A FUNDAMENTAL STUDY TO DEVELOP STANDARD TECHNOLOGY CRITERIA FOR IT-CONSTRUCTION FUSION TECHNOLOGIES, TO BE APPLIED TO A U-CITY

Kyoon-Tai Kim[1], Jae-Goo Han[2], Chang-Han Kim[2]

[1] Senior Researcher, Ph. D., Construction Management & Economy Research Div., Korea Institute of Construction Technology, Goyang-Si, Korea, Correspond to ktkim@kict.re.kr
[2] Researcher, Construction Management & Economy Research Div., Korea Institute of Construction Technology, Goyang-Si, Korea

ABSTRACT: As the demand for a convergence between construction technologies and IT is on the rise, as seen in the visualization of U-City construction, studies on the ways in which IT in should be utilized in the building and construction field have been continuously and actively performed. However, there has been almost no development of standardized technology criteria relating to the life cycle of a building (planning, design, construction, and maintenance). That is, there are almost no examples of efforts made to combine construction technology and IT in a fundamental way, considering the environment, the facility, its spatial characteristics, engineering, materials, and structure, aspects that are commonly required not only for interior spaces but also for exterior construction of U-City. Despite the fact that a state-of-the-art infrastructure has been built, and the competency of users with the cutting-edge technology, composite studies on technologies, facilities, services and spaces are still lacking, and basic research on the composite operation method including compatibility and linkage between facilities and services within a U-City has been insufficient as well. It is generally known that by fusing IT with construction technologies, the total period of construction taken can be reduced and construction expenses can be curtailed, while construction quality can be improved. For this reason, it is vital to prepare a standardized base to connect cutting-edge IT with the construction technologies. In preparing such a base, the most urgent issue is to develop standardized technology criteria.

The ultimate objective of this research is to establish the technological criteria system required to apply construction-IT fused technologies to U-Cities, and to develop the technological criteria for the design, construction and maintenance of the U-Cities. This paper, whose objective is to establish development strategies for construction-IT fused technologies by way of analyzing the criteria for conventional construction projects, the necessity of criteria for construction-IT fused technologies, and the current status of U-Cities' development, is the underlying research for this purpose. The strategies established are expected to be utilized in establishing the system of criteria for construction-IT fused technologies, and to contribute to a knowledge base in the construction-IT field. In addition, based on the strategies established, criteria for construction-IT fused technologies, such as design criteria and construction standards, will be developed, and by applying these criteria and standards, the ultimate objectives of U-Cities, which are the enhancement of urban competitiveness and the satisfaction of residents, will be attained

Keywords: Feasibility study; Financing; Mixed-use development; Planning

1. INTRODUCTION

1.1 Background and Objective

It is expected that massive amounts of funding will be invested in the development of Ubiquitous cities each year in Korea, amounting to KRW 41 trillion won in 2009 and KRW 50 trillion won in 2010. Moreover, it is estimated that the effect on production inducement will reach more than three times the amount of money invested.[1] For this reason, many countries, including Korea, have identified 'U-cities' as a new national growth engines, and are striving to develop and implement related technologies. As a result, about 30 local autonomous bodies in Korea have applied U-City concepts in promoting the development of new towns or the redevelopment of previously existing cities, and 48 such U-City projects are currently in the planning or development stages.

To build a U-City in an actual urban space, the IT infrastructure should ideally be built in advance, and in fact should be systematically taken into account from the earliest stage of U-City Development. Thus far, no criteria have been established to allow U-Cities to be implemented effectively. For this reason, it is high time that criteria for construction-IT fused technologies be prepared, in order to incorporate IT into the urban infrastructure.

The ultimate objective of this research is to establish the technological criteria system required to apply construction-IT fused technologies to U-Cities, and to develop the technological criteria for the design, construction and maintenance of the U-Cities. This paper, whose objective is to establish development strategies for construction-IT fused technologies by way of analyzing the criteria for conventional construction projects, the necessity of criteria for construction-IT fused technologies, and the current status of U-Cities' development, is the underlying research for this purpose. The strategies established are expected to be utilized in establishing the system of criteria for construction-IT fused technologies, and to contribute to a knowledge base in the construction-IT field. In addition, based on the strategies established, criteria for construction-IT fused technologies, such as design criteria and construction specifications, will be developed, and by applying these criteria and specifications, the ultimate objectives of U-Cities, which are the enhancement of urban competitiveness and the satisfaction of residents, will be attained

1.2 Scope and Methodology

The scope of the criteria for construction projects encompasses various factors, including design criteria and construction standards. This research is restricted to construction specifications, since as a fundamental study its objective is to set the rudimentary direction for the establishment of criteria for construction-IT fused technologies.

