From model to case study on digital convergence maturity

Seung-Jun Yeon, Sung-Hyun Hwang, Hee-Kyung Kong

***Abstract*—** This study was conducted with the larger goal of designing a maturity model for digital convergence services, needed to set a policy for their promotion. Its primary objective is to determine the relative importance of maturity indicators related to digital convergence readiness, the level of use of, and the level of satisfaction with, services and performance in four major fields in which digital convergence services are currently used: education, healthcare, transportation and public administration. The data for this study were obtained by surveying a panel of 80 experts from the four fields, and the experts were sampled based on a list, using both the purposive sampling and snowball sampling methods. Analysis was performed using the AHP technique. The results show that in education, healthcare and public administration, convergence readiness is the most important factor, followed by the level of use and level of satisfaction and performance, in this order. Meanwhile, in the field of transportation, the level of use and satisfaction proved the most important, followed by convergence readiness and performance. To measure the current levels of IT use in the healthcare and education fields, this study used an expert 'Delphi' survey. The IT field was classified into network and contents for the purpose of measurement. The research findings revealed that the healthcare field has lower levels of use of both IT networks and contents. IT utilization in the education field did not show a very satisfactory level either, being somewhat lower than the ideal level, although it was higher than in the healthcare field. In order to raise the levels of IT use in the healthcare and education field sectors, the government should carry out the appropriate investment, education and training.

***Keywords*—** Convergence, Maturity, Readiness, Usage, Performance, AHP.

I. Introduction

THE convergence between IT and other industries is taking place currently at multiple levels including between technologies, between services as well as between companies. Amid high hopes that digital convergences services will help spawn new industries, serving as the new sources of competitiveness, they are also expected to become blue ocean areas for products and services with virtually unlimited potential for value creation. Digital convergence services are already commercialized, and various government policy undertakings related to broadcasting and telecommunications are currently being implemented in line with the changing media demand at a national and societal level and the evolving policy environment. However, on the research front, there is an extreme dearth of existing literature related to strategies for promoting digital convergence services or evaluation of related performance benefits. More recently, there have been discussions about methods to measure the penetration of digital convergence services in different sectors of society and assess performance benefits resulting from their use, so that related information may be used for making policies for their promotion. Such methods would provide useful estimates for developing service promotion policies, and assist service providers in developing successful business models, which may be used as references for related export projects. They would also help identify new promising business areas

This study, a pre-study conducted in view of developing policy suggestions for promoting digital convergence services, attempts to develop an early framework for assessing the level of maturity among digital convergence services and determine the relative importance of measurement indicators. The framework proposed in this study is developed around three indicators - readiness, the level of use and level of satisfaction and performance - and their relative importance is measured in four major sectors in which digital convergence services are used most actively; namely, education, healthcare, transportation and public administration.

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II. Designing A Converged Digital Media Service Framework

Before proceeding to develop a framework for digital convergence services, one must first define precisely what digital convergence services are. The Korea Communications Commission defined them as "new-concept services, born out of the application of convergence technology elements from the broadcasting and telecommunications sectors to existing service fields to create high market value," while mentioning multimedia-based services and mobile services as two main components of these services. Thanks to their multimedia capabilities and mobility, digital convergence services are able to improve productivity and efficiency across all sectors and fields of our society, including education, healthcare, public administration, transportation. Various pilot programs are currently underway to test them.

Of the many fields in which digital convergence services may be productively used, these four fields have been selected by the Korean government as the priority areas for promoting their utilization. Education, public administration, transportation and healthcare are four of the most important public interest fields, delivering essential services to Koreans, which are crucial for improving their quality of life.

Figure 1. Service Fields

Field	Description
Education	Diffusion of IPTV in schools; creation of a distribution system for high-quality educational content; development of converged digital media-based education services through promotion of video conference-based education programs among others.
Public administration	Discovering new demand for multimedia-aided public services, including government-to-citizen services, local or tourist information, legal advice services.
Transportation	Creation of a new transportation service market which can promote easy access to transportation information and the smart evolution of transportation means.
Healthcare	Creation of a multimedia-based healthcare service market providing services such as disease prevention, telemedicine and healthcare information services.

