The Attitude of Construction Students toward Sustainability in the Built Environment

Ahn, Yong Han* and Kwon, Hyuksoo**
Ph. D. Candidate, Building Construction*, Technology Education**, Virginia Tech

건축물에서의 친환경개념에 대한 건축공학전공 대학생의 태도

안용한*, 권혁수**
버지니아 공대 박사수료

Abstract

This study investigates the level of the construction student's familiarity and interest in sustainability, their attitude toward sustainability, and the factors for bringing student's attitude toward sustainability. To accomplish the main objectives, this study employes a survey instrument created and developed by the authors. This is a descriptive and correlation study using responses from construction students at the Building Construction department at Virginia Polytechnic Institute and State University in Virginia. The results of descriptive statistics and multiple regression using SPSS version 16 present the following findings. Construction students perceive that they have a relatively high level of familiarity with sustainable construction and sustainability. Secondly, student's attitude toward sustainability is changed based on several factors such as sustainable construction courses, a professor who is interested in sustainability, their interest in the construction industry, university initiative, and the level of sustainability for student's learning facilities. Finally, the construction student's attitude toward sustainability can be improved by offering sustainable construction courses in construction programs, having professors who teach and research sustainability, and adopting sustainable initiatives at the university level such as campus recycling and various sustainable programs.

Keywords: Building construction education, Sustainable construction, construction student's attitude toward sustainability.

Ⅰ. Introduction

Construction is a significant industry that profoundly influences our economy, natural environment, and health. The construction industry is the largest industry in the United States, employing over 6.7 million people in 732,000 companies and generating over $1.1 trillion in revenue in 2005 (EPA, 2007; Census, 2005). At the same time, the construction industry contributes to major environmental issues and problems including global warming, climate change, ozone depletion, soil erosion, desertification, deforestation, acidification, loss of diversity, land pollution, water pollution, air pollution, and depletion of fisheries (Kibert, 2005; Shan, 2006). With the recognition of these challenges and issues associated with construction activities, the industry introduced and accepted the concept of "sustainability" through sustainable construction, green building, and sustainable development.

This sustainability movement brings the associated benefits to our society and construction

industry. Formal construction education curricula integrating sustainability issues provide an ideal mechanism for achieving the final goal of sustainability education (Cotgrave and Alkhaddar, 2005 Zhang, Zimmerman, Mihelcic, and Vanasupa, 2008). Construction programs in the United States have a vital role in sustainability education because they produce construction professionals who will become leaders of changing the industry. Academic scholars have studied the importance of sustainable construction education in several countries including the U.K., the U.S.A., and Australia.

With these significant and potential benefits of sustainable construction, this study investigates the construction student's attitude toward sustainability.

Ⅱ. Theoretical Background

The most widely accepted definition of "sustainability" was prepared by the World Commission on Environment (Bruntland, 1987) in its report "Our Common Future". This definition will be integrated into construction because construction process and practices significantly influence on the issues mentioned. Thus, sustainable construction means that constructed structures including buildings, bridges, and roads are designed, operated, and demolished in an environmentally and energy efficient manner which can minimize the impact on the environment, improve the working environment for the occupants, and reduce the operation and maintenance costs (EPA, 2008). This sustainability movement brings the associated benefits such as environmental stewardship, social responsibility, economic prosperity (Kibert, 2003).

Formal construction education curricula integrating sustainability issues provide an ideal mechanism for achieving the final goal of sustainability education (Cotgrave & Alkhaddar, 2005 Zhang et al., 2008). Mead (2002) defined the status of sustainable construction in the construction industry and suggested the importance of sustainable construction education in construction programs. Ahn and Pearce (2007) investigated the expectations of sustainability of construction related firms. Kibert (2003) did research on "Sustainable Construction at the Start of the 21st Century." Hayles, Robson, and Holdsworth (2006) did a case study about how the Royal Melbourne Institute of Technology (RMIT) incorporates into their undergraduate programs the issues of housing sustainability and affordability. Hayles and Holdsworth (2006) did a case study about how RMIT changed their curriculum for sustainability. Cotgrave and Alkhaddar (2006) examined on green curriculum within construction programs in the United Kingdom.

