2006-1412: DEVELOPMENT OF AN UNDERGRADUATE PROGRAM FOR CONSTRUCTION EDUCATION IN BANGLADESH USING GENERAL LINEAR MODEL

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Development of an Undergraduate Program for Construction Education in Bangladesh using General Linear Model

Abstract

The purpose of the study is to develop an undergraduate curriculum for construction education in Bangladesh. A standard Likert style survey instrument was used to gather the data related to the importance of construction education in the country. This survey instrument was sent to educators engaged in the teaching of disciplines closely related to construction and professionals who are involved with the construction industry in Bangladesh. The results of the survey were used to analyze the need for construction education in Bangladesh and a broad category of topics the curriculum should encompass. The data was analyzed by administering a General Linear Model. The results from the study indicate that it is important to introduce a program at an undergraduate level in Bangladesh to produce professionals capable of managing the construction projects effectively and efficiently. Based on the findings of the study, a detailed curriculum for construction education at an undergraduate level for universities in Bangladesh is recommended to be developed with content requirements within the following subject categories:

- Communications, humanities, and social sciences,
- Mathematics and Science,
- Business and Management,
- Architectural and Engineering Design Disciplines, and
- Construction Practice.

Keywords: Bangladesh, construction education, construction industry, general linear model, undergraduate curriculum

I. Statement of the Problem

Construction Industry in Bangladesh

Bangladesh construction industry is growing steadily at a constant rate. Total construction expenditure of the country has increased from Tk. 100 billion (1.67 billion US dollars) in the early 1990's to about Tk. 200 billion (3.33 billion US dollars) in 2003. Figure 1 shows a steady increase of the country's construction output which is presently over 8 per cent of its GDP[1]. Most of the construction works are in the public sector. Funding for a high percentage of construction projects come from multilateral development agencies (MDA) like the World Bank or Asian Development Bank.

The rapid growth in the construction sector demands an adequate number of professionals with a broad understanding of the principles of construction science as well as leadership skills in motivating teams and integrating a wide range of tasks to produce a completed project. These

professionals should be capable of managing the construction projects effectively and efficiently. Apart from developing skills for logical thinking, computing, and communication, they must be capable of assuming the responsibilities for the planning, co-ordination and financial control of a construction project.

The duties of a construction graduate also include the determination of most appropriate method and sequence of construction operations for a particular project. They must be able to predict and monitor the construction operations in terms of labor, materials, equipment, and technical difficulties, and finally timely execution of all project items. They are responsible for dealing with scores of issues at the construction site, such as safety of construction operations, design and engineering of construction systems, and temporary structures. It is also their responsibility to keep track of progress and quality standards and ensure that the project is completed on time and budget.

Construction Education in Bangladesh

There are education programs at an undergraduate level in Bangladesh related to specific domains of construction, such as architecture and civil engineering, but none of the institutions of higher education in the country offer a course specifically geared toward producing professionals with an understanding of the total construction process from the inception of a project to its completion. Only university that proposes to offer a course on construction education is Prime University in Dhaka. But the institute has not yet developed a program for the course. It is, therefore, proposed to develop a curriculum for construction education at an undergraduate level that can be adopted by any institute of higher education in Bangladesh.

A construction education is multi-disciplinary in nature. The curriculum should focus on basic scientific, quantitative, and qualitative topics that provide a foundation for applied construction technology. It will be structured on the principles of management, mathematics, statistics, and the design disciplines applied to the behavior of equipment, human resources, materials, and methods used in construction.

Construction Education in Selected Countries

USA

Construction education is relatively new in most countries around the world. The discipline is only about sixty-year old even in the United States, where construction industry accounts for about 10 percent of the nation's gross domestic product [2]. Presently, there are 100-plus U.S. schools that offer four-year baccalaureate degrees in construction. In order to manage a construction volume of more than $800 billion per year, the country is predicted to have a demand of more than six thousand construction graduates a year [3]. The schools of construction are capable of producing less than half the annual demand for such professionals.

Most of the schools of construction in the U.S. are accredited by the Associated Council of Construction Education (ACCE) and some by the Accrediting Board for Engineering and Technology (ABET). The programs in construction provide the graduates with a broad

understanding of the principles of construction science, business and management aspects of the profession, and leadership skills in motivating teams and integrating a wide range of tasks to produce a completed project [4].

United Kingdom

Building science and construction programs in the United Kingdom are generally geared toward producing professionals who are capable of providing overall planning, management, co-ordination, and financial control services for construction projects. The graduates from these programs are also employed as building control surveyors and services engineers. They are three-year degree programs.