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Before developing a framework for these four fields, we first analyzed existing performance evaluation models and indices. Existing indices can be classified into three types: comparative index, scale-type index and maturity index. With a comparative index, a base year is chosen and is set to 100, as is the case with indices like the KOSPI and the KOSDAQ, to calculate an index value for years that follow the base year. In the case of the KOSPI index, for example, a value of 100 is assigned to the base date of January 4, 1980. The value of the composite stock price index at this reference date is set to 100, and the total market capitalization, calculated by weighting the price per share for each stock by the total number of listed shares on a given date, is compared with that of the reference date. These indices allow the analysis of price growth or decline trends by quarter or by year and can be maintained consistently and continuously.

As for scale-type indices, they are oftentimes used for calculating the national competitiveness of countries. As a general rule, indices comparing national competitiveness such as the WCS or NCR are calculated by standardizing various qualitative and quantitative indicators and applying a weight to them. Indices of this type, although they offer the advantage of being able to take into consideration a large number of items, also have a major drawback. The evaluation items can vary depending on the period evaluated, as they are importantly affected by changes in the external environment; there is, therefore, no real guarantee of consistency with indices of this type. Finally, with maturity indices, maturity phases are first established for the object measured for maturity, and then the current level of maturity1 is measured so that directions to be taken to reach an ideal phase can be suggested.

Of the above-described indices, those that are used frequently in the ICT fields are listed in Table 2 above:

Figure 2. Types of ICT-related Indices

Scale-type indices	[UN] e-Government readiness index, [UN] Online participation index, [ITU] ICT development index (IDI), [ITU] Digital opportunity index (DOI), [WEF] Network readiness index, [WEF] National competitiveness index (technology readiness), [IMD] National competitiveness index (technology infrastructure), [EIU] Digital economy index, [EIU] IT industry competitiveness index
Maturity indices	[UN] Web Measurement Index

As has been already said, methods for evaluating performance, although varied, all have their respective innate limitations. In this study, we will present a digital convergence maturity model (DCMM), developed by combining several methods, in a manner to maximize the respective advantages of each of them and remedy their associated disadvantages.

This model was developed under three principal criteria: The first is that the index was designed drawing on existing evaluation indices. When evaluating existing indices, we paid particular attention to their relevance to digital convergence services. The second criterion was that the design of the maturity model should enable the identification of future improvement opportunities. The third and last criterion was the requirement of considering performance variables. The DCMM, developed in a manner to satisfy these three criteria, proved effective in remedying flaws of existing indices, since scale-type, maturity and impact indices were appropriately combined in this model. Meanwhile, to determine the level of use of digital convergence services, we designed an index which can allow us to determine the level of use for each field by dividing network and content into five stages each and measuring the current level and required level for each field.

The framework was designed drawing on reference materials from the WEFT and IMD, and its main factors are readiness, usage and satisfaction and performance. The model, although similar to the NRI framework, is distinct from it in that the constructs used are different. It further distinguishes itself from the NRI in that the results are expressed as levels, and not in specific values, as is the case with the latter framework.

Readiness, here, means the readiness of digital convergence services in each field evaluated. Readiness is measured in four subcategories; namely, system readiness, indicating the level of system readiness on the service provider's side, service readiness, indicating the level of interfacing between the service provider and user, digital convergence readiness, indicating the level of maturity of the use environment for digital convergence services, and convergence environment readiness, indicating the readiness for digital convergence services at a societal level.

Usage-and-satisfaction refers to the level of use of, and level of satisfaction with, digital convergence services in the four fields studied. Usage-and-satisfaction is measured in four sub-categories, including system utilization and satisfaction, service utilization and satisfaction, digital convergence

utilization and satisfaction and convergence environment satisfaction. Performance means performance benefits resulting from the utilization of digital convergence services in each of the four fields evaluated. The focus was on the level of contribution by digital convergence services to performance in high-level tasks. Details are given in Table 3 above:

Here, for the stages in system readiness, the stages of development for general information systems were used, while in the case of service readiness, the stages were designed drawing on the UN's web access model.