Ahn et al. (2008) developed a sustainable construction course designed for university construction programs that used a systematic course development approach. Haselbach and Fiori (2006) explained the importance of developing an appropriate pedagogy, curricula, and accreditation. Graham (2000) did research concerning teaching and learning environmental literacy for the building professions. Even though many scholars have indicated the importance of sustainable curriculum in construction programs, in reality only a small number of programs from among the members of Associated Schools of Construction offer their students such courses. Those who do include Colorado State University, University of Florida, Texas A&M University, Virginia Polytechnic Institute and State University, Minnesota State University Moorhead, Alfred State College, and Old Dominion University (Tinker & Burt, 2004).

In conjunction with a literature review related to sustainability, sustainable education, and the expectation of sustainable education, several scholars indicated that the main aim of sustainable education is the change of student's attitude that will change their behavior (Cotgrave

& Alkhdddar, 2005). The extensive literature review in the areas of sustainability, sustainable education, and the change of attitude and behavior toward environmental issues suggests the need for a methodology for changing construction student's attitude toward sustainability during their education period. The alteration of their attitude will eventually impact not only themselves but also the whole construction industry for a more sustainable future.

Ⅲ. Research Design

1. Research Objectives

The main objective of the study was to identify the level of familiarity and interest in sustainability in construction, to classify the most recognized sustainable rating system by construction students, to discover the relationship between the attitude toward sustainability and the year of construction students, and to detail factors related to construction student's attitudes toward sustainability in construction programs. Specifically, the study intended to answer the following research questions:

1) What is the level of familiarity with sustainable construction possessed by construction students and student's attitude toward sustainability in a construction program?

2) What is the best predictive model for the dependent variable of the attitude toward sustainability as related to the following independent variables: sustainable construction and/or environmental class, professors who are interested in the areas of sustainability and/or environment, construction industry interest for sustainable construction, and the willingness to purse sustainable projects and thesis?

2. Survey Instrument

Survey research was the method used to accomplish the main objectives. The survey instrument was created and developed by an author-based review of the literature and other studies such as Cotgrave & Alkhd and Ahn & Pearce's survey questionnaire. The survey instrument is composed of five sub-categories: (1) understanding the demographic information of each respondent, (2) identifying personal perception of sustainability, (3) examining the curriculum for environment/sustainability, (4) recognizing other factors for a student's attitude toward sustainability/environment, and (5) identifying the student's perspective of sustainability in the construction industry.

The individual survey questions were composed of three types, a five-point Likert-type scale question, a dichotomous question, and an open-ended question. The survey instrument was examined by a research measurement expert and two academic experts in construction and pilot tested by 10 Ph.D. students at the building construction department at Virginia Tech. The reliability of questions regarding attitude toward sustainability was measured using the Pearson correlation (Pearson r). The initial pilot responses received three days later resulted in a coefficient of reliability of r = 0.82. The content of attitude questions was

considered reliable and was not revised. Several typo errors were corrected and several words in the questions were revised to increase the clarity.

3. Research Procedure

This was a descriptive/correlation study using responses from construction students at the Building Construction Department at Virginia Polytechnic Institute and State University in Virginia, USA. This study was approved by the School's Institutional Review Board (IRB). The sample size was 254 building construction students excluding first year students because the authors believe that they do not fully understand the terms and definitions of sustainability and other construction terms.

<Table 1> Research sample and response rate

	Sophomore		Junior		Senior		Masters		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Sample	91	100	68	100	70	100	25	100	254	100
Response	36	40	36	53	30	44	16	64	118	47

The developed survey instrument was encoded at the web survey tool called "Survey Monkey" to facilitate the distribution and collection of the survey questionnaire. After successfully developing the web survey link, the invitation email with the survey link was sent to building construction students with a short invitation letter. The authors opened the web survey site for two weeks to collect data. During the two weeks, the authors sent an additional email to motivate students to participate in the survey and also solicited course instructors to mention the importance of the study. In addition, the authors set up the survey program so that the survey only allowed one response per computer to minimize multiple attempts from students.

