3. Research Method

3.1. Definition of IT Capital

We give the definition of IT capital as is the IT ability that an organization and a business accumulate over a period of time to gain a competitive advantage. It can be divided into tangible assets, such as IT infrastructure, hardware, software and networks, and into intangible assets, such as the capability of information staff and the experience accumulated in this domain.

IT capital structure of this research is extended from the IC structure of Edvinsson and Malone (1997), and we think that there are some relationship between IT capital and each capital as follow:

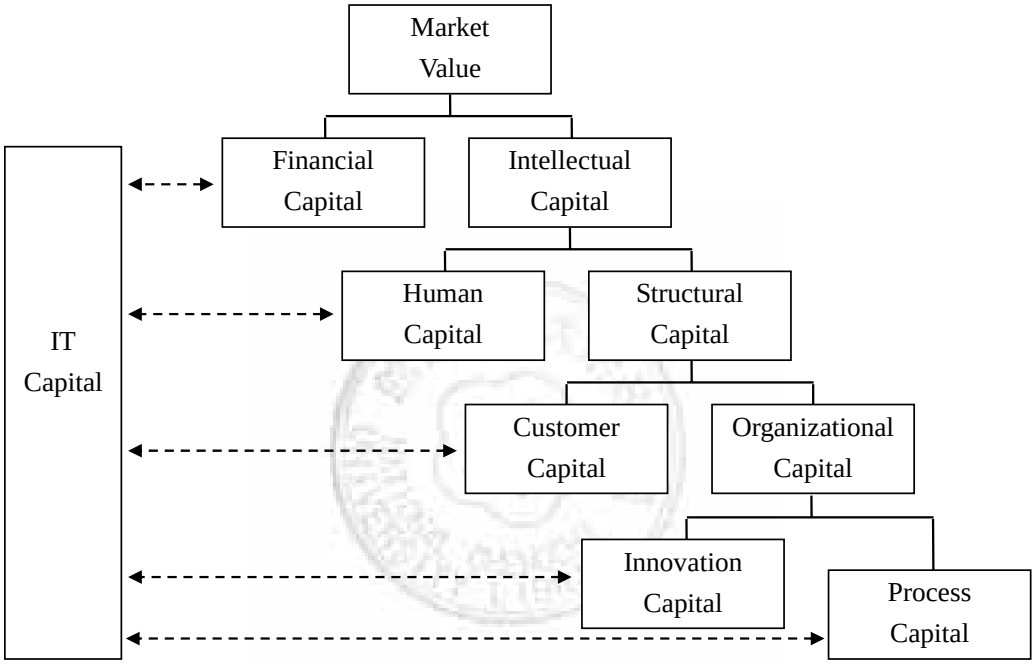

Fig. 3.1: IT capital structure

Source: Extended from Edvinsson & Malone (1997)

In the intellectual capital, IT capital plays an important role. Other capitals often depend on IT infrastructure and application to offer them information. When they need innovation and services, they often have to rely on IT, such as automation and computerization, to achieve their goals. For example, business process, which is an important component in the organization, is a kind of procedure, step, and department's core, and it could enhance the operating efficiency and improve the competitiveness through the support of IT.

Using the concept of system perspective, we divide IT capital into the two dimensions of IT input and IT output, and then we propose the following structure of IT capital performance indicators:

3.2. Development of Indicators

To develop the IT performance indicators and dimensions, we integrated several theories which literature review had stated into our original conception, such as three views of IT assessment, a classical pyramid shape of information management functions, and the recent research of intellectual capital. We carefully defined the indicators and construct the dimensions repeatedly using the methods of top-down and bottom-up analysis.

At first, according to the system perspective, we divided IT capital into two main dimensions of IT input and IT output. The conceptions of IT input indicators were mostly based on the resource-oriented view, capability-oriented view, and management-oriented view of IT assessment. However, the conceptions of IT output indicators were mostly based on the classical category of information management function and the intellectual capital research.

Depending on the resource-oriented view, IT investment was not only the expenditure in the financial statement but also a resource of organization. The resource would generate long-term benefit for the enterprise continuously. Therefore, we considered plenty of existing tangible and intangible resource, such as IT expenditure type and amount, the number of staff and the IT infrastructure facilities, to conclude the indicators and dimensions. For example, the dimensions of human resource, IT infrastructure and IT R&D ability and the indicators of IT budget, PC/NB per person, and the number of R&D employees were particularly based on this view.