Figure 3. Definition of Pillars

Sub Index	Pillar	Definition
Readiness	System readiness	- Level of system provision on the part of the service provider, consisting of five phases: introduction, active use, integration, interlinkage and maturity.
	Service readiness	- Level of interfacing between the service provider and user, consisting of five phases: emerging presence, enhanced presence, interactive presence, transactional presence, and networked presence.
	Convergence readiness	- Level of development in the use environment for digital convergence services, consisting of two perspectives: network and content perspectives. - Each perspective consists of five phases according to the level of network and content development.
	Convergence environment readiness	- Readiness of the convergence environment, measured in five areas: legal and regulatory infrastructure, human capacity, investment, leadership and standardization.
Usage and satisfaction	Usage of and Satisfaction with systems	- Extent to which systems are used and Level of overall satisfaction with the converged digital media service system.
	Usage of and Satisfaction with services	- Extent to which services are used and Level of overall satisfaction with digital convergence services.
	Usage of and Satisfaction with digital convergence	- Extent to which digital convergence services are used and Level of overall satisfaction with digital convergence.
	Satisfaction with convergence environment	- Level of overall satisfaction with the convergence environment
Performance	Converged digital media service-attributable performance enhancement	- Performance benefits realized from the utilization of digital convergence services, consisting of five phases: cost cut, work improvement, promotion of collaborative work, innovation in medical consultation process and creation of new business models.

III. The Relative Importance of Factors

To determine main factors contributing to the promotion of digital convergence services, in this study, we measured the relative importance of readiness, usage and satisfaction and performance in four fields in which digital convergence services are currently used (education, healthcare, transportation, public administration).

To do so, we conducted a survey of 80 experts each specialized in one of the four fields. For the selection of experts, we employed the technique of purposive sampling, using a list, as well as the snowball sampling method. Table 4 provides the summary description of the survey performed for this study. Snowball Sampling is a technique used to identify potential subjects in studies where subjects are hard to locate. The researcher asks a small number of initial subjects to help identify people with a similar trait of interest.

Figure 4. Survey Design Summary

Target sample	Experts in the fields of education, healthcare, transportation and public administration
Method of survey	Delphi survey (using email and fax)
Sample size	80 total experts (education: 19, healthcare: 20; transportation:18, public administration: 23)
Sampling method	Purposive sampling using a list (purposive sampling), Snowball Sampling
Survey period	Oct. 15, 2010 – Feb. 11, 2011

Based on the results of the above-mentioned survey, in terms of the relative importance of the sub-indices for the four fields, readiness was the most important in education and healthcare, followed by usage and satisfaction, and performance, in this order. In the transportation field, usage and satisfaction proved the most important, followed by readiness and performance, in this order. In public administration, readiness was the most important, and usage/satisfaction and performance were second and third most important. It is noteworthy that, in this study, readiness and usage proved more important than performance, considered to retain central importance from the perspective of information systems. These results may owe to the fact that fields evaluated in the present study are public-interest fields, rather than for-profit fields. Also experts evaluate that these services are still remained relatively lower stages in maturity. And it may shows that supplier's perspective is considered relatively stronger than customer's perspective.

Figure 5. Relative Importance of Pillars in the Education Fields

Factor		Sub factor		
Category	**Importance**	**Category**	**Importance**	**Ranking**
Readiness	0.4596	System readiness	0.4537	1
		Service readiness	0.3142	2
		Digital convergence readiness	0.1417	3
		Convergence environment readiness	0.0905	4
Usage & Satisfaction	0.3730	System utilization and satisfaction	0.3635	2
		Service utilization and satisfaction	0.4123	1
		Digital convergence utilization and satisfaction	0.1342	3
		Convergence environment satisfaction	0.0900	4
Performance	0.1673	Digital convergence performance level	0.1673	-

Figure 6. Relative Importance of Pillars in the Healthcare Fields

Factor		Sub factor		
Category	Importance	Category	Importance	Ranking
Readiness	0.5344	System readiness	0.3267	2
		Service readiness	0.4216	1
		Digital convergence readiness	0.1396	3
		Convergence environment readiness	0.1122	4
Usage & Satisfaction	0.2856	System utilization and satisfaction	0.3390	2
		Service utilization and satisfaction	0.3990	1
		Digital convergence utilization and satisfaction	0.1580	3
		Convergence environment satisfaction	0.1040	4
Performance	0.1800	Digital convergence performance level	0.1800	-

Figure 7. Relative Importance of Pillars in the Transportation Fields

Factor		Sub factor		
Category	Importance	Category	Importance	Ranking
Readiness	0.3631	System readiness	0.4386	1
		Service readiness	0.2513	2
		Digital convergence readiness	0.1481	4
		Convergence environment readiness	0.1620	3
Usage & Satisfaction	0.4589	System utilization and satisfaction	0.2715	2
		Service utilization and satisfaction	0.4681	1
		Digital convergence utilization and satisfaction	0.1612	3
		Convergence environment satisfaction	0.0993	4
Performance	0.1780	Digital convergence performance level	0.1780	-