The research will take the following procedure.

First, terminologies related with the criteria for construction-IT technologies are defined through research of the existing literature and related systems in Korea.

Second, the necessity of criteria for construction-IT fused technologies is analyzed through an analysis of the current status of the development of U-Cities in Korea, as well as in other countries.

Third, the direction in which the criteria for construction-IT fused technologies should develop is established by analyzing the composition and content of conventional construction criteria.

Fourth, strategies are established for the development of construction-IT fused technologies.

Rightfully, a complete discussion on this topic should be structured along five phases: project initiation; feasibility studies and financing; planning and design; construction; marketing and operational management. Due to limitation of space, only the first three phases are addressed in more detail. Theoretical aspects are associated or compared with the actual happenings in two selected cases – the Kuala Lumpur City Centre in Malaysia and the Suntec City in Singapore. Practical information of the two cases was collected through interviews with personnel who were once involved in these projects, in conjunction with secondary data obtained from Internet websites and news articles.

2. Trend Analysis of Related Technologies

2.1 Definition of Terminologies

(1) Ubiquitous

The word "ubiquitous" has come to define a new paradigm in the era of information. Ubiquitous is derived from a Latin word, which means that 'God exists everywhere and at all times,' however, in the context of IT the term refers to an environment of "ubiquitous computing," meaning that users can freely use a computer or access services by logging on to a network, from anywhere and at any time.

(2) U-City

U-City is a compound word combining Ubiquitous with City. According to the law on U-City Construction, a U-City is defined as a city providing ubiquitous urban services anywhere and at any time, through a ubiquitous city infrastructure that utilizes, in a ubiquitous manner, urban technologies that can improve quality of life for residents.[2] The definition in the law, however, is so obscure that it has difficulty conveying any clear meaning. To explain the meaning more specifically, by incorporating the aforementioned definition of ubiquitous in the IT context, a U-City is an intelligent city wherein ① all aspects of the urban infrastructure (U-urban infrastructure), including roads, bridges, tunnels, residence, squares, offices, public buildings, and hospitals, incorporate cutting-edge IT (U-urban technologies) and ② anyone, from anywhere and at any time(Ubiquitous), can access diverse services related to transportation, environment, welfare, residence life, and safety(U-urban services), through the information that is collected, integrated, analyzed, and processed from the U-urban infrastructure.

(3) Construction Criteria

Construction criteria are the standards required for construction management to improve technologies and secure the quality of a construction project throughout the entire process. Construction criteria are categorized into design criteria, Construction specifications and technological lower-level criteria. Design criteria refer to standards specifying the restrictions of design conditions in order to maintain the quality, strength, safety and performance of a project or structure. In Korea, there are a total of 20 design criteria, including structure design criteria for construction. Construction specifications are standards for the manufacture and installation of components, equipment and materials, performance requirements, chemical components, and physical quality. Construction criteria in Korea consist of 18 standard specifications and 11 owner's standards specifications. Lower-level technological criteria include diverse guidelines, manuals, handbooks, technical directives, and standard drawings. [3]

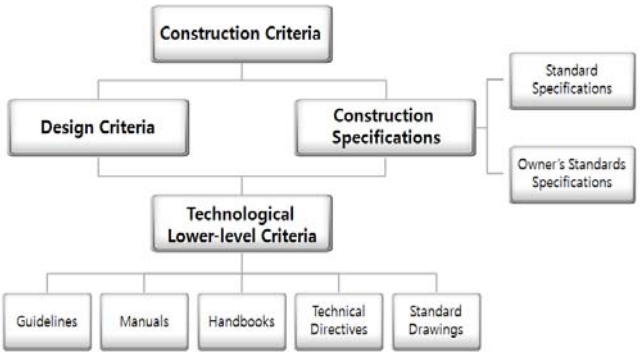

Fig 1. Diagram for Construction Criteria System in Korea

(4) Construction-IT Fused Technology

Construction-IT fused technologies are the technologies needed to build U-urban infrastructures, meaning the technologies that define a space as a U-Space in which public facilities and infrastructures provide citizens with the U-Services they require. For example, such technologies would equip public facilities or urban infrastructures such as roads, bridges, tunnels, residence, squares, offices, public buildings and hospitals with IT, to provide citizens with U-Services.

(5) Criteria for Construction-IT Fused Technology

Construction-IT fused technologies refer to design criteria, construction criteria and maintain directives required to design, construct and maintain the U-City infrastructure. Conventional construction criteria specify standards for construction or civil works, including standard specifications for construction projects and civil works projects. To build a U-City, construction technologies fused with IT should be applied at the city development stage. As of yet no criteria for such technologies have been established.

