify which variables should be included and understand the tangible or intangible benefits that IT generates. The length of the influence period for IT is the issue to study. Because IT is used by people and organizations, the dynamic interactions are not clear. The proportion of variables that would lead to incorrect results should also be considered.

Davern & Kauffman (2000) present a perspective that emphasizes the importance of understanding where potential value from IT investment lies and how best to relate it contextually to the measurement of the firm's realized value across multiple levels of analysis. In order to understand how and why realized value often differs in practice from potential value, they clearly define the potential offered by IT investment and highlight the key role of value conversion contingencies.

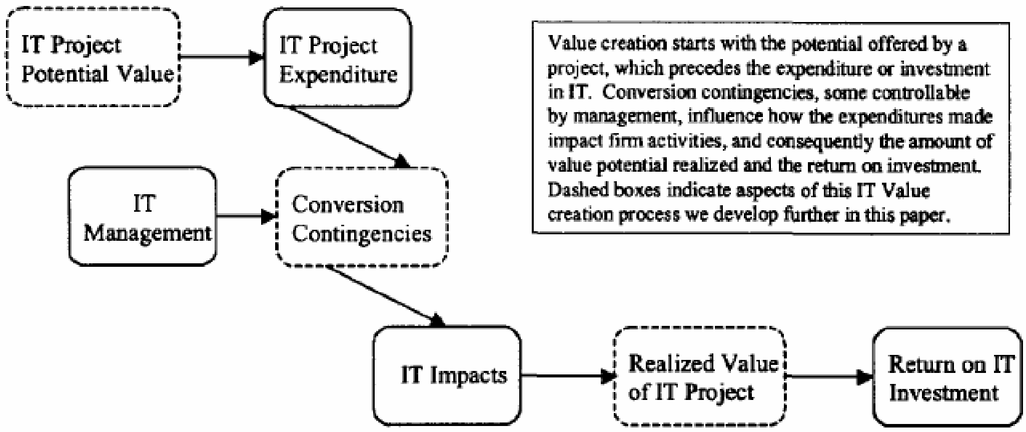

Fig. 2.8: The IT Value Creation Process: From Potential to Realized Value and Return

Source: Davern & Kauffman (2000)

Conversion-effectiveness problems within a firm are a difficulty for any investor trying to justify an IT investment. Davern & Kauffman (2000) argue that an appropriate assessment methodology is one that leads to an understanding of the potential value of an IT investment. The bellowing figure depicts this relationship between potential value and realized value and summarizes the key issues.