Depending on the capability-oriented view, some IT investment could not only generate the operational benefit but also the long-term tactical and strategic capabilities in the future. We should measure the tangible and intangible capabilities which IT could provide to include the complete benefits. For example, the dimension of IT application capability and the indicators of problem handling ability (short-term), certification items and the contribution to business strategy (long-term) were particularly based on this view.

Depending on the management-oriented view, appropriate measurement indicators for each company would not be alike due to the different conditions of enterprise inside and outside environment. In addition, each IT investment did not create the benefit in the same position. To construct comprehensive indicators, we must consider the structure of various kinds of enterprises and the environment of enterprise’s industry. For example, the dimension of organizational structure and culture and the indicators of IT department position, the size of IT department and business model were particularly based on this view.

In the research of intellectual capital, IT enabled the transformation of enterprise’s business model and process. Measuring IT intangible assets had become

an important issue for academic researchers and practitioner. They usually divided intellectual capital into several capitals, such as human, innovation, process and relationship capital, to analyze enterprise tangible and intangible assets and to provide supporting of decision making and strategy adopting. In each capital, IT played an important role and contributed to the profit more or less. Therefore, it is suitable to analyze the benefit of our IT output dimensions by the classification of intellectual capital. For example, the dimensions of innovative products and services, process efficiency, and supplier/customer relationship and the indicators of the innovation capability and the contribution to business process were particularly based on this theory.

In the classical types of information systems, organizations could be divided into strategic, management, and operational levels and into four major functional areas: sales and marketing, manufacturing and production, finance and accounting, and human resources. Information systems serve each of these levels and functions. The organization had executive support systems at the strategic level; management information systems and decision-support systems at the management level; and transaction processing systems at the operational level. Thus, the typical IT systems found in organizations were designed to assist workers or managers at each level. As was previously stated, we had defined a lot of indicators associated with information systems. According to this theory, we added the dimension of knowledge management and organizational learning and the indicator of the contribution to cost reduction to measure the part of IT output benefit completely.

The relation between existing theories and the IT capital indicators was described as follows:

Table 3.1: Relationship between theories and IT capital indicators and dimensions

Theories	IT capital dimensions	IT capital indicators
Resource-oriented view of IT assessment	➢ IT Human Resources	✓ IT personnel expenditures ✓ The size of IT department ✓ Personnel turnover rate
	➢ IT Infrastructure	✓ IT budget ✓ PC/NB per person
	➢ IT R&D Capability	✓ R&D budget ✓ The number of R&D employees
Capability-oriented view of IT assessment	➢ IT Application Capability	✓ Certification items ✓ IT application level ✓ Problem handling
	➢ Strategy Contribution and Decision Quality	✓ The contribution to business strategy and revenue
Management-oriented view of IT assessment	➢ Organizational Structure and Culture	✓ IT department position ✓ CEO background ✓ Business model
	➢ IT Human Resources	✓ The size of IT department
	➢ IT Application Capability	✓ IT application level
Intellectual capital research (human capital, innovation capital, process capital and relationship capital)	➢ IT Human Resources	✓ IT personnel expenditures ✓ Personnel turnover rate
	➢ Innovative Products and Services	✓ The innovation capability ✓ The contribution to innovation
	➢ Intellectual Property	✓ The quality and quantity of intellectual property
	➢ Process Efficiency	✓ The contribution to business process
	➢ Supplier/Customer Relationship	✓ The requirements of supplier/customer relationship ✓ The contribution of supplier/customer relationship
classical pyramid shape of information management functions	➢ Reducing Cost	✓ The contribution of cost reduction
	➢ Knowledge Management and Organizational Learning	✓ Knowledge management execution ✓ The contribution to knowledge management
	➢ Strategy Contribution and Decision Quality	✓ The contribution to business strategy and revenue

As was previously stated, this research constructed related human and facility dimensions based on the resource-oriented view, including ‘IT Human Resources’, ‘IT Infrastructure’ and ‘IT R&D Capability’. Based on the capability-oriented view, we constructed related short-term and long-term capability dimensions, including ‘IT Application Capability’ and ‘Strategy Contribution and Decision Quality’. Based on the management-oriented view, we constructed related dimension of ‘Organizational Structure and Culture’. In addition, the indicators of ‘The size of IT department’ and ‘IT application level’ could also correspond to this theory. According to the intellectual capital research, four sub-capitals would be related to our dimensions of ‘IT Human Resources’, ‘Innovative Products and Services’, ‘Intellectual Property’, ‘Process Efficiency’, and ‘Supplier/Customer Relationship’. According to the classical category of information management functions, three levels of operational, management and strategic systems were related to out dimensions of ‘Reducing Cost’, ‘Knowledge Management and Organizational Learning’, and ‘Strategy Contribution and Decision Quality’. Furthermore, each indicator was careful created and constructed by the related dimensions and theories.

