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New Approaches for IT Human Resource Development: Korean Cases and the Applicability to Other Countries

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Abstract This article aims to examine the achievement and limitation of adaptation of supply chain management (SCM) to IT human resource development (HRD) in Korea and to derive the implication of the Korean experience to other countries. In late 1990s, the IT New Deal Policy and the quantitative expansion of IT HR were introduced. Since mid-2000s, there has been much innovation in IT products as well as increased demand of highly qualified IT experts. The SCM in IT HRD was introduced in 2004 and continuously developed more. Since the late 2000s, IT convergence expanded to traditional industries and the new IT-based-industries were created in Korea. In this regard, Korea established the Seoul Accord as an international IT engineering education accreditation system in 2008. In response to the paradigm change, in 2011, the Korean government developed TOPCIT, which is a kind of competency test for evaluating IT competency.

Keywords IT HRD, SCM, skills mismatch, accreditation, competency test

Ⅰ. Introduction

This research aims to examine the achievement and limitation of adaptation of supply chain management (SCM) to the IT human resource development (HRD) of Korea and to derive the implication of the Korean experience to other countries. During the examination, the issues in adaptation of SCM to IT HRD are discussed and the applicability of the Korean experience to other countries is also discussed. The research methodology is a descriptive way about historic events from the perspective of the SCM framework.

After launching light-industries (textile and apparel industry and food and beverage industry etc.) in the 1960s and heavy and chemical industries (shipbuilding industry, automobile industry, electrical and electronics industry

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and petrochemical industry etc.) in the 1970s, large Korean companies started making semiconductor products in the early 1980s (Webb, 2007).

In the mobile telecommunication sector, the country introduced the world's first CDMA service in 1996 with Korean smart phones now competing for top position in the global smart-phone market. However, in spite of very successful economic development until the mid-1990s, the Korean economy confronted the Asian Financial Crisis in 1997 and many workers were left unemployed amidst the collapse of many firms.

To overcome the economic crisis and ensuing high unemployment rate, the Korean Government tried to boom up venture companies including IT companies through a Venture / IT New Deal Policy. The Government supported and supplied IT facilities to education institutions to better support infrastructure during the crisis. The quantitative expansion of IT human resources has been accomplished by the government's consistent support. From this perspective, the IT New-Deal to overcome the crisis in 1997 was an impetus to expand IT HR (human resource) policy.

Until early 2000s, the establishment of IT departments and the increase of the student enrollment were signs of expanding the infrastructure of the IT industry. Since the middle of 2000s, there have been lots of innovations and inventions in IT products including display, semiconductor, mobile phone along with the increased demand of highly qualified IT experts. The IT New-Deal policy also brought the supply chain management (below, SCM) model to IT HR education in 2003. The concept of SCM regards the education institute as supplier and company as demander, while allowing the education of IT HR to match with the needs of companies.

Since the late 2000s, IT convergence expanded to the traditional industries (automotive, shipbuilding, and so on) and so new IT-based-industries were created in Korea. In this regard, Korea established the Seoul Accord[1] as an International IT engineering education accreditation system, that had participants from the USA, UK, Japan, Canada and Australia in 2008.

Table 1 Periodical overview of IT HR in Korea(1997-2013)

Year	97	98 ~ 02	03 ~ 07	08	09	10	11	12	13
Condition	Crisis	Focusing on Venture	High-Tech IT H/W	IT convergence, S/W					
IT HR		Expansion of IT HR	SCM	Accreditation TOPCIT					

IT is becoming general technology to all industries, and IT HR is a key element in the shift to the new paradigm of a smart society. Demand for IT HR

[1] The Seoul Accord is a special version of the Washington Accord as a general engineering education standard.

has spread among all industries, and the quality of IT HR is becoming increasingly important. With response to the paradigm change, the Korean government has developed TOPCIT in 2011 and has now begun implementation. TOPCIT is a kind of competency test for detecting IT competency, in order to allow the objective evaluation of competencies required by the company and to strengthen the management of the quality of higher education.

In chapter 2, theoretical issues in using SCM in IT human resources development are discussed. Chapter 3 and chapter 4 examine the development of the education of IT HR in Korea from the perspective of SCM. During the examination of Korean experiences, the achievement and issues related to the supply chain model in IT HRD are considered. In Chapter 5, the achievements and limitations of using SCM in IT HRD are discussed and the applicability of the Korean experience to other countries is also discussed.