Figure 8. Relative Importance of Pillars in the Public administration Fields

Factor		Sub factor		
Category	Importance	Category	Importance	Ranking
Readiness	0.4874	System readiness	0.2413	2
		Service readiness	0.3645	1
		Digital convergence readiness	0.2314	3
		Convergence environment readiness	0.1628	4
Usage & Satisfaction	0.3572	System utilization and satisfaction	0.1446	4
		Service utilization and satisfaction	0.3992	1
		Digital convergence utilization and satisfaction	0.2956	2
		Convergence environment satisfaction	0.1605	3
Performance	0.1554	Digital convergence performance level	0.1554	-

An additional analysis was conducted, meanwhile, to determine the relative importance of the pillars composing the sub-indices as well. The results of this analysis are as shown in Figures 1-4. Concerning readiness, system readiness appeared the most important in the fields of education and transportation, and service readiness in the fields of healthcare and public administration. These results may show that experts are considered more important internal customers in service organization in the fields of education and transportation.

IV. A Case Study of DCMM

This case study seeks to measure the current levels of IT utilization in South Korea's healthcare and education fields in terms of system readiness and service readiness. Also, IT is measured in terms of the network field and the contents field: the former was divided into the five stages of Cable, Web Service, Mobile Service, Wireless, and Internet of Things (also known as Future Internet), while the latter was divided into Voice/Text, Image, Video, 3 Dimension, and Augmented Reality(AR)/Tangible.

Table 1. System Readiness and Service Readiness of Healthcare field

		System Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.36	0.27	0.00	0.36	3.36
	Web Service	0.36	0.27	0.36	0.00	0.00	2.00
	Mobile Service	0.64	0.00	0.27	0.00	0.09	1.91
	Wireless	0.55	0.18	0.18	0.00	0.09	1.91
	Internet of Things	0.45	0.18	0.09	0.09	0.18	2.36
Contents Level	Voice/Text	0.27	0.18	0.09	0.09	0.36	3.09
	Image	0.18	0.27	0.36	0.09	0.09	2.64
	Video	0.36	0.36	0.18	0.00	0.09	2.09
	3D	0.45	0.27	0.09	0.00	0.18	2.18
	AR/Tangible	0.82	0.00	0.09	0.00	0.09	1.55
		Service Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.09	0.45	0.18	0.00	0.27	2.91
	Web Service	0.18	0.27	0.36	0.09	0.09	2.64
	Mobile Service	0.45	0.18	0.09	0.18	0.09	2.27
	Wireless	0.27	0.45	0.00	0.18	0.09	2.36
	Internet of Things	0.45	0.18	0.18	0.09	0.09	2.18
Contents Level	Voice/Text	0.09	0.36	0.18	0.09	0.27	3.09
	Image	0.27	0.18	0.27	0.09	0.18	2.73
	Video	0.27	0.27	0.18	0.00	0.27	2.73
	3D	0.45	0.27	0.18	0.00	0.09	2.00
	AR/Tangible	0.73	0.09	0.09	0.00	0.09	1.64

To conduct this study, a Delphi survey was conducted targeting nineteen medical experts and twenty educational experts. Purposive sampling was used. Each expert was required to answer one item only.

First, the healthcare field is outlined as follows. Regarding system readiness, in the network field, Cable was found to be in

stage 3.3 on average; Web Service in stage 2; Mobile Service and WIRELESS in stage 1.9 each; and Internet of Things in stage 2.3. Herein, to calculate the average level, each stage was multiplied by each stage value (i.e., stage 1 was multiplied by 1; stage 5 by 5). Also, regarding the contents field, Voice/Text was found to be in stage 2.9; Image in stage 2.6; Video in stage 2; 3D in stage 2.1; and AR/Tangible in stage 1.5. And, in the case of the service readiness of the healthcare field, in the network field, Cable was found to be in stage 2.9 on average; Web Service in stage 2.6; Mobile Service in stage 2.2; WIRELESS in stage 2.3; and Internet of Things in stage 2.1. Also, in the contents field, Voice/Text was found to be in stage 3.0; Image and Video in stage 2.7; 3D in stage 2; and AR/Tangible in stage 1.6. Intuitively speaking, it may be said that the higher the levels of system readiness and service readiness, the higher the utilized network or contents level should be. However, the level of IT utilization in the South Korean healthcare field is not so high.