The total response rate was 47% (n = 118). However, there were 4 incomplete responses which were discarded for statistical analysis. The master students have a high response rate compared to second year from 33% to 64%. Moreover, the response rate increased from the lower year to upper year which was clearly shown in <Table 1>.

The statistical analysis used to interpret the data included descriptive statistics, ANOVA, and multiple regression statistics. Descriptive statistics were used to determine the self-perceived level of familiarity with sustainable construction in the building construction program, the most recognizable sustainable benchmarking system for construction students, teaching methodologies which were the most preferable to increase student's understanding of sustainable construction, and the mean and measure of variance of the attitude toward sustainability in building construction students. Analysis on Variance (ANOVA) analysis was conducted to identify the relationship between the attitude toward sustainability and the status of student's year (sophomore, junior, senior, and master student). Multiple regression analysis was used to determine the best model for explaining the variance associated with the student attitude toward sustainability in the construction program based on the linear combination of the independent variables.

Ⅳ. Findings & Interpretation

Demographic of participants measured by the study were the status in university, gender, and the years of work experience in the built environment. The respondents' status in the program is shown in <Table 1>. Eighty eight percent of respondents were male, twenty percent of respondents did not have any full time work experience in the field of construction, and sixty percent of the students had less than two years of work experience. Sixty two percent of respondents were born in metropolitan areas (over 50,000 populations) and thirty eight percent were born in rural area (less than 50,000).

1. Familarity

Familiarity of sustainable construction was measured by a five Likert-type scale question which was "Are you familiar with sustainability, especially regarding the built environment?". The student responses showed a level of familiarity of sustainability from 1 (unfamiliar) to 5 (very familiar), with average of 3.56 out of 5. The analysis of variance (ANOVA) analysis was run to identify differences among the status in the university. The result showed a significant difference of the student's familiarity

toward sustainability among the status of university level (Sophomore, Junior, Senior, and Graduate student), having the F-value of 6.645 ($p<0.05$). According to multiple comparison using "Tukey Method", the average score of the familiarity of sustainable construction between sophomores and juniors and junior, senior, and master students were not significant different. However, the average scores of familiarity with sustainable construction of senior and graduate students are significantly greater than one of sophomores.

2. Student's Atittude Toward Sustainability

The student's attitude toward sustainability was measured based on five questions related to student's perception of sustainability. The individual question was divided on a five Liket-type scale from "1: definitely not" to "5: definitely yes". The overall student's attitude toward sustainability is very high in the range between 3.7 and 4.36. as shown in <Table 2>.

3. Factors for the Student's Attitude

In order to identify factors affecting student's attitude toward sustainability, the correlation coefficient (Pearson r) was used. The correlation coefficients between student's attitude toward sustainability and other variables such as sustainable facilities (r=0.395), class and educcation (r=0.636), construction industry interest (r=0.496), university initiative (r=0.547), and university faculty (r=0.542) are significantly high (all coefficient value are significant in the significance level of 0.01). Construction student's attitude toward sustainability is influenced by several factors such as sustainable facilities (e.g. LEED certified building) in the university, sustainable construction and/or environmental class (education), construction industry interest, sustainable initiatives in a college and university, and a professor teaching and doing research for sustainable construction. The mean of five factors are shown in <Table 3>.

4. Regression Model for Student's Attitude toward Sustainability

The predictive model for the dependent variable of the construction student's attitude toward sustainability is based on the following independent variables: sustainable facilities (e.g. LEED certified building) in the university, sustainable construction and/or environment class (education), construction industry interest, sus-

<Table 2> The student's Attitude for Sustainability

Questions	Mean	S.D.
Believe that environmental issues are important	4.3596	1.0005
Think it is for construction professionals to inform the general public about the effects of construction work on the environment	4.0789	0.9037
Think sustainability as an important criteria for your future career.	3.9211	1.1221
Pay additional cost for buying a sustainable (green) building	3.7982	0.9517
Think public organizations have to incorporate the concept of sustainability into their facilities	3.7632	0.9893

<Table 3> Factors for Student's Attitude toward Sustainability

Independent Variables	Mean	S.D.
A professor teaching and doing research in sustainable construction	4.0000	0.9593
Sustainable construction and/or environment class (education)	3.9298	0.9474
Construction industry interest	3.9123	1.0267
Sustainable initiatives in the university or college	3.7719	0.8625
Sustainable facilities (e.g. LEED certified building) in the university	3.0526	1.0876

tainable initiatives in the university or college, and a professor teaching and doing research in sustainable construction.