Ⅱ. Theoretical Issues

The idea of 'supply chain management' itself can be traced to the 60s and 70s, when firms began to view themselves as closely linked functions whose joint purpose was to serve their customers. In the 80s and 90s, many firms continued to further integrate this internal integration (Mentzer, J.T. et al., 2001). That allows firms to optimally respond to customer demands. It is a holistic view of the firm from the origin of raw materials through to the use of completed products or services by the ultimate consumer. The idea of supply chain optimisation can be looked upon as "something to be", some objectives for the future. The core of supply chain management is communication, allowing ultimate consumers to become partners in the process. As a result, not only is the product or service more likely to be delivered to the customers as it is currently desired, but the product or service can actually be changed in design as the needs of the customer changes (Fredendall and Hill, 2001).

The concept of supply chain management is soon applied to education, and the interlinkage between practice and theory has been evaluated in the late 1990s and early 2000s (Bak and Boulocher-Passet, 2013): industrial visits as a tool to establish a link between industry and education, and embedded operations through course content, teaching and assessment in 1998 and the assessment of industry-education links through business executives' perspectives in 2000. Bak and Boulocher-Passet (2013) further suggest a SCM consultancy module for industry and supply chain management education, with the key stakeholders (lecturer-student-company).

Gowen and Tallon (2003) review the critical impact of human resource

factors on the competitive advantage of SCM practices. Their results show an interactive role of managerial and employee support to enhance the effectiveness of employee training and to mitigate the adverse effects of barriers to implementation on the success of SCM practices. Lengnick-Hall et al. (2013) also study the relationships between strategic human resource management and the supply chain. They argue that firms with a supply chain orientation will increase organizational (and supply chain) performance if they enable an effective blend of alignment and flexibility among their HR systems. Flexibility in this context involves how tightly or loosely coupled the human resource systems are among supply chain member firms as identified by particular strategic approaches (explorative, adaptive, and integrative).

However, despite the wide adaptation of SCM in education and the close linkage between SCM and human resource, there remains doubt on whether SCM is applicable to the education and training of the IT sector, which is the one of the fastest-changing areas of technology. Bringing attention to the increasing importance of flexibility in modern production systems, particularly in the software sector (Cusumano, 1992), Cusumano et al. (2000) argues that technologies like the Internet have permanently accelerated the flow of information and new products and services around the world, and that managers in the age of the Internet must build the capabilities to change quickly all the time. From the series of research, which highlighted the rapid change of IT skills, they said that there is an increasing importance in the ability to learn skills rather than having ready-made skills itself.

Based on the previous debates and issues about the adaptation of SCM in the education and training of the IT sector, this article attempts to show how IT HRD in Korea has evolved with the concept of SCM and to examine the achievement and limitation of the application of SCM in IT HRD in Korea. This article further discusses the remaining issues and the applicability of IT HRD in Korea to other countries.

Ⅲ. Early Adaptation of SCM in IT HRD

1. Limitations of Quantitative Expansions of IT HRD

Despite the quantitative expansion of IT HRs, there have been qualitative mismatches in demand and supply of IT workers, with accelerating technological changes in IT. The remained mismatches caused new directions to arise for qualitative improvement of IT HRs from 2003 through SCM. According to manpower projections of 2005, the quantitative expansions of IT HRs were anticipated as shown in Table 1. Here, based on the IT occupational projection

from 2004-2015, the demand of IT HRs increased from (in thousands) 1,462 in 2004 through to 2,161 in 2010, and up to 2,440 in 2015 with an annual growth rate of 3%. The projected growth rate of IT occupational HRs is much higher than the average for the whole occupation.

