IDENTIFYING THE DEMAND FOR INNOVATIVE FUTURE CONSTRUCTION TECHNOLOGY

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Abstract: Construction projects are getting bigger and more complex while the average productivity of the industry is not improving enough. It is essential to look at the means available, in order to improve the efficiency and effectiveness of the construction industry. Fusion of traditional construction technology and new technology is an alternative plan for technology innovation. For the successive fusion of different technologies, it is necessary to develop systematic research strategies that consider variable issues such as how to define the area for technology fusion, how to estimate the marketability of new technologies, and how to apply the new technologies. This paper presents a study to identify the demands for innovative future construction technology based on the strategy of technology fusion. Over 157 survey participants were experts from construction companies, academia, government supported research institutes, and government agencies. The survey results show global research trends, technological demands for technology fusion, obstacles to innovative research, and so on.

Keywords: Construction industry, Innovation, Technology Fusion

1. INTRODUCTION

Construction industry has played such an important role in producing and maintaining a variety of social infrastructure. Infrastructure, such as roads, airports, buildings, subways, and water mains, is crucial to all people living in any modern society. Without proper support of the infrastructure, it would be remarkably difficult to conduct many of our day-to-day activities. We now face, though, ever increasing challenges to maintain the service of the construction industry at an acceptable level of quality. Construction projects are getting bigger and more complex while the average productivity of the industry is not improving enough. Labor shortage, along with high wage, is a dominating problem that has prevented the construction industry from functioning in the way it is supposed to (function?). Moreover, ever increasing quality of lives is now asking for an unprecedented level of satisfaction in the services that the construction industry perform.

Technology is a key driver to solve the above mentioned problems and innovation of construction practices through technology fusion is a viable strategy to bring the construction industry to a new efficiency and safety level. Here, technology fusion is defined as a systematic interdisciplinary effort to destroy the walls between many science and engineering disciplines. An important consensus has been being formed that the construction industry has reached its limit in its ability to revolutionize the way construction projects are conducted. Without learning from other disciplines and without teaching the construction knowledge to other discipline, it is extremely difficult to truly restructure the conventional construction processes, so that significant level of improvement in productivity, quality, and safety, is hard to be obtained.

A number of research efforts are now designed to encourage technology fusion in many advanced regions of the world. The amount of funding for interdisciplinary type research has been increased remarkably. Fusion of traditional construction technology and so-called high technology such as IT (Information Technology) and NT (Nano Technology) is performed in various research organizations, including CMS[1] (Civil and mechanical system), CERF[2] (Civil engineering research foundation), and FIATECH[3] (Fully integrated and automatic technology) in the United States; JACIC[4] (Japan Construction information center) in Japan; and VTT in Finland.[5] In parallel with the global trend of interdisciplinary or multidisciplinary research, Complex for Technology Fusion (C4TF) was recently established with the support of Korean Ministry of Construction and Transportation. C4TF is a research institute designed to conduct truly interdisciplinary research for the purpose of innovating the currently stagnant construction productivity, safety, and quality.

For the successive fusion of different technologies, it is necessary to have a plan based on a well-thought-out big picture. One of the main roles of C4TF is to develop the research strategy. Although many efforts have been made to develop component level techniques, such as sensing and robotics, insufficient investments have been made to identify the strategies and the technologies that are most needed for the next generation of construction industry. Thus, the expert-based survey for technology foresight is performed to identify what topics to be studied in what way for the significant advancement of the construction industry. This paper presents a comprehensive analysis of survey results that shows 1) the global research trend in the area of technology fusion, 2) the weakness of Korean

construction research in technology fusion, 3) the research area most needed for the next generation of construction industry, and 4) the obstacles to be overcome for the successful performance of construction research.

2. SURVEY DESCRIPTION

A literature review about research strategy development in construction industry and other industries[6]-[8] was conducted to identify common trends and issues. The findings from the literature review provided a basis for formulating the survey questaionare. To ensure that the questions of the survey form properly address the important issues, the survey questionare was pre-tested in its development stage, among six experts in construction process and statistics. After the comments from the experts were addressed, the final version of the survey questionnaire was distributed, in e-mail, to the people who were considered experts in varous disciplines of construction industry and high tech industry. Out of 1537 people who were asked to take part in the survey, 157 people responded. Fig. 1 shows the organizations that the 157 respondents were affiliated with at the time of response. Government supported research institute accounts for the biggest portion (58%), sequentially followed by academia (18%), construction company (12%), and government agency (11%).

