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Survey Research of Measuring the Perceptional Level of Core Technologies in the Area of Super Tall Buildings in Korea

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Biography

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Abstract

The projects of super tall buildings are increased in the world due to urban concentration, symbolization of city, and the rapid development of structural design and facility systems. Korea also launched a research program, Super Tall Buildings R&BD Center (STBRC) funded by government, in order to obtain basic and core technologies in the super tall building research area. In spite of this effort, however, it was not clearly known how well the current level of technological development of Korea in the area comparing to the advanced countries and the meanings of accomplishment of the proposed technologies are identified, with respect to opening a new market in the world as well as the competing capacity against to the world class organizations that have top level of technologies.
Thus, this paper aims to implement a survey questionnaire asking the perception level of technology development to domestic and international experts in the area of super tall building, such as CTBUH, in which top level experts are gathered, based on quantitative and qualitative data from Korea as well as CTBUH.
From the current research projects and organizational system of STBRC a hierarchical technology tree was derived, and the descriptions of each technology on the tree and its current level of development were identified. The questionnaire was sent to the domestic and international experts through the mini Delphi process that includes two rounds of questionnaires. During the process, the result from the first round was revealed to both domestic and international experts at the second round in order to have a common consensus. Thus, the process succeeded to narrow the differences the viewpoints of experts between Korea and the world as well as come up with a new hierarchical technology tree of super tall building that is expected to be used in the world as a norm.
Main contents of the questionnaire are the levels of 23 technology areas on the technology tree in Korea comparing to the ultimate level of technology or the advanced countries that have top level of technologies, as well as relative importance of each technology. Especially, authors used the Gompertz function of the technology growth curve in order to calculate present and future levels of each technology, which is called Dynamic Technology Level Analysis. The technique enables researchers to analyze current level of each country, the trend of technology gabs between Korea and advanced countries, and the speed of technology development.

Keywords: super tall building, technology development level, technology growth curve

Introduction

Global demands for super tall buildings are rising rapidly worldwide in the wake of urbanization, advances in structural design and facility system technology and popularity of urban landmarks. Accordingly, Korea launched Super Tall Buildings R&BD Center (STBRC) in 2009 to obtain basic and core technologies in the super tall building research area. However, Korea has yet to understand precisely how well its technologies can match other leading countries from comprehensive perspectives pertaining to super tall buildings and how much it has progressed to close the gap with international standards in each of the specific initiatives. All in all, Korea has not fully understood not only the domestic market but also the global market for super tall buildings, which compromises strategic approaches relating to technology development objectives and global market expansion.

This survey research analyzes the perception level of technology development in comparison with other leading economies in the super tall building area to re-define technological prowess necessary for making inroad into global market and establishing technological independence and re-establish applicable targets.

Survey Technique using Technology Growth Curve

This survey research conducted a survey designed in reference to qualitative analysis and quantitative data on the perception level of super tall building technology in Korea in comparison with other leading nations of super tall building technology. To ensure accuracy of the survey, survey technique using technology growth curve was selected among a variety of technology development perception level survey techniques. In addition, to guarantee objectivity of the survey findings, not only Korean experts on super tall buildings but also global leading experts including those represented in CTBUH(Council on Tall Buildings and Urban Habitat) are surveyed.

1. Technology Development Level Survey Technique

Technology development perception survey has been conducted in major leading economies and other development countries, covering and utilizing various of topics and techniques, subject to applicable purpose. The US Office of Science & Technology Policy (OSTP) published the National Critical Technologies Report (1995), surveying the perception level of technology development in 90 sub-areas of national critical technologies and analyzing the U.S. predominance of technology over Japan and Europe in comparative terms. Japan compares the number of research papers and patents, the number of researchers and corporate revenues with the U.S., Europe, Korea and China regularly to understand the level of research, technology development and industrial technology prowess in 5 key areas, with the Ministry of Education, Culture, Sports, Science & Technology taking the lead. (National Institute of Science and Technology Policy 2008). On the other hand, EU, in the Key figure 2007 on "Science, Technology and Innovation" compared its member nations and the U.S. to understand major aspects of their investment and return on knowledge economy initiatives (2007) and China, in its “Chinese Technology Outlook Report”, identified 218 technology development areas in IT, BT and new material sectors and surveyed its perception level of technology development in comparison with other technology-leading nations (2003). In other words, technology leaders such as the U.S. conduct survey on technology development to identify remaining gap with other latecomers or strategy and vision for subsequent development in the future while developing counties survey on technology development to understand technology gap with leading economies and develop strategy to catch up with them.