Table 2 Projections of IT HRs based on occupation in 2005

(Unit: thousand people, %)

	2004	2010	2015	Annual growth rate (04-15)
IT Occupational HR	1,462	2,161	2,440	3.0
Whole Occupational HR	22,557	24,444	25,600	1.2

Source: Chang (2005)

Table 3 Differences between Supply-Demand of IT HRs, in 2004-2015

(Unit: thousand people)

	Growth demand(Dg)	Substitution demand(Ds)	Supply (S)	Difference [S-(Dg+Ds)]
2 yrs. college	228	33	418	156
4 yrs. university	444	46	578	88
Graduate level	220	11	167	-64
Total	892	90	1,163	180

Source: Chang (2005)

From focusing on total higher education, the size of the newly demanded IT HRs was projected as 982 thousands persons, which consists of the growth demand for 892 thousands, and the substitution demand for 90 thousands during the 2004-2015 period. In this projection, the size of the total supplied in Korea was expected to be 1,163 thousands people during 2004-2015, and therefore there would be an over-supply of IT HR in higher education overall. However, despite the over-supply, there would be an under-supply at the graduate level in IT HRs.

It was also anticipated that the shortage of IT experts would be serious in spite of the overall over-supply of IT HR. The jobless rate of college and university graduates who majored in information technology was almost 68% in February 2001 (KISDI. 2003). However, according to a survey (KIPA, 2003), over 70% of the companies had a lot of problems in hiring suitable persons that they needed. Companies still faced a job market with a dearth of suitable IT experts, despite of overall over-supply of IT HR. Also, according to

KIPA's technological forecast (KIPA, 2003) at that time, the life cycle of IT HRs was getting shorter as the technological change of IT becomes faster. The average life cycle of S/W human resources was anticipated as about 7 years. Therefore, the industry requested a systematic industrial recall in education.

2. Introduction of SCM Model

To deal with the problems of quantitative expansions, a new approach of HRM was involved in the management of engineering education, especially in the field of IT. The concept of SCM was adapted from this perspective. It is well known that the SCM model highlights global optimization of all activities along with the supply chain and the highest priorities in customer demand. These characteristics of SCM are expected to improve the supply-oriented IT HRD process, producing a robust university-industry collaboration system, which is urgently needed to imbue the Korean educational institutions with pragmatism.

In principle, the SCM-based IT HRD model does not intend to restrict the discretion of universities or to pursue blindly the requirements of business. Rather, it focuses on facilitating a mutual understanding and benefit. Business is asked to express precisely the specifications of knowledge, skills and capability of workforces that they need, instead of generally complaining about the lack of skilled manpower. Universities are expected to be more effective in helping students find jobs after graduation by aligning all their educational efforts and resources with what the industry really needs. Also, the government can formulate and implement more adequate HRD policies on the basis of accurately knowing how many workers are needed, during what times, and in what areas.

For the new HRD model to be implemented effectively, the following three tasks are needed to be done in advance. First, a more improved IT HRD and supply process has to be designed in views of SCM on the basis of a thorough diagnosis and analysis of the existing ones. Secondly, an effective university-industry collaboration system has to be established in order to put the new industry-oriented education process into practice. And thirdly, an accreditation system has to be set up for businesses to recruit trustworthy graduates who have taken the new demand-oriented educational programs.

As mentioned above, the previous Korean IT HRD process can be defined as a "push process" which fails to reflect the requirements of industries. To become a demand-oriented "pull process", it is important to determine a time point where universities start to seriously take industrial needs into account in their education. In the manufacturing area, a kind of push process, called Build-to-Stock, is usually adopted when customers' requirements are

unrecognizable on the supply chain.

One of the critical drawbacks of this approach, however, is that it costs the firm enormously to change specifications of its final products according to unexpected changes of customers' preferences. To remedy the inefficiency of such a push approach, a systematic analysis on the production process is necessary to identify a certain processing point to which a production process can be implemented regardless of changes in customers' requirements. This point is called a "response buffer" which essentially means that products can be customized to meet clients' specific needs from this point. That is, a pull process, called Configure-to-Order, starts here. Thus, the process prior to the response buffer can be named as a "general basic process", while the process after the response buffer is referred to as a "specific application process".

This concept in the production process could be well grafted into the IT HRD process. As an example, let's consider a curriculum in a computer science department offering a four-year education and training program. The curriculum could be split into two parts: one being the "basic" curriculum including common necessary courses which provide a base for, and are applicable to various ranges of computer and software areas, and the other being an "advanced" curriculum consisting of application courses and projects through which students acquire knowledge and skills specifically demanded in the field. In this case, the response buffer could be the end of the 5^{th} or 6^{th} semester. So, industrial requirements can be filled up after the response buffer by placing emphasis upon practical exercises and projects. Businesses could also take part in developing curriculum from this point.