2.2 Current Status of U-City Development

(1) Current Status in Korea

As of February, 2008, there are 48 U-City projects underway nationwide. These U-City projects pursue three objectives: the enhancement of network infrastructure, the creation of new services, and effective urban management. Although most of them are still in the planning stage, there are a few U-Cities that are almost fully implemented and managed, based on a world-class communication infrastructure and IT in Korea. The U-City projects have been, nevertheless, developed focusing on infrastructure for public services and some exemplary services, and such projects are still at the early stage. In addition, the investment and inroads made by the private sector in this area are not sufficient. The ultimate objectives of the enhancement of urban competitiveness and resident satisfaction have not yet been attained.[4] <Table 1> shows some representative U-City projects in Korea.

Table 1. Representative U-City Projects in Korea

U-City	Supervisor	Characteristics
Sangam DMC	Seoul Metropolitan City	Building a cutting-edge IT Complex
U-Daegu	Daegu Metropolitan City	Building a U-City testbed and fostering U-industry
U-Daejeon	Daejeon Metropolitan City	Building the urban comprehensive information system such as One-stop Comprehensive Administration System and Fire and Disaster Management System
U-Busan	Busan Metropolitan City	Specialization of Marine and Shipbuilding Industry and Promotion of Free International City
U-Hwaseong	Korea Land Corporation	Implementation of U-City equipped with all the cutting-edge IT
Gwanggyo	Gyeonggi Urban Innovation Corporation	Broadening convenience of residents' lives and public social service, and forming BT/NT and R&D cluster
U-Osong	Chungcheongbuk-do	Forming U-Bio intelligent city and bio-science complex for the future
U-Jeju	Jeju-do	Forming a base for global business and R&D, and fostering industries including tourism, transportation, bio and culture.

(2) Current Status in Other Countries

There are about 22 projects that we can call U-City projects underway in other countries, and their objectives, direction and content vary depending on the infrastructure upon which the U-Cities have been built. Most projects have, however, focused on investment in infrastructure and in services of a private nature. In addition, efforts have been made to build a self-sufficient city that provides refreshing services that go beyond conventional urban functions. The various directions in which such projects are proceeding shed light on the characteristics of each country and individual city. However, it is hard to find cases of cities built with composite services, including urban planning, to the extent that they have been undertaken in Korea [4]. <Table 2> shows some representative overseas U-City projects.

(3) Analysis of Current Status

Each U-City has different objectives, areas and expected effects depending on the main body promoting the projects. In general, the central government sets the direction of U-City development, with a view to balanced national development and effective management. In addition, it has a focus on building information technology cities that promote cutting-edge industries and technologies, as well as implementing a ubiquitous

environment based on the IT infrastructure and technologies. Local autonomous bodies promote U-City projects with a view to enhancing the industrial environment for companies and the living standards of residents by building information cities. Accordingly, they have made efforts to attract new residents and companies, in order to secure financial resources and enhance the quality of life for residents. Communications service providers and SI providers want to secure sources of income by building and providing systems, solutions, communication services and more.

Table 2. Representative Overseas U-City Projects

Country	Project Name	Content
Malaysia	MSC	Formation of Multimedia Complex
Finland	Aribianranta	Conservation of conventional urban culture and link with art and education
Singapore	OneNorth	Securing broadband wireless network and integrating urban functions
Denmark	Crossroads	Promotion of International Research City
Spain	DigitalMile	Building of Information City
Brazil	Sapiens Park	Development of Tourism Industry
Northern Island	SciencePark	Building of Knowledge-based City

Consequently, as there are so many participants in building a U-City, it is practically difficult to apply uniform requirements and set consistent technological criteria and standards. In the case of construction-IT fused technologies, where construction technologies such as roads and bridges are incorporated with the state-of-the-art IT, it is also difficult to establish a unified system. As the result, there have been no examples of the development of technological criteria found in this field.

3. Analysis of Conventional Construction Criteria

3.1 Composition of Construction Criteria

The 3PART method using general items, material items, and other items, which is most frequently used in Europe and the U.S., has also been widely used in Korea. It is composed to include PROJECT – VOLUME – DIVISION – SECTION – PART – ARTICLE – PARAGRAPH – SUB-PARAGRAPH.