3.3. Research Dimensions of IT Capital

3.3.1. Dimensions of IT Capital

This research divides IT capital indicators into three levels of measurement dimensions. The first level includes “IT Input” and “IT Output.” From the perspective of IT input, it is divided into five aspects including “IT Human Resources,” “IT Infrastructure,” “IT Application Ability,” “IT R&D Ability,” and “Organizational Structure and Culture.” From the perspective of the IT output, it is divided into seven aspects including “Strategy Contribution and Decision Quality,” “Innovative Products and Services,” “Reducing Cost,” “Process Efficiency,” “Supplier and Customer Relationship,” “Knowledge Management and Organizational Learning,” and “Intellectual Property.” The analysis of IT capital indicator is as follows:

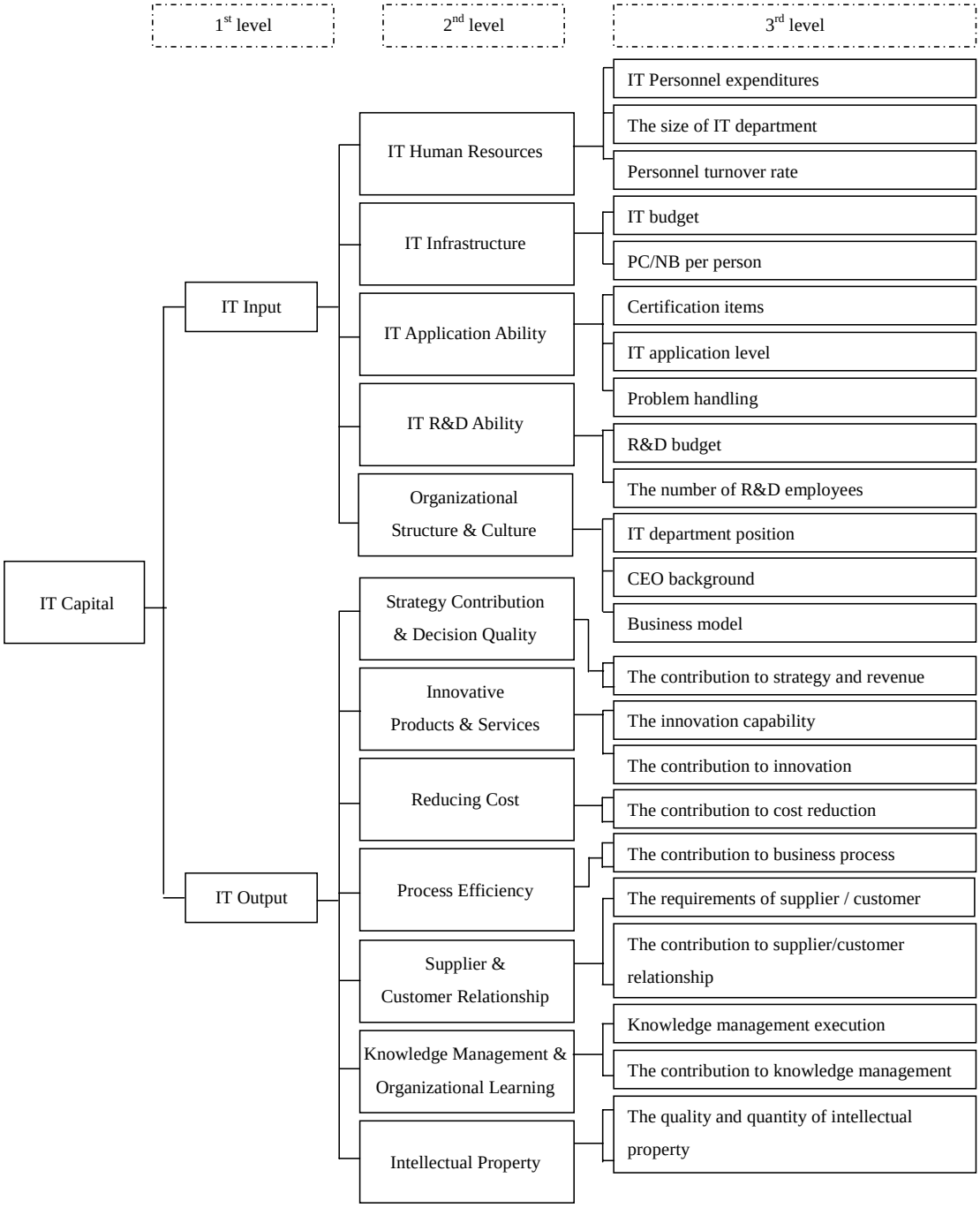

Fig. 3.2: Structure of IT Capital performance indicators
Source: This research

3.3.2. Research Dimensions in the Form of Questions

Referring to the measurement indicators studied by other researchers, we depended on our analysis hierarchy to define indicators and to construct the questionnaire as follows:

A. Measurement Perspectives of IT Input

A.1. IT Human Resources

From this perspective, we hope to measure personnel expenditures, the number of employees, professional tenure, and personnel turnover rate of IT department staff.

Table 3.2: Dimension of IT Human Resources

Indicators	No.	Questions
IT Personnel expenditures	1	The total expenditures of IT department
	2	The personnel expenditures of IT department
	3	The training expenditures of IT department
The size of IT department	4	The total number of IT department staff and the ratio of the number of IT department staff to the number of all staff
	5	The average professional tenure of IT department staff
	6	The average age of IT department staff
Personnel turnover rate	7	The turnover of IT department staff

A.2. IT Infrastructure

From this perspective, we hope to measure hardware & software expenses, maintenance fees, and the deployment ratio of computers and notebooks inside an organization.

Table 3.3: Dimension of IT Infrastructure

Indicators	No.	Questions
IT budget	8	Computer hardware expenses
	9	Computer software expenses
	10	IT Maintenance fees
PC/NB per person	11	The ratio of the number of personal computers to the number of employees
	12	The ratio of the number of notebook computers to the number of employees

A.3. IT Application Ability

From this perspective, we hope to measure how the organizations apply the ability of IT. According to the system and certification items, we could understand the quality and quantity of IT application. We also measure the efficiency of applying IT and handling problems.

Table 3.4: Dimension of IT Application Ability

Indicators	No.	Questions
Certification items	13	Main information systems
	14	Items which owns IT quality certification