In addition to the HRD process innovation, it is also significant to match expectations with qualifications of students between university and industry. To ensure a fit, they should have an open discussion and come to a consensus on a standardized curriculum comprising of detailed courses and course trees.

One of the important characteristics of SCM is to collect information from various actors on the entire supply chain using information and telecommunications technologies, and manage the whole supply process with the purpose of rationality and global optimization. IT-based business-to-business (B2B) collaborations have provided a main tool for the innovation in SCM. At the core of the B2B collaboration are standardized workflows and information sharing among participating companies.

The IT HRD process improvement based on the SCM model would, in the end, result in a collaboration mechanism which enables both the supply and demand sides to cooperate. A physical form of the collaboration mechanism could be an education-to-business (E2B) web site on the Internet. Major participants in the E2B site would be businesses, universities and the government, and they could work together across planning, implementation and ex-post analysis stages. Detailed information on the collaboration among them is

presented in Table 4.

Table 4 Participants of E2B site and their division of labor

Stage / Participants	Planning stage	Implementation stage	Ex-post analysis stage
Business	- Required technological areas - HR demand forecasts and recruiting plan - Policy suggestions	- Recruiting plan - Recruiting results - Recruiting results vis-à-vis plan information	- Feedback on educational effectiveness - Suggestions on curriculum change
University	- Curriculum information - HR supply forecasts - Acquired technological areas	- HR supply plan - HR supply results - HR supply results vis-à-vis plan information	- Review on the adequacy on the curriculum based on demand information - Curriculum change plan
Government	- Analysis on the imbalance between supply and demand - HRD policy formulation	- Monitoring of HR supply and demand - HR statistics - Interim review on policy effects	- Overall analysis and evaluation on HRD and supply

Source: Hwang, et al. (2006)

The successful operation of the E2B portal site will depend a lot on the proactive participation of all actors in the IT HR supply chain. The accuracy and reliability of the information and the comfortable usage of relevant web sites will facilitate recognition and participation of a variety of stakeholders. In particular, the information provided by universities needs to include their curriculum and course syllabus as well as quantitative measurements on the competency of their students so as to enhance the credibility of their education and training programs.

The role of accreditation in the IT HRD and supply is twofold. On one hand, it will distinguish decent IT-educational programs, and make public the evaluation results to help businesses to find more reliable and high-qualified workforces. On the other hand, the widespread deployment of accreditation is anticipated to upgrade overall levels of IT education all around the country. Preparations for the accreditation in universities will contribute to improvement of curriculum, and changes in educational methods and content to yield a more industry-oriented workforce.

The accreditation system will have the following three traits. First, when IT departments establish and implement standardized demand-oriented curriculums and study courses in terms of SCM, the accreditation system will mitigate the burden of each university to develop their own curriculum and to contact businesses individually. But that can also be a weakness of the system in that differing situations surrounding each university are neglected and the

autonomy of universities are hampered. Thus, the government needs to specify the standardized curriculum and education methods to a minimum so that universities can maintain discretion to a certain extent in educational planning and execution.

Second, the weight of accrediting activities will not be given to external aspects of universities such as the number of faculty members, educational facilities, etc., but to the internal educational process. That is, the accreditation system will look at standardized curricula, implementation processes, and quality of trained students. Here, the implementation process includes course composition, educational methods, experiment and exercise methods, term projects, methods of evaluation and so on. The quality of trained students measures whether university graduates reach a certain performance level which the IT industry imposes, and can be judged indirectly depending on their grades in the course or directly by the scores obtained in a nation-wide common test.

Third, quantitative criteria are needed to eliminate any possible risks of distorting evaluation results by subjective judgments of evaluators. Korea is a geographically small country, so personal relations and inadequate lobbies are liable to work during the evaluation process. Thus, quantitative criteria are regarded as a more effective evaluation process.

The procedures to deploy demand-driven (pull-based) IT HR projects have three steps. First, to know quantitative and qualitative supply and demand on human resource of IT companies, there should be reliable bases such as a career path map, a forecasting model and surveys of detailed technical levels based on a skills standards framework. It is very crucial to derive elaborate forecasts on differences between supply and demand of human resources for a better direction to IT HR policy.