The education field was analyzed as follows. In the case of system readiness, in the network field, Cable was found to be in stage 3.4 on average; Web Service in stage 3.7; Mobile Service in stage 2.6; WIRELESS in stage 2.8; and Internet of Things in stage 2.6. Also, in the contents field, Voice/Text was found to be in stage 3.8; Image in stage 4.1; Video in stage 3.8; 3D in stage 2.2; and AR/Tangible in stage 2.4. In the case of service readiness, in the network field, Cable was found to be in stage 3.7 on average; Web Service in stage 3.9; Mobile Service in stage 2.4; WIRELESS in stage 2.6; and Internet of Things in stage 2.5. In the contents field, Voice/Text was found to be in stage 3.7; Image in stage 4.1; Video in stage 3.9; 3D in stage 2.5; and AR/Tangible in stage 2.72. Thus, the education field displayed a higher level of IT utilization than the healthcare field in every aspect.

Table 2. System Readiness and Service Readiness of Education field

		System Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.27	0.36	0.00	0.36	3.46
	Web Service	0.19	0.09	0.18	0.27	0.36	3.73
	Mobile Service	0.18	0.18	0.54	0.00	0.09	2.63
	Wireless	0.18	0.27	0.27	0.09	0.19	2.84
	Internet of Things	0.27	0.36	0.09	0.00	0.27	2.64
Contents Level	Voice/Text	0.00	0.18	0.18	0.18	0.45	3.90
	Image	0.00	0.09	0.09	0.36	0.45	4.18
	Video	0.00	0.18	0.27	0.09	0.45	3.81
	3D	0.36	0.27	0.18	0.09	0.09	2.27
	AR/Tangible	0.45	0.18	0.09	0.00	0.09	2.44
		Service Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.18	0.36	0.00	0.45	3.72
	Web Service	0.09	0.09	0.18	0.09	0.54	3.91
	Mobile Service	0.27	0.18	0.45	0.00	0.09	2.45
	Wireless	0.36	0.09	0.27	0.09	0.18	2.63
	Internet of Things	0.36	0.27	0.09	0.00	0.27	2.54
Contents Level	Voice/Text	0.00	0.18	0.18	0.04	0.54	3.79
	Image	0.00	0.09	0.09	0.36	0.45	4.18
	Video	0.00	0.18	0.18	0.09	0.54	3.99
	3D	0.27	0.27	0.27	0.00	0.18	2.54
	AR/Tangible	0.36	0.18	0.09	0.09	0.27	2.73

Additionally, an analysis of the gap between the ideal stage and the current stage was conducted, the results of which are shown in Table 3, 4, 5, 6.

Table 3. Expected System Readiness and Service Readiness of Healthcare field

		System Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.00	0.45	0.00	0.55	4.09
	Web Service	0.09	0.09	0.27	0.36	0.18	3.45
	Mobile Service	0.00	0.18	0.09	0.18	0.55	4.09
	Wireless	0.18	0.09	0.27	0.00	0.45	3.45
	Internet of Things	0.18	0.09	0.09	0.18	0.45	3.64
Contents Level	Voice/Text	0.00	0.27	0.18	0.00	0.55	3.82
	Image	0.00	0.18	0.36	0.00	0.45	3.73
	Video	0.00	0.27	0.09	0.18	0.45	3.82
	3D	0.00	0.09	0.18	0.18	0.55	4.18
	AR/Tangible	0.09	0.09	0.27	0.09	0.45	3.73
		Service Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.18	0.18	0.09	0.55	4.00
	Web Service	0.00	0.18	0.27	0.27	0.27	3.64
	Mobile Service	0.09	0.00	0.27	0.09	0.55	4.00
	Wireless	0.00	0.18	0.18	0.09	0.55	4.00
	Internet of Things	0.09	0.18	0.00	0.18	0.55	3.91
Contents Level	Voice/Text	0.00	0.27	0.18	0.09	0.45	3.73
	Image	0.00	0.09	0.18	0.18	0.55	4.18
	Video	0.00	0.00	0.18	0.18	0.55	4.27
	3D	0.00	0.00	0.09	0.09	0.55	4.18
	AR/Tangible	0.00	0.18	0.09	0.09	0.36	3.64