Through stepwise regression which removes and adds independent variables to the regression model for the purpose of identifying a useful subset of predictors, three key independent variables were selected because these variables created the best fitting model to explain the dependent variable, student's attitude toward sustainability. The overall regression model with the three independent variables: sustainable construction or environmental class, sustainable initiatives in the university or college, and professors teaching and researching sustainable construction) successfully predicted the dependent variable (student's attitude toward sustainability), which was indicated by a F-value of 42.875 ($p<0.05$) and a R-square of 0.539 ($p<0.05$) as shown in <Table 4>.

The model accounted for nearly 54.2% of the variance in student's attitude toward sustainbility. While looking at the contribution of each independent variable, the "construction and/or environmental class (education)" was a significant predictor in this model. The coefficient of "construction and/or environmental class (education)" ($\beta=0.361$) was significant ($t=5.936$, $p<0.01$), and this was also verified by the significant Pearson's coefficient between "construction and environmental class (education)" and student's attitude toward sustainability ($r= 0.636$, $p<0.01$).

<Table 4> Best Fitting Predictive Model for Student's Attitude for Sustainability

Model Summary

a. Predictors: (Constant), class, university initiative, professors

Model	R	R Square	Adjusted R Square	S.E. of the Estimate
1	0.636	0.405	0.399	0.60157
2	0.716	0.513	0.505	0.54638
3	0.736[a]	0.542	0.529	0.53247

Model 1 : Class
Model 2 : Class + University Initiative
Model 3 : Class + University Initiative + Professors

The second independent variable, the "sustainable initiatives in the university or college" was a significant predictor in this model. The coefficient of "sustainable initiatives in the university or college" ($\beta=0.275$) was significant ($t=4.197$, $p<0.01$), and this was also verified by the significant Pearson's coefficient between "sustainable initiatives in a college or university" and student's attitude toward sustainability ($r= 0.547$, $p<0.01$). The final coefficient of "professors who teach and research in terms of sustainable construction" ($\beta=0.169$) was significant ($t=2.622$, $p<0.01$), and this was also verified by the significant Pearson's coefficient between "professors" variable and student's attitude toward sustainability ($r=0.542$, $p<0.01$).

Ⅴ. Conclusion & Recommendation

Three conclusions were identified based on the purposes and findings of this study. They are presented here with related supporting data and recommendations.

Construction students perceived that they have a relatively high level of familarity with sustainable construction. The descriptive statistic shows that master students have the highest level of familarity of sustainable construction compared with sophomores, juniors, senior, and master students. However, the concept of sustainability is very significant to other engineering students as well as construction students. Therefore, a study regarding the sustainability of other engineering students is necessary.

The attitude toward sustainability for construction students is changed based on several factors such as sustainable construction courses offered by sustainable experts, the sustainable initiatives in the university or college, the interest in sustainable construction by the construction industry, and the sustainable facilities in the university or college as presented in the correlation coefficients.

The construction student's attitude toward sustainability can be improved by offering sustainable construction courses in construction programs. Therefore, courses related to sustainable construction should be implemented as a major requirement for construction students. Also, actively adopting sustainability initiatives at the university level such as campus recycling, sustainable programs, research, and education for a sustainable future supports construction student's attitude toward sustainability. In this context, the sustainable components in university environment and infrastructure would be very significant to students' attitude toward sustainability. In particular, a case study of the university's sustainable construction campaign and/or student's participation of university initiatives can be helpful for student's attitude toward sustainable construction. Therefore, this study recommends that the classes regarding sustainable construction should be implemented with a more practical perspective.