3.2 Conventional Construction Specifications Related to Construction-IT Fused Technology

The fused technologies incorporating construction technologies and IT are sometimes used in the electronics and communication field and measurement-related field. Hence, 29 Conventional specifications in total which are consisted of 18 standard specifications and 11 owner's standard specifications and used in Korea, are analyzed. There are 6 specifications in total, including criteria related to information and communication, such as 'standard specifications for building electricity facilities,' 'owner's standard specifications for expressway construction'. <Table 3> shows the content and system of the construction specifications.

4. Direction of Establishing Criteria for Construction-IT Fused Technologies

4.1 Direction of establishing criteria for construction-IT fused technologies

The criteria for construction-IT fused technologies will become the standards for building a U-City in Korea. Criteria for design, construction and maintenance by process should be established, taking into account the characteristics of the space in which the U-Services will be provided, as well as the characteristics of construction drawn from the construction procedure, and the design factors drawn from the planning process. The directions to which criteria should be established are as follows:

1. As the criteria to be developed, the 3PART method using general items, material items and other items shall be adopted, which is most frequently used in Europe and the U.S.
2. The criteria system to be established shall include PROJECT – VOLUME – DIVISION – SECTION – PART – ARTICLE – PARAGRAPH – SUB-PARAGRAPH.
3. The criteria shall specify technical requirements in all aspects of construction, in addition to engineering requirements including types, dimensions, installation method, test method, and inspection method of materials.
4. The criteria shall adopt open specifications, so as to enable the use of other materials and engineering methods other than those specified in the criteria, insofar as a certain level of criteria is met.
5. As construction-IT fused technologies are developed, the construction criteria shall be improved by process and synthesized to include construction-IT fused technologies that have not yet been considered.
6. Unlike construction items which are already systematized, the criteria for construction-IT fused technologies are very difficult to organize in a systematic manner. In addition, unlike conventional specifications, the criteria have not yet been established, technically or systematically. Therefore, the fundamental directions and system will be presented by way of establishing the criteria for U-City Construction.

Table 3. Content and System of Construction-IT Fused Technology-Related Construction Criteria used in Korea

		. Owner's Standard Specification for Express Way Construction (Revised Dec. 2005)	. Owner's Standard Specifications for Happy City Construction (Established Nov. 2007)	. Seoul Metropolitan City's Standard Specifications (Revised Sep. 2006)	. Owner's Standard Specifications for Housing Construction (Revised Dec. 2007)	Owner's Standard Specifications for Architecture and Electricity Facility Work (Revised Nov. 2003)	Owner's Standard Specifications for Dam Construction & Sewage Work (Revised Nov. 2001)
Electricity	1. Electricity Work -General	○	○		○	○	○
	2. Plumbing & Wiring Work	○	○	○	○		○
	2.1. Plumbing	○	○	○	○		○
	2.2. Wiring	○	○	○	○	○	○
	2.3. Wiring Road Work	○	○			○	○
	2.4. Duct Work		○	○			○
	2.5. Cable Tray Work		○	○			○
	3. Lighting Work	○	○		○	○	○
	3.1. Lighting (by Type)	○	○		○		○
	3.2. Obstacle Light Equipment Work	○			○	○	
	4. Electric Facility Work	○	○		○	○	○
	4.1. Closed-type Distributor	○	○				○
	4.2. Power Transformer	○	○		○		○
	4.3. Circuit Breaker	○	○				○
	4.4. Lightening Arrester	○	○				○
	4.5. Gas Insulation Facility	○			○		○
	4.6. Auto-control Equipment	○	○				○
	5. Backup Power Work	○	○	○	○	○	○
	5.1. Private Electric Generator	○	○			○	
	5.2. Static Power Supply Facility	○	○	○		○	○
	6. Electricity Protection Work	○			○	○	○
	6.1. Electric Fire Prevention Equipment				○	○	○
	6.2. Auto Fire Detector Equipment		○				○
	6.3. Evacuation Guiding Facility		○		○		○
	7. Lightning Protection and Grounding Facility Work	○	○		○	○	○
	7.1. Lightning Protection Facility	○	○		○	○	○
	7.2. Grounding Facility	○	○		○	○	○
	8. Power and Electric Facility Work	○	○			○	○