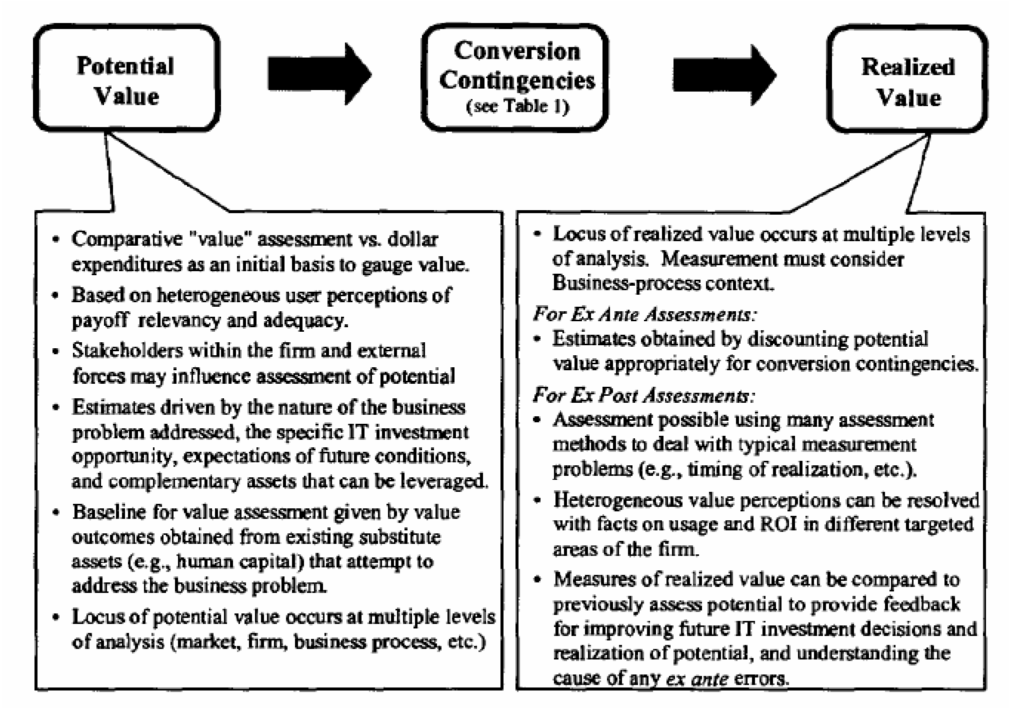

Fig. 2.9: Potential Value, Conversion Contingencies and Realized Value

Source: Davern & Kauffman (2000)

Analysis level (characteristics)	Examples of generalized value conversion contingencies
Market (environmental conditions, competitor actions, government regulation, technology standards)	Competitor makes an investment in a comparable IT solution and acquires some of the identified potential. Technology standards change impacting value realized from network externalities.
Firm (strategy choices, managerial performance, decision-making quality, IS development discipline, tolerance for change)	Failure to invest in infrastructure (a complementary asset) necessary to leverage and integrate the new applications being invested in, resulting in reductions in the realization of potential. Inadequate senior leadership in championing the project to ensure it receives the resources necessary to realize its potential.
Work group (knowledge dissemination, use of team leaders to promote adoption, work group differences)	Failure to invest in key complementary assets such as training, slack time to absorb changes etc., resulting in potential going unrealized. Lack of sharing of knowledge of effective system use across work groups causing potential value to be left on the table.
Business process (process design choices, system adoption subsidies, local management of change)	Inappropriate design of incentive schemes or procedures for use of application systems prompts problems with the adoption and effective use of systems, diminishing realized value.
Individual user (Individual differences, experience, risk-aversion, acceptance of change, professional level)	User inexperience, lack of training or cognitive limitations lead to ineffective use of systems, e.g., overriding recommendations of decision support systems in air traffic control or forecasts of consumer demand [15] leading to potential value being lost.

Fig. 2.10: Value Conversion Contingencies Across Multiple Levels of Analysis

Source: Davern & Kauffman (2000)

Davern & Kauffman (2000) propose that the location of potential value occurs where the opportunity to obtain returns from IT investments exists for an organization. This can occur at the level of the individual user, the work group, the business process, the firm, or the marketplace. Importantly, the two locations (potential and realized) are not necessarily the same. Any given IT project may have more than one location of value. Furthermore, a project that has a positive potential value at one level of analysis may have a negative potential value at another. Therefore, identifying both the locations of potential and where IT value gets realized is critical to how researchers and practitioners understand the measurement of value contribution from IT investments in organizational settings.

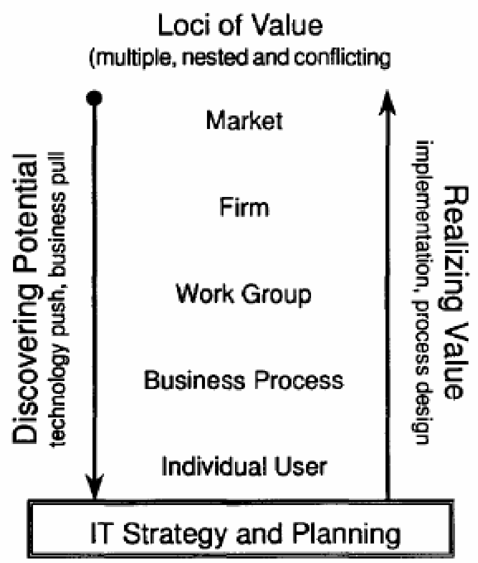

Fig. 2.11: Discovering Potential and Realizing Value
Source: Davern & Kauffman (2000)

Their framework and approach provides not only guidance about how and where to measure value potential and value payoff, but also a way of thinking about IT investment and the associated conversion contingencies that can limit the realization of an IT investment's potential.