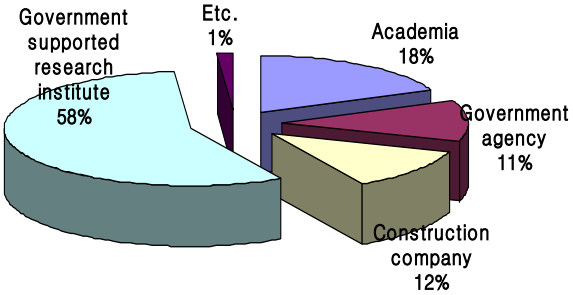

Fig. 1 Affiliation of Respondents

Fig. 2 shows the technical classification of the 157 respondents. Civil engineering accounts for the biggest percentage (63%), while architectural engineering takes up the second biggest portion (21%). Equipment and construction management constitute 4% of the total respondents, respectively.

3. ANALYSIS OF SURVEY RESULTS

3.1 Global Trends of Technology Fusion

The survey participants were asked to identify the global trends of technology fusion, including research environment, social atmosphere, and technology status. They were also asked to rank the trends, from 1 to 6, on which trend is more significant.

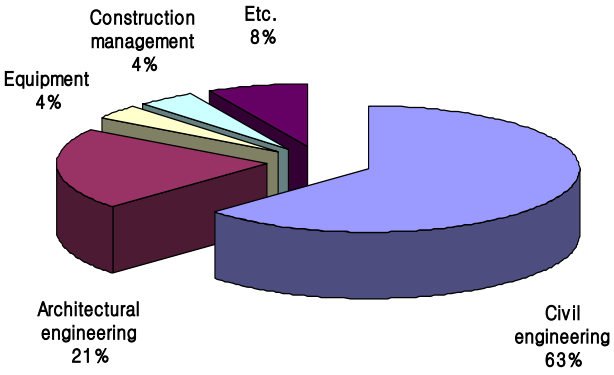

Fig. 2 Technical Classification of Respondents

Each respondent was asked to select 6 items from predefined sixteen items of global research trends and to suggest two research trends in a free format. The answers from 157 respondents identify a total of 26 items as global trends of technology fusion. The six items presented in Fig. 3 are ranked at top 20% of the 26 items, so they were considered as representative global trends by Pareto's law. The majority of the respondents placed "Clean (environmentally friendly) construction", which accounts for the biggest percentage (71.3%), on their top six priority list. It seems that environmental issues now become the center of interest in construction industry. "New material (ex. nanotechnology based materials)", which also belongs to the technological area, is selected by 61.1% of the respondents as global trend. The first two items, which were selected by most of the respondents, belong to the technological area. It means that the evolution of the technology fusion will be driven by the development of technology. Those technical trends were sequentially followed by the social and environmental trends such as "Adequate budgeting" (53.5%), "Research through strategic planning" (48.4%), and "Joint research by multidisciplines" (47.1%).

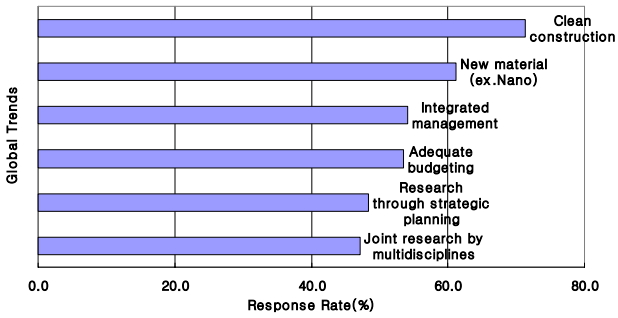

Fig. 3 Global Trends of Technology Fusion

Fig. 4 presents the portion of respondents' affiliation for the previous six items selected as principal global trends. It will be helpful to understand how the affiliation of the respondents affects the point of view in predicting the future

trend of technology fusion. As shown in Fig. 4, the affiliation of respondents who select “Clean Construction” and “New material (ex. nano)” as global trends of technology fusion is well distributed. That is, the consensus of construction industry is well built up for the development of the above two items. On the other hand, the affiliations of respondents who selected “Research through strategic planning” as one of the principal global trends are concentrated in the academia and government supported research institute. It seems that the academia and research institute which has been leading the research and development of technology think highly of the importance of preliminary research to find the development strategy.