Like other developing nations, Korea also conducts survey on technology development perception level to identify technology gap with leading nations or organizations known to be technology leaders. What sets Korea apart is that the country conducts survey not only on comprehensive technology development level across different sectors but also on specific individual technologies actively. For example, in construction sector, Korea has surveyed on not only technology gap with leading countries but also in relative term with other industries since 1993 and used in-depth technology development survey techniques for specific construction technology applications such as long-span bridge and super tall building to chart its technology development level in comparison with global technology leaders (2004).

2. Selection of Optimized Survey Technique

The survey techniques for measuring technology development perception level can break down into several types in consideration of technology life cycle and time period. In the past, irrespective of technology life cycle, gap with top technology leader nation or organization was determined in terms of percentage (%). However, these days, dynamic profile of changing technology development level is determined on the basis of 5 stages of technology growth curve, including introduction, growth, expansion, maturing and decline. In relation, the survey technique using technology growth curve has begun to be used recently. Such survey technique also determines the number of years required for reaching an ultimate upper limit, measuring the rate of technology evolution in Korea and other leading economies.

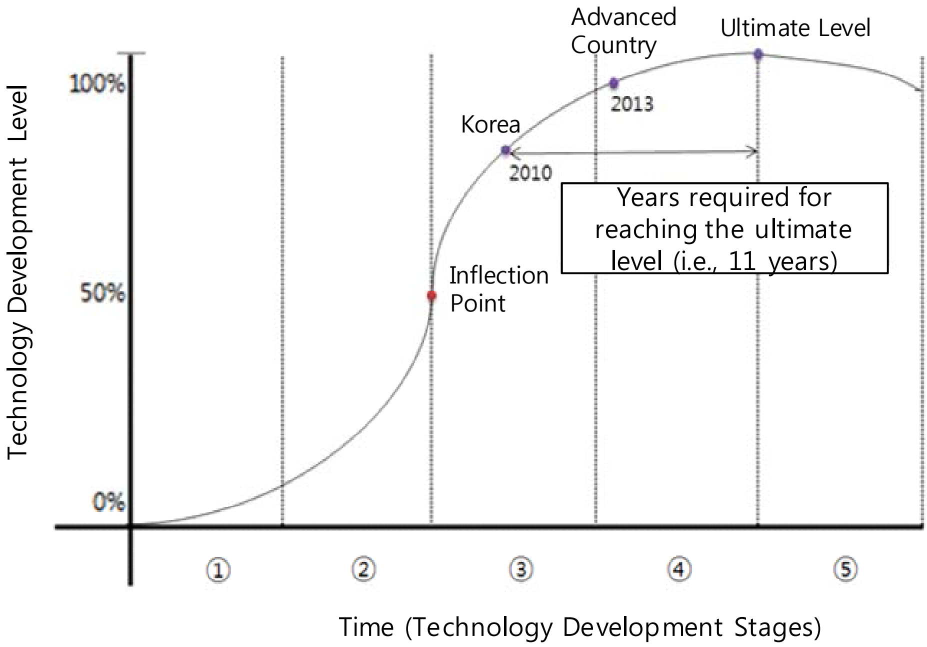

Figure 1. Technology Growth Curve & Technology Development Level

As described in the above, this paper derives the level of core technologies for super tall buildings of today and near future (following technology development) on the basis of dynamic technology growth curve-based model. Technology growth model has a variety of models from mathematical models using s-curve to Lokta-Volterra model, which is a co-evolution model in which multiple technologies and products interact and co-evolve with each other. Notably, the s-curve model breaks further down into Bass model of early days to Pearl and Gompertz models known most extensively in these days. Also the simulation model that structures and simulates a model on the assumption that technology grows in interaction with relevant elements is also a type of technology growth model. As the s-curve model describes technology growth stages best, this research has focused on s-curve mathematical models. Level of each core technology for super tall building covered herein includes survey of technology development level required for future innovation and trend analysis rather than past history. Therefore, Gompertz model was selected among various mathematical models. Gompertz model assumes that development of applicable technology is determined by remaining development to reach its theoretical upper limit.

III. Survey Preparation

1. Technology Tree

The procedure of the technology level survey consists of preparation, execution and analysis of survey findings. In the preparation stage, first, based on the present structure and projects of STBRC a technology tree of super tall building was developed. The proposed technology tree consists of 3 levels. The main classes in Level 1 encompasses 4 technology items and the 2nd and 3rd levels include 11 and 23 technology items, respectively (See Table 1).