2.3. Performance Indicators in High-Tech Industry

2.3.1. IC Indicators of PIP project in the IT Sector

Claessen (2005) reported how IT sector organizations in all five Nordic countries have worked together to start a project on using intellectual capital (IC) reporting to improve strategy formulation in SMEs in the IT sector.

From a management perspective the question is also whether there is any relation between IC measures or indicators and the managerial steering models available and if this affects the strategy formulation process. There is a vast body of available literature, Marr et al. (2003) state that there is little empirical testing of theories in the area of strategy development, diversification and expansion.

The PIP project (Putting IC into Practice) is started on February 15, 2004. The project's participants consist of three generations of entrants. There are ten companies starting as first generation companies, another ten added as second generation after 8 months from start and finally the last ten as third generation enter the project in month 24. The project is divided into four phases and tasks.

Phase one	Phase two	Phase three	Phase four
Identify indicators	Implementing indicators in participating companies	Identifying proper management tools for participating companies	Presenting the results of the project final report
Decide on the meaning of indicators	External reporting of results from implementation	Measurement of input in new models by harmonized indicators	Further dissemination and post project continuum
Create liaison networks with accountants, consultants etc.	Revision based on results	Evaluation of contribution, i.e. to learning process and economic results	
Prepare results for dissemination			

Fig. 2.12: PIP Project overview

Source: Claessen (2005)

(1). Phase one: Identifying the IC indicators relevant to the business

The participants had to decide on what indicators to use and how they were measured and also list new indicators if not already available.

(2). Phase two: Writing the preliminary IC report using the Danish guidelines

The Danish format for IC reporting is made up of two-parts consisting of a knowledge narrative on one hand and supporting indicators on the other. In the first part, the company stated its vision/mission, explained its business area and its management challenges. The IC indicators were then arranged into 15 categories along the three different dimensions of IC, i.e. human, structural and relational capital. The total number of indicators identified was around 100.

Human capital	Structural capital	Relational capital
Employees	Information systems	Customers
Staff turnover and recruiting	Quality management	Market and image
Skills and competence	Innovativeness	Visibility of expertise
Employee satisfaction and attitude	Competence development	Networks
Executive competency	Working conditions	
	Governance	

Fig. 2.13: Categories of IC indicators

Source: Claessen (2005)

The challenge was to identify the right causal relationships and track the right elements as measures loose validity over time and the nature of things being measured is maybe not correctly understood. The first learning point was to identify what indicators to use and what these indicators represented. The second learning point was to look at the indicators that none or only some of the companies used.

(3). Phase three:

The participants met for a work meeting to review the indicators and started work on identifying relevant managerial steering models. They would use a revized version of the Kaplan and Norton (2004) strategy map. The critical success factors (CSF) of the company were then aligned with the company's vision/mission.

The maps created by the companies listed only a few critical success factors, not more than 12 and usually fewer. Hence, the participants unanimously voted them to be too complicated to be of practical use. The companies agreed that, the simpler the model, the more it would help. The main thing was to identify the IC values and how they affect the company and how the future vision/mission of the company could be translated into a plan for execution.

(4). Phase four:

At the end of the project a possible 30 companies will have completed the learning journey, as this is designed as learning by doing.

By using these indicators with strategy maps and scorecards, the companies are provided with tools and information to improve their strategy formulation process and develop further their competitive advantage. Claessen (2005) reports on the practical application of the resource-based view of strategy, where intangible resources play a major role in the internal development path of a company.

2.3.2. Performance Indicators of e-Commerce in the Manufacturing Sector

A set of constructs to measure e-commerce capability in Internet-enhanced organizations, are developed by Zhu & Kraemer (2002). A potential framework for augmenting the theoretical basis of e-commerce value is the resource-based view of the firm, which links firm performance to organizational resources and capabilities. Firms create performance advantages by assembling resources that work together to create organizational capabilities. The resource-based view has been extended with the dynamic capabilities perspective (DCP) to address the realities of high-velocity markets and rapid technological change. DCP refers to the ability of a firm to achieve new forms of competitive advantage by renewing technological, organizational, and managerial resources to achieve congruence with the changing business environment.