	8.1. Power Facility	○			○	○	
	8.2. Electric Facility	○				○	○
	8.3. Transportation Work		○		○		
	9. Monitoring & Control Facility Work		○		○	○	
	9.1. Electricity Monitoring Facility		○		○	○	
	9.2. Parking Monitoring Facility		○	○	○	○	
Information & Communication	1. Information & Communication Facility Work - General	○	○	○	○	○	○
	A. General Work	○		○	○		○
	B. Quality Control & Inspection	○		○			○
	2. Information & Communication Facility Work	○		○			
	A. Optical Cable Work	○			○		
	B. Communication Line Work		○		○		○
	C. IT Facility Work	○		○	○	○	○
	D. IT Grounding Work	○	○	○			○
	3. Information & communication Control Equipment Work				○		○
	A. Wireless Communication Equipment	○	○	○			
	B. CCTV Equipment	○	○	○		○	○
	C. TV Facility		○	○	○	○	○
	D. Broadcasting Facility		○	○	○	○	○
	E. Interphone		○	○	○	○	
	F. Internal Line Exchange Facility		○	○	○		
	G. Telephone Facility		○				○
	H. Sign Facility			○		○	
	I. Electric Clock Facility		○			○	
	4. Measuring & Controlling Equipment Work						○
	A. Monitoring & Control Equipment						○

4.2 Strategies for establishing criteria for construction-IT fused technologies

To establish criteria for construction-IT fused technologies, common items by construction should be, more than anything else, drawn based on construction criteria in relation to the fields of electricity, communication and measurement. For the common items by construction, only standard and essential items in the construction concerned will be drawn and stated. By excluding the items specified in the conventional construction criteria other than the common items, redundancy problems that may occur due to conflicts with the conventional construction criteria should be avoided.

Next, the factors to be combined with cutting-edge IT should be selected, such as sensing, control, communication and service provision. Finally, the criteria for building the U-City infrastructure required to implement the U-Services should be drawn up. At this time, all possible services related with the construction concerned should be included. In addition, to make the U-City infrastructure intelligent, the criteria shall specify that an infrastructure linked with IT devices or sensors can be built. However, since installation criteria may vary depending on the IT device or sensor product, the criteria should not restrict the device or sensor to be used. Hence, standard and common factors should be specified. Strategies made in this manner can be diagrammed as in <Figure 2>.

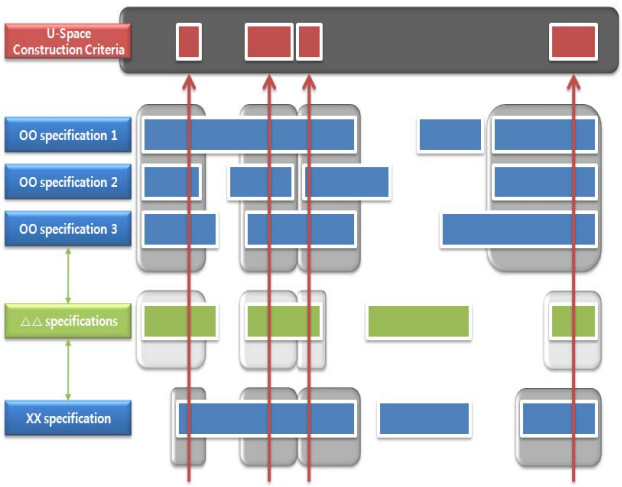

Figure 2. Conceptual Map for Construction-IT Fused Technology Criteria

5. CONCLUSIONS

Many U-City projects are now being planned, in Korea and overseas. There have been a variety of studies on how to fuse construction technologies such as civil works, roads, bridges, tunnels and residences with cutting-edge IT such as sensing, control, communication and monitoring services. Thus far, there have been almost no studies on the development of technical criteria in accordance with Life Cycle Costing (planning-design-construction-maintenance). Hence, this study ultimately aims to establish a system of technical criteria for the application of construction-IT fused technologies to a U-City, and to develop technological criteria for the design, construction and maintenance of a U-City. As a fundamental study, we analyze the current status of U-Cities and the necessity of criteria for construction-IT fused technologies, and establish strategies for the formation of criteria for construction-IT fused technologies by analyzing conventional construction criteria in this paper.

The strategies established in the paper will be directly utilized in establishing a system of criteria for construction-IT fused technologies. Based on the strategies and the system, we are going to continuously implement the development of criteria for construction-IT fused technologies, including criteria for design, construction and maintenance. The criteria for construction-IT fused technologies will be expected to contribute to the successful construction of a U-City.

Acknowledgement

This research was supported by a grant (07High Tech A01) from the High-Tech Urban Development Program, funded by Ministry of Land, Transportation and Maritime Affairs of Korean government.

REFERENCES

[1] The Federation of Korean Information Industries, u-biz conference 2008, 2008.5
[2] Law on Construction of a U-City, 2008.3
[3] Korea Institution of Construction Technology, How to Write Construction Specifications, The Ministry of Construction and Transportation, 1999. 11.
[4] Land & Urban Institute, A Study on U-City Promotion Methodology, Korea Land Corporation, 2008.10