Second, based on this forecast, the supply of IT HR should respond to the demand of companies through competitive reinforcement programs in college education that includes curriculum reform, internship, and competent faculty leadership. The IT curriculum reform project has helped students improve problem-solving capabilities through practice and project-oriented programs since 2001, while the non-IT course curriculum reform project has concern about the integration of computer programming and IT technologies with non-IT courses. To strengthen the computer-software education areas, the Korean government suggests a college standard curriculum and detailed syllabus for about 5 major tracks (embedded system s/w; system integration; system development; multimedia and game; business information technology track) that has influenced industries' needs since 2004. Moreover, to adapt to technological changes and the industries' demand, it also supplies demand-oriented lecture books. In addition, students are available for internships at IT companies when they are in school to acquire field experiences. Also,

professors who participate in the 'IT HRD through SCM program', have many opportunities to learn IT hot skills through the "Teach the Teachers program". Ultimately, there are plans to offer the accreditation system to universities for establishment of quality management in IT HR programs.

Third, university and industry collaboration systems are set up in terms of an on-and-off line as a matching system between supply and demand. That is, demand collaboration (forecasting models and career path maps for manpower), design collaboration (curriculum, detailed syllabus, etc.), supply collaboration (job matching), and capacity collaboration (internship) between academic institutions and industries are considered as key success factors of SCM. Thus, the expected outcome of SCM is the academic institution's optimal supply (IT HR reflected industry's needs) to the industry at the right time.

Ⅳ. Quality Improvement of IT HRD with SCM

1. Persistent Skills Mismatch

From 1997 to 2012 in Korea, USD 25 billion was invested to improve the quality of IT education. As a result, 266,000 IT human resources with over 37,000 people with masters or doctorates have been provided in higher education in 2000-2011 (NIPA, 2012a). Even though such a large amount of funding was invested and a large number of IT human resources had been provided (in total, 213 hundred will be excess in 2011-2015), skill shortages in SW are persistently anticipated (the shortage of 58 hundred).

About SW HRs, even though there are 6,500 graduates from the SW major and 13,000 graduates from SW related majors such as electrical engineering and communication engineering each year, only 3,000 new-comers go to fields of SW, mainly because of the avoidance of SME-based SW and for a lack of opportunities to enter large companies, who prefer experienced programmers. Due to a lack of vision of SW professionals from a career perspective and the lack of compensation, many avoid working in SW SME and have a higher turnover rate, which is a sign of increasing high instability in SW HRs.

In addition to serious shortage of SW HR, college education also does not properly meet field requirements. SW development is a process of problem solving, and the curriculum for SW should provide students with practice as well as theory. However, most of the curriculum is run excessively by theory-oriented approaches. Now, government supports the restructuring and establishing of field-based practices to increase practice-oriented SW HR, along with a new master's program that converts the non-SW graduated to SW engineers.

Table 5 Anticipated excess / shortages of IT HR by job in 2011-2015

(Unit: hundred person)

Job	2011	2013	2015	Total (´11 - ´15)
Development and design of SW/SI	-2.2	-7.3	-34.1	-58.1
Digital contents	2.8	-2.4	-11.6	-16.0
System management	-0.9	1.4	0.1	3.5
Telecommunication and broadcasting	-4.7	-0.5	-0.2	-6.3
Development and design of H/W	31.0	39.8	39.4	190.0
Maintenance of H/W	16.5	17.6	16.9	86.3
IT education	-2	-0.4	-0.7	-3.6
IT marketing	3.5	3.8	2.8	17.9
Total	44.0	52.2	12.6	213.6

Source: Lee (2011)

Furthermore, retraining of existing staff is also one of the urgent issues in response to the rapid technological change in SW. To solve this issue, the government enforces company training programs through training incentives and tax reductions, and directly supports existing SW developers' re-training with a voucher schema.

2. Development of Quality Improvement

Despite improvement in the quality of college-level IT education to foster higher quality of IT human resources, the IT industry has to solve existing difficulties in aspects of finding and offering jobs in IT human resources. As the IT industry involves into different types of businesses, the necessary competence may vary depending on the sectors. Therefore, colleges should consider how to train IT human resources according to the needs and demands of the field, in order to overcome the gap between IT education and industry.