IT application level	15	The ratio of jobs completed through the Internet
Problem handling	16	The average completion time of IT project
	17	The average time of handling problem by IT department

A.4. IT R&D Ability

From this perspective, we hope to measure the R&D investment and the labor power related to the IT R&D ability.

Table 3.5: Dimension of IT R&D Ability

Indicators	No.	Questions
R&D budget	18	The sum of money of IT R&D expense
The number of R&D employees	19	The number of employees which actually join the IT R&D

A.5. Organizational Structure and Culture

From this perspective, we hope to measure the IT department position, such as whether it is centralized or decentralized, and find out what level the IT department is at in the organization. Furthermore, we survey the background of the CEO and the business model, such as B2B, B2C, C2B, or C2C. It could help us to understand the organizational makeup of companies.

Table 3.6: Dimension of Organizational Structure and Culture

Indicators	No.	Questions
IT department position	20	IT department position in company's institutional framework
CEO background	21	Background and experience of the CEO
Business model	22	Business model in the company

B. Measurements Perspectives of the IT Output

B.1. Strategy Contribution and Decision Quality

From this perspective, we hope to measure how IT helps the strategy and revenue through the effect and support of the management, the viewpoint of each department as to the contribution of the IT department, the improvement ratio of strategy-making and revenue contribution from IT in each year, and the comparison of profit with industry peers.

Table 3.7: Dimension of Strategy Contribution and Decision Quality

Indicators	No.	Questions
The contribution to strategy and revenue	23	The effect of the IT managers on the corporate decision
	24	The contribution of IT department to the revenue for each department
	25	The influence of IT department on the decision of moving, expanding or combining factories
	26	The influence of IT department on the decision of increasing, decreasing or merging the production line and product category
	27	The effect of IT on decision-making
	28	The contribution of IT to the revenue
	29	The contribution of IT to the quality of strategy-making by administration
	30	The comparison of profit with industry peers
	31	The comparison of quality of strategy-making with industry peers

B.2. Innovative Products and Services

From this perspective, we hope to measure the innovative capability through the ratio of innovative proposals by the IT department staff and the type of innovative proposals, and to measure the importance of the capability through the degree that senior managers and other departments value it. Other questions are the improvement ratio of IT for innovation in each year and the comparison of innovative capability with industry peers.