Table 1. Technology Tree for Super Tall Building Technology Level Survey

Technology Tree for Super Tall Building		
Level 1	Level 2	Level 3 (23)
1. Project Management Technology	1-1. Project Management Technology for Super Tall Building	1-1-1. BIM Applications for Design, Construction, and Maintenance of Super Tall Buildings

2. Core Engineering Technology	2-1. Integrated Design for Freeform Structural System	2-1-1. Optimized Design Technology for Freeform Structural System
	2-1. Integrated Design for Freeform Structural System	2-1-2. Computerization Platform of Design Integration for Freeform Structural System
	2-2. Energy Saving and Eco-friendly Technology	2-2-1. Application Technology for Renewable Energy
		2-2-2. Design and Control Technology for Energy Saving and Natural Ventilation
	2-3. Structural System for Performance Improvement	2-3-1. Wind-induced Vibration Control Technology
	2-3. Structural System for Performance Improvement	2-3-2. Prevention Technology of Progressive Collapse
	2-3. Structural System for Performance Improvement	2-3-3. Prevention Technology of Explosive Terror and Design Technology for Mitigation of Impact
	2-4. Planning Technology for Vertical Urban Space	2-4-1. Design Planning Technology for Vertical Transportation in Super Tall Building
		2-4-2. Technology of Urban Planning for Super Tall Building
3. Materials and Construction Technology	3-1. High-performance Materials for Co2 Reduction	3-1-1. Extra High-strength Steel Technology
	3-1. High-performance Materials for Co2 Reduction	3-1-2. Technology on the Application of Super Concrete
	3-1. High-performance Materials for Co2 Reduction	3-1-3. High-strength Steel-Concrete Composite Structures
	3-2. Technology for Stabilization of Construction	3-2-1. Accurate Construction Technology for Compensation of Lateral Movement
	3-3. Technology for High Speed Construction	3-3-1. Intelligent Technology of Construction Techniques on Site
	3-3. Technology for High Speed Construction	3-3-2. Technology of Integrated Project/Construction Management
4. Maintenance and Disaster Risk Reduction Technology	4-1. Technology for Building Automation and Management	4-1-1. Intelligent Maintenance Technology
	4-1. Technology for Building Automation and Management	4-1-2. Sensor Network Management Technology
	4-2. Technology of Power Grid for Super Tall Building	4-2-1. Power Grid and System Integration Technology for Super Tall Building
	4-2. Technology of Power Grid for Super Tall Building	4-2-2. Design Technology for Gridable Building Power Systems for Super Tall Building
	4-3. Technology of Disaster Risk Reduction for Super Tall Building	4-3-1. Technology for Safety Assurance in Evacuation
	4-3. Technology of Disaster Risk Reduction for Super Tall Building	4-3-2. Fire Risk Assessment and Fire Extinguishment Technology
	4-3. Technology of Disaster Risk Reduction for Super Tall Building	4-3-3. Fire-proof Performance Securement Technology

2. Mini Delphi Process

Specific technology overview and current technology level were identified for selected technology sectors and a mini-delphi survey was conducted on experts at Korea and abroad. The Delphi procedure is an "expert survey" technique that reviews initial inputs in 3 subsequent steps. Mini Delphi is a two-round procedure that simplifies the original 4 steps to one initial input collection step and another review step to overcome the constraints of original delphi procedure such as difficulties with expert engagement over prolonged survey period and unnecessary 2nd and 3rd review steps for some sectors.

In addition, a cross-parallel survey technique that aims to have agreed consensus from different experts in the world was developed in the research. The result from the first round would be reviewed by engaged experts at Korea and abroad all together, and then, based on this, the second round of survey is implemented. This cross-parallel way requires in order to identify any reasons if the opinions from both, Korea and abroad, are quite different by analyzing causes and derive common consensus. Thus, difference in opinion between experts in Korea and abroad would be narrowed, objectivity is secured and internationally compatible super tall building technology system and development level survey findings are made.

3. AHP Weight

In the meanwhile, to determine the priorities of 23 technology items, core technology evaluation was conducted. Evaluation criteria consisted of quantitative ones from market perspective such as strategic importance and economic knock-on effect as well as qualitative ones from commercialization perspective such as capabilities under possession and market exclusivity. To determine appropriateness of each evaluation criterion and weight between evaluation criteria, AHP evaluation was conducted on experts and following weights were determined.

[Table 2] Evaluation Criteria & Weights for Prioritization of Core Super Tall Building Technologies

Selection Criteria	AHP Weight
Strategic importance	0.360
Economic knock-on effect	0.215
Capabilities under possession	0.145
Market exclusivity	0.279
Total	1.000

In the priority evaluation, top 10 key initiatives including Non-standard Integrated Design System and IT Platform Development Technologies, High-strength Steel-concrete Composite Structure Technology, and Serial Collapse Prevention Technology were selected.