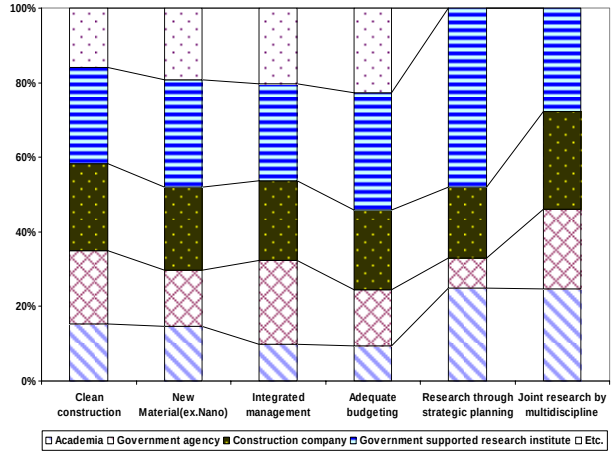

Fig. 4 Portion of Respondents’ Affiliation for Global Trends

3.2 A National Weakness of Research in Technology Fusion

The survey asked to select the weak point in the research area of technology fusion in Korea from the six items 120which a respondent has selected as global trends of technology fusion in the previous question. Fig. 5 shows the response rates of the top six items that the respondents think as the lagging area of technology fusion in research, social, and technological environments. The survey results indicates that “Clean construction” accounts for the biggest portion (54.8%) and “Adequate budgeting” and “Integrated management” take up the second biggest portion (44.6%), respectively. “Research through strategic planning” (40.1%), “Joint research by multidiscipline” (36.9%), and “Environment for sustainable development” (29.9%) are sequentially selected as the national weak point in the area of technology fusion.

It can be estimated that the reason why the majority of respondents select “Clean construction” as the principal weak point is not for deficiency of technology but the absence of consensus for the development of research foundation on the environmental problems. The respondents think that the active movement for environmental problems such as the establishment of an associated law and promotion of social concern falls behind other developed countries because the environmental problems for the next generation has recently been raised to a main interest in Korea. Thus, the top six items selected as the weak point of Korean construction research in technology fusion is based on the social and research environment. To achieve the noticeable growth in the research area of technology fusion, the weakness recognized in this survey should be complemented urgently.

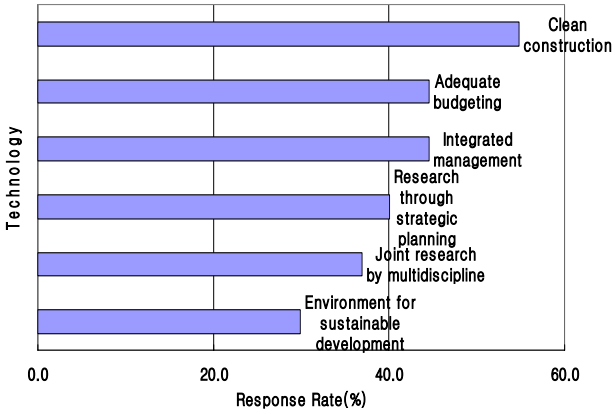

Fig. 5 Deficiency of Domestic Technology Fusion

3.3 Most Needed Research Area in Technology Fusion

The survey asked to select most needed technologies to innovate in the construction industry by technology fusion and mark the required time to complete the development. Each respondent selected five items from the 13 predefined items and suggested an item in a free format, which results in a total of 29 items identified. The six items shown in Fig. 6 are listed at top 20% of the proposed 29 items so that they can be considered to have high demands for development by Pareto’s law. “Disaster forecasting” and “Ubiquitous infra construction” are both selected as the most needed technologies with 82.2% of respondents placing those in their top five priority list. There happens massive damage in properties of human beings by a natural disaster at every year repeatedly in Korea, so that “Disaster forecasting” is always identified as the most important technology. It is also worth noting that remarkable synergy effects are expected in “Ubiquitous infra construction” in relation to information technology (IT) industry. Since IT industry in Korea, which has the characteristics of concentrated investment in research and development, internal capacity for international competitiveness, and high applicability to various industries, can raise up the technology level of construction industry. They are sequentially followed by “Pollution prevention” (72.6%), “New materials (ex. Nano)” (67.5%), “Super logistics management” (52.9%), and “Artificial intelligence” (23.6%).