The Internet is unique in terms of connectivity, interactivity, and open-standard network integration. These characteristics have very different impacts on customer reach and richness of information. The integration of e-commerce capability and IT infrastructure may improve connectivity, compatibility, and responsiveness of firm information systems, which leads to greater efficiency and lower costs.

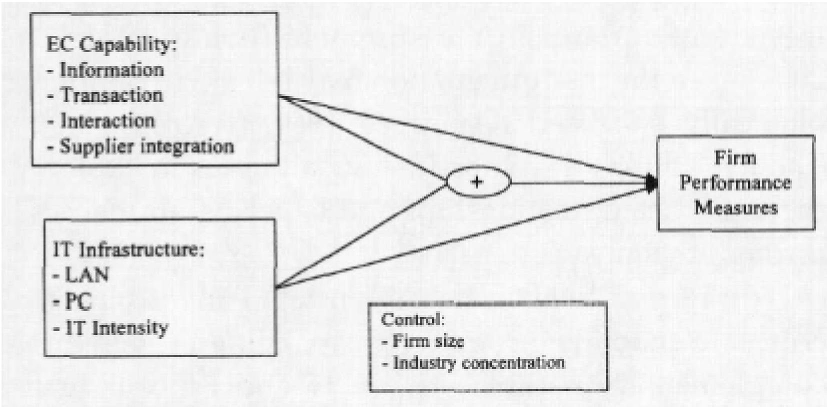

Fig. 2.14: Conceptual Framework
Source: Zhu & Kraemer (2002)

Variable	Description	Definition
PC	Number of PCs	PC is the total number of personal computers (including laptops) in the company.
LAN	Total Number of Local Area Networks	LAN represents the total number of installed local area networks in an organization, which denotes the extent of the connectivity of the organization's IT infrastructure. In general, LANs are measured by "bridges."
MIPS	Total Installed MIPS	MIPS is the total level of installed processing power, measured in millions of instructions per second (excluding personal computers).
IT Stock	Total Purchase Value of Systems	It is the total purchase value of all computer systems in the organization, which was calculated by CI and was based on the current value of the installed base.
IT Intensity	Intensity of IT Investment	It is created during this study by dividing IT Stock by the number of employees, EMP. By revealing IT value in dollars per employee, IT intensity indicates the relative emphasis put on IT and computer systems in each organization.

Fig. 2.15: IT Infrastructure Metrics
Source: Zhu & Kraemer (2002)

Variable	Description	Definition
REVPEREMP	Revenue Per Employee	It is calculated by dividing revenues (SALES) by the total number of employees (EMP) in each firm. This figure measures the productivity per employee in the firm.
GRMGNPCT	Profit Margin (%)	It is equal to the difference of SALES and COGS divided by SALES. It is an indicator of a firm's profitability.
COGS	Cost of Goods Sold	The item represents all costs directly allocated by the company to production, such as direct materials and supplies, direct labor, and overhead (not included in XSGA).
INVX	Inventory Turnover	The inventory turnover rate is calculated by COGS, divided by the average inventory level, INVT, (i.e., the average of the current year's total inventories and the prior year's total inventories). It represents the number of times the average inventory of a firm is sold over a given time period (typically a year). It is an indicator of a firm's operational efficiency along its supply chain.

Fig. 2.16: Performance Metrics
Source: Zhu & Kraemer (2002)

They analyzed all manufacturing companies from the Fortune 1000 list and generated a database of 260 companies. Data used in this study were obtained from both secondary data collection and public databases. First, data on e-commerce capabilities were collected through detailed content analysis on each company's Web site. These capabilities data were then matched with IT-infrastructure variables from the Harte-Hanks database of computer equipment, and financial-performance variables from Standard & Poor's Compustat database. Some companies used extranets or EDI to conduct businesses with their suppliers, which might not be observable from the Web site. To collect data on supplier connection and backend systems, they designed a survey of IT executives and e-business managers.