4. Technology Survey Items

Key survey items consist of technology development level of Korea in comparison with leading countries having the most developed technology in 23 core technology sectors, technology development level of Korea and leading countries in comparison with ultimate technology level, development stage in technology life cycle and core technology evaluation item. And core technology evaluation items include strategic importance, capabilities under possession, market exclusivity and economic knock-on effect.

IV. Survey Findings

As the technology development perception level survey is still in progress, this paper suggests only example of survey findings. Technology level survey findings can be expressed in technology development level of Korea in comparison with countries having the most developed technology in 23 core technology sectors, "technology development level of Korea and leading countries in comparison with ultimate technology level", "technology development level and gap of Korea in comparison with a nation having the most developed technology", "time required for reaching ultimate technology level" and "development stage in technology life cycle", etc. Technology level and the gaps in each finding are expressed in bar chart or table format and technology level of each country is expressed in s-curve, using Gompertz curve.

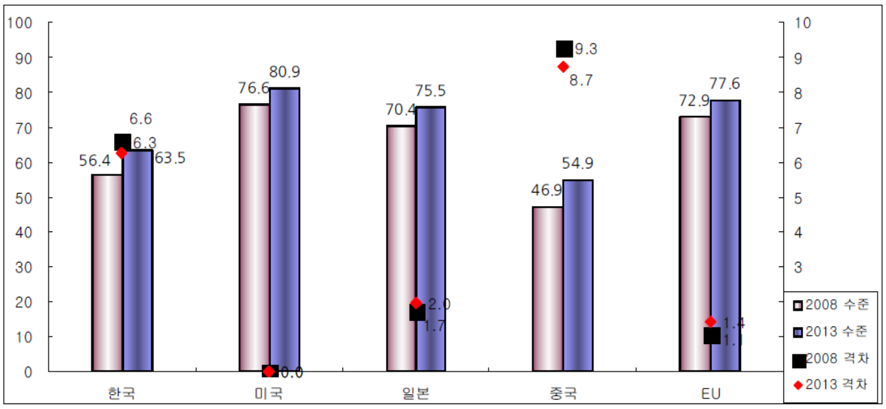

Figure 2. Technology Level & Gap between Korea & Technology-Leading countries (Ex.)

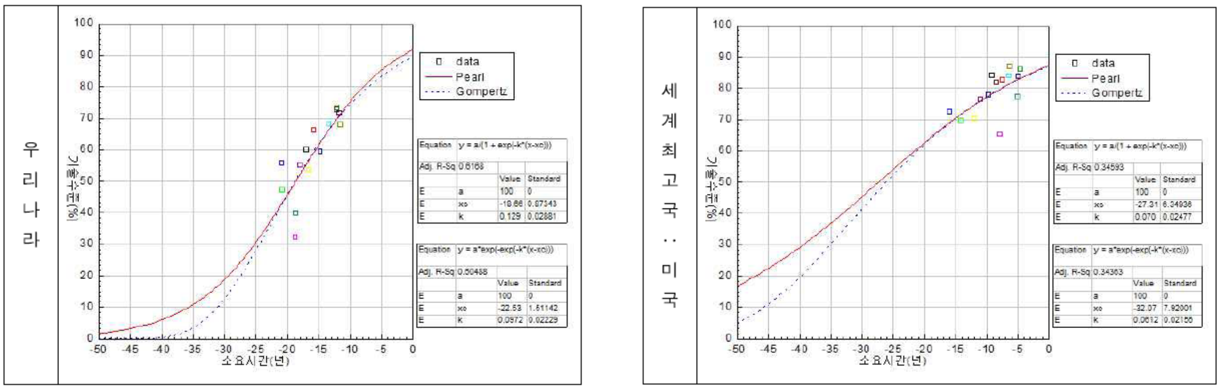

Figure 3. Teleology Grow Curve-Based Technology Level Analysis (Ex.)

V. Conclusion

Korea is now implementing or engaging in high-profile super tall building projects in other countries actively and its super tall building construction technology epitomizing the architectural technology of a country is now entering an advanced stage. Against the background, the government is launching a variety of R&D programs to upgrade technological prowess not only in construction but across the entire spectrum including design, analysis, disaster control and maintenance. Accordingly, this paper attempted to analyze the current status of super tall building technology in Korea and suggest future-oriented development direction by using the most recently developed technology growth curve-based technology development level survey. Based on the research outcomes herein, more aggressive strategy and policy need to be developed and supported to contribute to more drastic and determined technology development efforts of the government.

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