Finally, university faculty who teach and perform research in sustainable construction are one of the major factors positively affecting student's attitude toward sustainability. Thus, the concept of sustainability should be embedded in all courses or classes for construction students because it is very pervasive in the field of construction and can be strongly affected by the classes related to sustainability and its appropriate teaching

국문요약

이 연구는 친환경 개념에 대한 건축공학 대학생의 친숙함과 흥미의 정도, 태도, 그리고 친환경 개념에 대한 학생들의 태도를 향상시키기 위한 요인들을 조사하고 있다. 연구의 목적을 이루기 위해, 이 연구는 저자들에 의해 개발된 설문 조사 방법을 채택하고 있다. 이는 미국 버지니아주 버지니아 공대의 건축공학과 학생들을 대상으로 하는 설문조사를 기반으로 한 기술/상관 연구이다. SPSS를 이용한 기술통계와 다중회귀분석을 통하여 다음과 같은 결과를 제시하고 있다. 첫째, 건축공학 전공 학생들은 대체로 친환경 건축에 대한 높은 친밀감과 흥미를 가지고 있다. 둘째, 친환경 개념에 대한 건축공학 전공 학생들의 태도는 친환경 건축 수업, 친환경 관련 수업과 연구를 담당하는 교수진, 친환경적인 학생들의 학습환경 또는 시설들, 그리고 친환경 건설 관련 학교 행사와 실천과 같은 요인들에 기반해 달라지는 것으로 나타났다. 마지막으로, 친환경 개념에 대한 건축공학 학생들의 태도는 특히, 건축공학 프로그램에서 친환경 건축관련 수업을 제공함으로 향상될 수 있다.

주제어: 건축공학교육, 친환경 건축공학, 공학생의 친환경관련 태도

References

Ahn, Y. H. & Pearce, A. R. (2007). Green Construction: Contractor Experiences, Expectations, and Perceptions. *Journal of Green Building, 2*(3), 106-122

Ahn, Y. H., Kwon, H., Pearce, A. R. & John, W. (2008). Integrated sustainable construction: A course in construction for students in the USA. *Proceeding of American Society of Engineering Education Annual Conference (ASEE),* Pittsburgh, United States.

Bruntland, G. (Ed.). (1987). *Our common future: The World Commission on Environment and Development.* Oxford: Oxford University Press.

Cotgrave, A. & Alkhaddar, R. (2006). Greening the curricula with construction programs. *Journal of Education in the Built Environment, 1*(1), 3-29.

Environmental Agency Protection (EPA) (2007). *Construction.* Retrieved September 12, 2007, from http://www.epa.gov/sectors/construction/index.html

EPA (2008). Green Building. Retrieved May 12, 2008, from http://www.epa.gov/greenbuilding/pubs/about.html

Graham, P. (2000). Building education for the

next industrial revolution: Teaching and learning environmental literacy for the building professions. *Construction Management and Economics, 18*, 917-925.

Haselbach, L. M. & Fiori, C. M. 92006). Construction and environment: Research foci for a sustainable future. *Journal of green building, 1*(1), 148-157.

Hayles, C. S., Robson, K. & Holdsworth, S. E. (2006). A case study from RMIT: introducing property undergraduates to the immediate issues of housing sustainability and affordability within Australia and New Zealand. *Proceeding of the PRRES Conference,* Auckland, New Zealand.

Hayles, C. S. & Holdsworth, S. E. (2006). Curriculum change for sustainability. *Proceeding of the Built Environment Education Annual Conference,* London, United Kingdom.

Kibert, C. J. (2005). *Sustainable construction green building design and delivery,* John Wiley & Sons, N.J.

Mead, S. P. (2002). Green building: Current status and implications for construction education. *Proceeding of Association of School of Construction,* Fort Collins, Colorado.

Shan, S. (2006). *Sustainable practice for the facility manager,* Blackwell publishing, India.

Tinker, A., & Burt, R.. (2004). Greening the construction curriculum. *International Journal of Construction Education and Research, 9*(2), 26-33.

Zhang, Q,. Zimmerman, J., Mihelcic, J., & Vanasupa, L. (2008). Civil and Environmental Engineering Education (CEEE) transformational change: Tools and strategies for sustainability integration and assessment in engineering education. *Proceeding of ASEE Annual Conference,* Pittsburgh, United States.

교신저자: 권혁수