Table 4. Expected System Readiness and Service Readiness of Education field

		System Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.09	0.27	0.00	0.63	4.17
	Web Service	0.09	0.00	0.00	0.18	0.73	4.44
	Mobile Service	0.00	0.09	0.18	0.27	0.45	4.08
	Wireless	0.00	0.09	0.09	0.36	0.45	4.18
	Internet of Things	0.00	0.18	0.09	0.18	0.54	4.08
Contents Level	Voice/Text	0.00	0.09	0.09	0.00	0.82	4.54
	Image	0.00	0.09	0.00	0.09	0.82	4.63
	Video	0.00	0.09	0.09	0.00	0.73	4.09
	3D	0.00	0.18	0.09	0.27	0.45	3.99
	AR/Tangible	0.00	0.18	0.09	0.18	0.54	4.08
		Service Readiness					
		Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Average
Network Level	Cable	0.00	0.09	0.27	0.00	0.63	4.17
	Web Service	0.09	0.00	0.00	0.18	0.73	4.44
	Mobile Service	0.00	0.09	0.27	0.18	0.45	3.99
	Wireless	0.00	0.18	0.09	0.27	0.45	3.99
	Internet of Things	0.00	0.00	0.27	0.09	0.63	4.36
Contents Level	Voice/Text	0.00	0.09	0.09	0.00	0.82	4.54
	Image	0.00	0.09	0.00	0.09	0.82	4.63
	Video	0.00	0.09	0.00	0.18	0.73	4.54
	3D	0.00	0.18	0.09	0.27	0.45	3.99
	AR/Tangible	0.00	0.18	0.09	0.18	0.54	4.08

Table 5. Measured Stage vs. Ideal Stage of Healthcare field

Healthcare field		System Readiness			Service Readiness		
		Measured Stage (Average)	Ideal Stage (Average)	Gap	Measured Stage (Average)	Ideal Stage (Average)	Gap
Network Level	Cable	3.36	4.09	0.73	2.91	4.00	1.09
	Web Service	2.00	3.45	1.45	2.64	3.64	1.00
	Mobile Service	1.91	4.09	2.18	2.27	4.00	1.73
	Wireless	1.91	3.45	1.55	2.36	4.00	1.64
	Internet of Things	2.36	3.64	1.27	2.18	3.91	1.73
Contents Level	Voice/Text	3.09	3.82	0.73	3.09	3.73	0.64
	Image	2.64	3.73	1.09	2.73	4.18	1.45
	Video	2.09	3.82	1.73	2.73	4.27	1.55
	3D	2.18	4.18	2.00	2.00	4.18	2.18
	AR/Tangible	1.55	3.73	2.18	1.64	3.64	2.00

Table 6. Measured Stage vs. Ideal Stage of Education field

Education field		System Readiness			Service Readiness		
		Measured Stage (Average)	Ideal Stage (Average)	Gap	Measured Stage (Average)	Ideal Stage (Average)	Gap
Network Level	Cable	3.46	4.17	0.72	3.72	4.17	0.45
	Web Service	3.73	4.44	0.72	3.91	4.44	0.54
	Mobile Service	2.63	4.08	1.45	2.45	3.99	1.54
	Wireless	2.84	4.18	1.34	2.63	3.99	1.36
	Internet of Things	2.64	4.08	1.45	2.54	4.36	1.81
Contents Level	Voice/Text	3.90	4.54	0.65	3.79	4.54	0.76
	Image	4.18	4.63	0.46	4.18	4.63	0.46
	Video	3.81	4.09	0.27	3.99	4.54	1.54
	3D	2.27	3.99	1.72	2.54	3.99	1.45
	AR/Tangible	2.44	4.08	1.64	2.73	4.08	1.36

The largest gap in the healthcare field was found in AR/Tangible, followed by 3D and Internet of Things. The largest gap in the education field was Internet of Things, followed by Mobile and 3D. Based on these results, the above factors should be considered with top priority when investing in healthcare and educational IT in the future.