Table 3.8: Dimension of Innovative Products and Services

Indicators	No.	Questions
The innovation capability	32	The ratio of the number of IT department staff to the number of proposals
	33	The number of innovative proposals from IT department
	34	The relationship with innovative proposals of IT department and IT infrastructure
	35	The relationship with innovative proposals of IT department and business model
	36	The relationship with innovative proposals of IT department and business process
	37	The relationship with innovative proposals of IT department and production
The contribution to innovation	38	The contribution of IT on the innovative products and services
	39	The comparison of innovative products and services with industry peers

B.3. Reducing Cost

From this perspective, we hope to measure the contribution of IT for reducing business process and production costs. Then, we measure the comparison of reduced cost with industry peers.

Table 3.9: Dimension of Reducing Cost

Indicators	No.	Questions
The contribution to cost reduction	40	The contribution of IT for reducing business process costs
	41	The contribution of IT for reducing production costs
	42	The improvement ratio for the contribution of reducing costs by IT
	43	The comparison of reduced costs with industry peers

B.4. Process Efficiency

From this perspective, we hope to measure the contribution of IT for process efficiency through the contribution of IT for process efficiency of daily operation, customer service and delivery, the improvement ratio of IT for process efficiency in each year, and the comparison of process efficiency with industry peers.

Table 3.10: Dimension of Process Efficiency

Indicators	No.	Questions
The contribution to business process	44	The contribution of IT for daily operating process efficiency
	45	The contribution of IT for process efficiency of customer services
	46	The contribution of IT for process efficiency of delivery
	47	The improvement ratio for the contribution of process efficiency by IT
	48	The comparison of process efficiency with industry peers

B.5. Supplier/Customer Relationship

From this perspective, we hope to measure the contribution of IT to supplier/customer relationships. First, we understand the need of suppliers and customers for IT. Next, we will measure the contribution by IT through the increasing good relationship with suppliers and customers, the improvement ratio of IT for supplier/customer relationships, and the comparison of supplier/customer relationships with industry peers.

Table 3.11: Dimension of Supplier/Customer Relationship

Indicators	No.	Questions
The requirements of supplier/ customer relationship	49	The need of suppliers for IT infrastructure
	50	The need of customers for IT infrastructure
The contribution to supplier/ customer relationship	51	Increasing good relationship with suppliers by IT
	52	Increasing good relationship with customers by IT
	53	The improvement ratio for the contribution of supplier relationship by IT
	54	The improvement ratio for the contribution of customer relationship by IT
	55	The comparison of improving supplier relationship with industry peers
	56	The comparison of improving customer relationship with industry peers

B.6. Knowledge Management and Organizational Learning

From this perspective, we hope to measure the degree of implementation and

contribution of IT for KM through the time of implementing KM, the mechanism which merges knowledge rating into personnel assessment, and the frequency of managers using KM. We also measure the support of the CEO and each department for KM and the comparison of improving the KM environment with industry peers.

Table 3.12: Dimension of Knowledge Management and Organizational Learning

Indicators	No.	Questions
Knowledge management execution	57	The time of implementing knowledge base (KB) and KM
	58	Implementing the mechanism which merges knowledge rating into performance appraisal
	59	The frequency of managers using KB and KM
The contribution to knowledge management	60	The support of CEO for KM
	61	The degree of IT department for KM (by each department)
	62	The improvement ratio of IT for the contribution of KM and organizational learning
	63	The comparison of building environments of knowledge-sharing with industry peers

B.7. Intelligence Proprietary

From this perspective, we hope to measure the number and the type of intellectual property owned by organizations (such as patents, programs, business models, process reengineering, production automation, etc.) and to know the importance of IT intellectual property in the organization.

Table 3.13: Dimension of Intelligence Proprietary

Indicators	No.	Questions
The quality and quantity of intellectual property	64	The number and the type of intellectual properties owned by organizations

The research approach is case study orientation. There are six live case studies we have conducted to develop and verify the set of performance indicators for IT capital. Using our IT capital indicators, we conduct interviews with IT managers of the firms and they provide suggestion to our indicators. Finally, a questionnaire approach was taken to gather the scores from the IT managers to provide the validity of the indicator development.