Insufficiencies and qualification gaps of human resources in IT sectors are directly linked to demands for competent IT human resources, and thus the development of standards for IT competence is important. Therefore, it is necessary, to develop an IT competence index that more accurately reflects personal competence, and utilizes a more diversified spectrum of measures in order to improve the preparation of IT human resources.

In 2008, ABEEK (Accreditation Board for Engineering Education of Korea) was a founding signatory of the Seoul Accord-which promotes mutual

recognition and substantial equivalence of degree programs in computing and IT-related disciplines amongst signatory organizations-these programs are currently recognized by the Seoul Accord. Already since 1999 ABEEK has strived to assure the quality of educational programs in engineering and relative disciplines to improve the general quality in engineering and to enhance the professional competence of the graduates of those programs in Korea.

Furthermore, with the intention to introduce an assessment system for objectively measuring and certifying the competence of IT majors at colleges that inspires public confidence, a new approach is needed to solve the problem of skill mismatch. The Plans to Improve College IT Education (Ministry of Knowledge Economy, 2011) includes IT competence assessment test data collected in 2011. It aims to enhance the competence of IT graduates and the quality of IT education by measuring student abilities related to employment in industry, while maintaining consistency in corresponding to college curriculums.

Since there is no way to objectively evaluate the quality of a college education, companies require a means to assess practical experience and abilities when employing either new or experienced workers. However, there are no standards for objective assessment. Korean companies consider following criteria as recruiting new employees significantly: attitude and personality > practical skills > expertise > certificates (Jobkorea Corp., 2011).

In 2011, the Korean government, in association with major IT professionals in industry and academia, has endeavored to develop systems to train talented human resources at the college level and for companies to measure and assess their competence for companies. As a result, with the collaboration of industry-academia-research-government, a new model of IT competence assessment has been developed to measure the levels of understanding of business and management that are necessary to accomplish occupational tasks in the field of information technology. It also could assess IT business knowledge that is not covered by common IT certificates, communication skills regarding technical matters, and project management skills. Practical implementation of TOPCIT[2] starts in 2014.

[2] It is the abbreviation of the full name 'Test of Practical Competency in IT' and intentionally mimics the name of TOEIC and TOEFL with the aiming to be a TOEIC and TOEFL in testing the practical competency in IT.

Table 6 Structure of TOPCIT model

	Evaluation area	Purpose of evaluation	Subjects of the evaluation questions
Technical Part	software development skills	the capabilities to operate, manage, develop, and maintain on/offline solutions necessary for tasks based on the understanding and utilization of the concept and composition of software and system structures	-Basic understanding of software -Software analysis and designing -Software development -Software management -Application and convergence skill
	database building and operating skills	the capabilities to analyze, design, operate, and manage a database, and develop and maintain an application program based on the understanding and utilization of the concept and structure of a database	-Concept and structure of database -Database designing and building -Database programming -Database operation -Database application
	understanding of network and security	the capabilities to operate, manage, develop, and maintain applications based on the understanding and utilization of the concept and structure of a network and the concept of security	-Concept and structure of network -Internet technology and service -Multimedia network -Mobile network -Security
Business Part	understanding of IT business	the capabilities to understand knowledge for effective implementation of given tasks based on the understanding of IT management as well as business characteristics and environments and in utilization of business models and solutions	-Understanding of IT business -Utilization of IT business
	technical communicatio n skills	the capabilities to communicate with a certain interested party and help him understand by means of words, writings, and media on the process and result	-Understanding of business communication -Utilization of technical documentation
	project management skills	the capabilities to effectively manage the scope, schedule, resource, risk, and quality of a project that involves a certain cyclic process	-Understanding of project management -Area of project management -Means of project management
Integrated (Practical problem-solving)		the capabilities to solve problems at work	

Besides TOPCIT, there is another competence assessment test, K-CESA, which is developed to measure and assess (general) core competence items among college students by KRIVET. The test aims to assess the levels of basic vocational abilities of college students, support their self-development, and improve employment rates in an effort to develop the general competence produced by college education through talent nurturing (Jun, 2013).

TOPCIT is a test of human resources preparing for work in the IT industry as well as for existing workers to measure and assess their own competence. It is used to determine comprehensive abilities such as core knowledge and skills, which are basic requirements for IT majors and current workers to understand the IT business and to successfully solve problems at work in response to imminent needs. It has following features: computer based test (CBT); simulations to measure practical problem-solving skills; and a tutorial to practice CBT functions prior to the test.