Table 7. Environment Readiness of Healthcare field and Education field

Category		Score	
		Healthcare field	Education field
Laws/ systems	Relevant laws/systems	3.83	3.75
	Relevant industries' engagement	4.25	4.38
	Governmental determination	4.17	4.5
HR capability	IT utilization capability	3.92	4.25
	Education and training	3.25	3.88
Investment	Government investment	2.92	3.63

Last, in the environment linking IT to healthcare and education, environmental readiness was categorized into Laws/Systems, HR Capability, and Investment, and was evaluated using a 7-point Likert scale. The findings of this research are shown in Table 7. As shown in Table 7 above, in the healthcare field, a lack of investment by the government and a lack of education/training time earned the lowest scores. In the education field, the governmental investment and relevant laws/systems earned the lowest scores.

V. Conclusion

This study, aimed at determining key factors for the promotion of digital convergence services, measured the relative importance of readiness, usage and satisfaction and performance in four fields in which these services are currently in use; namely, education, healthcare, transportation, public administration. The data were obtained through a survey of 80 experts specialized in the four fields, selected using the purposive sampling technique based on a list and also the snowball sampling technique. The AHP was used for analysis. The analysis showed that in the fields of education and healthcare, readiness was the most important, followed by usage/satisfaction, and performance, in this order. In the field of transportation, usage and satisfaction mattered the most, followed by readiness and performance, in this order. In public administration, readiness was of highest importance, and usage/satisfaction and performance were second and third most important. These orders of importance can be useful references in the establishment of future digital convergence-related policies, as they are indicators of what the policy priorities should be.

This case study, focusing on the healthcare and education fields, attempted to measure the extent to which IT is being utilized in those fields. To that end, the level of IT utilization in the healthcare and education fields was divided into 'system readiness level' and 'service readiness level'. In the case of IT, readiness was measured in terms of the network and contents fields. The findings of the research indicated that in the case of healthcare, both the network and contents levels were in the low stages. The education field's readiness level was also found to be unsatisfactory, although its state of readiness was higher than that of the healthcare field and there was a certain gap between the ideal level and the current level. To boost informatization in the healthcare and education fields, the government should conduct the appropriate levels of investment, education and training.

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References

[1] Economist Intelligent Unit, Foresight 2020, Economic, Industry and Corporate trends, 2007.

[2] Kang, S. and Kim, J.,The Advent of the u-Health Age. SERI CEO Information, 2007.
[3] Korea Communications Commission, A Strategy for the Development of Converged Media-type Content, 2009.
[4] Korea Communications Commission, Korea Communications Commission Annual Report, 2009.
[5] Korea Institute for Industrial Economics and Trade, Industry Vision 2030, 2006.
[6] Korea Institute of Science and Technology Evaluation and Planning, Korea's Science and Technology Vision 2040, 2010.
[7] Ministry of Education and Human Resources, The History of Education Innovation through e-Learning, 2008.
[8] Ministry of Health and Welfare, u-Healthcare Survey, 2007.
[9] Oh, J., The Current Progress in Healthcare Informatization and Future Tasks, NCA CIO REPORT, National Computerization Agency, 2006.
[10] Samsung Economic Research Institute, The Economic Effect of u-Health and Development Strategy, SERI Issue Paper, 2007.
[11] Song, T., u-Health Trends in Japan, Korea Institute for Health and Social Affairs, 2009.
[12] Wetering, R. and Batenburg, R., A PACS Maturity Model, A Systematic Meta-Analytic Review on Maturation and Evolvability of PACS in the Hospital Enterprise, International Journal of Medical Informatics 78, 2009, pp. 127-140.
[13] Stanislav Milanovic. and Mastorakis, NE., Cost-Effective Migration to All-IP Third Generation Wireless Communications Infrastructure, International Reference Book Series in Science and Engineering, December 2002, WSEAS Press, http://www.worldses.org/New_Books.htm Proceedings of the WSEAS ICAI 2002, 2002, pp. 19-21, WSEAS Press, Puerto De La Cruz, Tenerife, Canary Islands, Spain.
[14] Cocerhan C., Protected areas from the region of Suceava and its touristic valorization, Recent Advances in Communications and Computer Science, International Journal of Energy and Environment, 2012, 2(6), pp.373-378, WSEAS Press.
[15] Botsis, T., Solvoll, T., Scholl, J., Hasvold, P., Hartvigsen, G., Context-aware systems for mobile communication in healthcare: a user oriented approach, AIC'07 Proceedings of the 7th Conference on 7th WSEAS International Conference on Applied Informatics and Communications, 2007, pp. 69-74.

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