Average time required to develop the technology for construction innovation with high priority is also investigated. The respondents select the estimated time to develop the technology from 3 cases: less than 10 years, 10-20 years, and more than 20 years. As shown in Fig. 7,

78.3% of the respondents predict that it will take less than 10 years to develop the most demanded technology and 97.5% of respondents predict the required time will be less than 20 years. It means that the proposed research areas of technology fusion are applicable and reasonable.

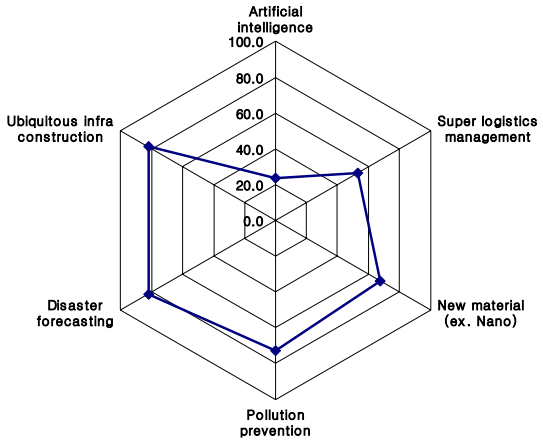

Fig. 6 Most Demanded Research Areas

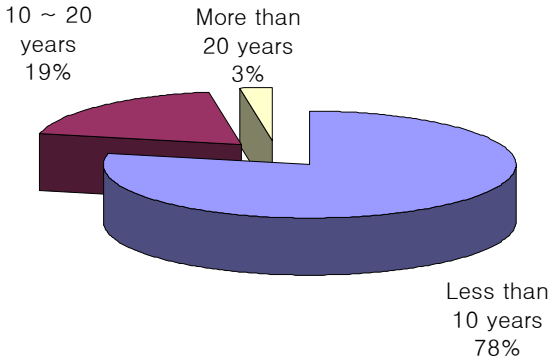

Fig. 7 Average Time Required for Technology Development

3.4 Obstacles to Research the Technology Fusion

The respondents were asked to select the five items which can be thought as environmental (socio-economical) and technical obstacles to perform the research for technology fusion, and rank them from 1 to 5. The survey results in Fig. 8 show that "Temporary research system is selected by 79.0% of respondents as the major barrier. It means that to organize the temporary research group composed of researchers from different disciplines deteriorates the research performance and capacity. Thus, a research institute needs to play the role of a center which provides a bridge of interdisciplinary cooperation. It is sequentially followed by "Small budget in construction research" (73.9%), "Deficiency of technology standard and research infra" (68.2%), "Exclusive culture in construction industry" (61.1%), and "Shortage of human resource" (60.5%). The principal obstacles to the research of technology fusion are not in the process of technology development but in the human resources, research infra and environment.

4. CONCLUSIONS

The survey on the technology foresight with 157 experts from construction companies, academia, government supported research institutes, and government agency was performed to identify what topics to be studied in what way for the significant advancement of the construction industry. From the analysis of survey, following results are obtained. The global trends show that the evolution of the technology fusion will be driven by the development of technology, especially "Clean construction and "New material with Nano technique." The weak point to complement and the obstacles to overcome for the noticeable growth in the research area of technology fusion are in the area of social and research environment such as "Temporary research system" and "Small budget in construction research." The most needed research areas of technology fusion are also proposed to strengthen the competitiveness in the international construction market. "Disaster forecasting" and "Ubiquitous infra construction" are selected as the most needed technology by 82.2% of respondents.

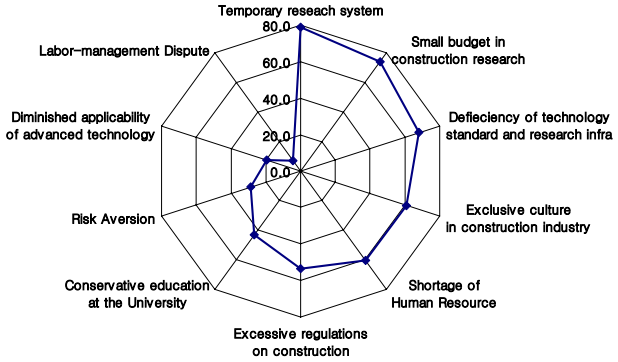

Fig. 8 Obstacle to the Research of Technology fusion

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