The common competence items are required for graduates from IT departments to carry out IT-related tasks successfully and the professional competence items are necessary for IT experts to implement given tasks. Common competence means the basic competence items required to solve problems successfully in business situations regardless of the office or position in software development.

Different levels of basic knowledge, application ability, and measurement according to areas should be reflected in the development of TOPCIT models. Basic knowledge, meaning fundamental and core knowledge to solve problems, is the theoretical knowledge to become IT engineers. Application ability means application/complex knowledge, not mere memorization, based on basic knowledge. These are the standards used to determine potential of individuals to be grown-up as experts in IT sectors. The measurement of levels according to area means to determine the levels of skills necessary for different IT sectors. These are the standards used to determine whether a human resource is eligible for a certain sector.

This intends to measure the levels of core knowledge, skills, and attitudes required for successful implementation of tasks and problem-solving in response to current needs regardless of positions and tasks in software development. The TOPCIT model was specifically applied to the sector of software development, since software development is a labor-intense area in which positive achievements are created. The highest percentage of HR is involved in this sector and SW comprises the fundamental elements in IT. Furthermore SW is the most crucial element in combination with other industries. In short, the improvement of IT competence among software developers directly leads to the advancement of general competence in IT.

Structure of TOPCIT consists of a technical and business part. The technical part includes software development skills, database building and management

skills, and understanding of networks and security, while the business part includes understanding of IT business, technical communication skills, and project management skills.

With the initiation of TOPCIT, it is expected that colleges will implement education programs adapted to the levels of the data yielded by TOPCIT, and will provide an important basis for the assessment of job applicants. In addition, current workers may utilize TOPCIT as a means to measure their own IT competence and to direct continuing learning in response to changes in technology. In particular, TOPCIT may be useful for IT HRD among backbone middle / medium companies that have employment and education systems that are inferior to those of large companies. The three entities all in unity - colleges as the supplier of IT human resources, companies as consumers, and job applicants for IT-related occupations - should support the establishment of an IT HRD ecosystem.

Ⅴ. Issues in Adapting SCM in IT HRD

Korea's HRD Policy for the past half-century has been to support industrial development. On one hand, its responses to the industry induced labor demand through education expansion (Industry development → Educational expansion). On the other hand, in advance of industrial development, the provision of the proper HR leads to and allows the following industrial development (Education improvement → Industrial development). In both directions, the former direction contributes more during state-led economic growth. However, with the transition from state-led economic growth to market-oriented development, the supply adapted to the needs.

Formal educational systems need to construct the structure in which human resources can be educated to meet the industries' requirements. For this reason, the government has intervened in training human resources directly, but it is not sufficient to help human resources meet the industries' requirement. The shortage of manpower having specific skills is due to an excess of demand, and a simultaneously low compensation of specific skills hinders the flow of manpower.

In education of IT HR, the expansion of IT HR had contributed to the development of IT Industries during the later 1990s to the early 2000s. In general, the Korean human resource development (HRD) policy for the IT workforce has been relatively well adapted to the change of labor: expansion of IT educational infrastructure for 1997-1999; quantitative expansion of IT HR for 2000-2002. After quantitative expansion of IT HR, increasing needs of qualitative improvement of IT HR were followed. With the increasing role of

market and company, there has been an evolutionary process in fostering qualified personnel: supply chain management (SCM) model for IT engineering education in 2004, accreditation system for IT engineering education in 2008, the test of practical competency in IT (TOPCIT) in 2011.

From the Korean experiences in adapting SCM in IT HRD, other countries could find some implications: the early adaptation of SCM in IT HRD to the modification of IT curriculum; accreditation system since 2008 and the test of practical competency in IT, to overcome skill mismatches. However it is reminded that the directions of HRD for industrial development and the role of government depend on many conditions: the stage of development of economy; the degree of development and the characteristics of technology; the degree of collaboration among school, industry and government. The development of HRD policy needs time-consuming efforts and trial-and-errors as well as financial investment.

Furthermore, there seems to be another problem related with future skills needs: the pre-provisions of a proper HR system should be prepared, in advance. This might be the next step to match current skills needs. From this perspective, what is further needed is to motivate universities to meet requirements for themselves.

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