Australia

Construction industry in Australia is one of the largest employers in the nation. Most of the Australian universities offer undergraduate education in construction to prepare the students for a professional career in building and construction related industries [5]. These programs help develop skills in how to manage people, materials, equipment and plant while focusing on issues such as cost, time, quality, safety and environment. They are geared toward educating students to become effective construction managers with comprehensive technological knowledge, management principles and communication skills. Like the programs in the US, the Australian schools offer four-year baccalaureate degrees.

Singapore

The construction industry in Singapore has an annual gross output of about $10 billion, with a capacity of about $12 billion. The industry contributes around 7 per cent of gross domestic product (GDP) and accounts for about 6.5 per cent of total employment [6].

Universities in Singapore produce construction graduates who are employed by the government as well as the private construction enterprises. Similar to many other rapidly developing countries of the world, construction in Singapore also has become a complex production process involving many advanced technologies. One consequence of this is the need for high caliber graduates in this discipline to manage the process. The construction education programs aim to produce such graduates. Professionals graduating from these programs provide professional advice to clients to enable them to complete their building projects to meet time, cost and quality targets [7].

Subject Matter Requirements for a Construction Education Program

The American Council for Construction Education (ACCE) recommends that a curriculum for construction education should include academic coverage of some core subject matter that is essential for a graduate to function effectively in the construction environment [4]. The categories suggested by ACCE are very generic and broad-based in nature that could be adopted by schools anywhere around the world. The courses taught under these categories could be tailored to meet the specific requirements of the construction industry of the region for which the program will be

developed. A study of the nature of construction education in selected countries around the world also suggest that most of these programs provide the graduates with a broad understanding of the subject matter courses under the categories detailed below.

Communications, Humanities, and Social Sciences

Construction is concerned with people and their relationships. Therefore, the ability to communicate, both orally and in writing, and the understanding of human behavior are essential assets to the constructor. It includes appropriate courses in communications, social sciences, and the humanities. The content should reflect the needs of the construction industry as well as the philosophy of the educational institution.

Mathematics and Science

A well-developed concept of mathematics and physical science is essential for a construction graduate. The technical process of construction can be best controlled by applying the principles of mathematics, statistics, and computer science. Moreover, an understanding of the behavior of materials, equipment, and methods used in construction require laws of physics, chemistry, geology, and environmental sciences.

Business and Management

A constructor is required to assume the responsibility of planning, management, co-ordination, and overall financial control of construction projects. A construction graduate should have a broad understanding of the fundamentals of the free enterprise system, accounting, finance, business regulations, contract law, and labor law of the country, and marketing. This category also involves fundamental courses to provide a foundation for contemporary business practices appropriate to applications in construction.

Architectural and Engineering Design Disciplines

A construction graduate must have an understanding of the processes of architectural and engineering design disciplines. The graduate must be capable of communicating with design professionals, and should be able to participate in planning phase of design-build projects.

Construction sciences including architectural and engineering design topics selected to communicate with the design disciplines and to solve practical construction problems are to be considered in this category.

Construction Practice

The construction practice curriculum is of vital importance in a quality construction program. Course material in this category covers both office and field activities required to complete any type of construction project efficiently.

Study Objectives

The objective of the study was to develop a curriculum for construction education at an undergraduate level in Bangladesh. In order to develop the program objectively, it was deemed necessary to find out the views of professionals involved with the country's construction industry and faculty members of education programs closely related to construction regarding:

1. The importance of construction education in Bangladesh.
2. Broad categories of topics to be included in a program for construction education.

Hypotheses

Following hypotheses were tested for the study:

1. The teaching of construction science at an undergraduate level in Bangladesh universities is essential for the development of the country.
2. It is essential for a construction graduate in Bangladesh to have a knowledge of
   a) Communications, humanities, and social sciences,
   b) Mathematics and Science,
   c) Business and Management,
   d) Architectural and Engineering Design Disciplines, and
   e) Construction Practice.

Assumptions

The study started with some assumptions that include:

1. The faculty members surveyed in this study had a thorough awareness of the requirements for a construction education program for Bangladesh universities.
2. The individuals from the industry surveyed in this study had a thorough awareness of the requirements for a construction education program for Bangladesh universities.
3. The responses made to the survey were not biased.
4. The surveying instrument was valid and it measured what it was designed to measure.

Limitations

1. This study was limited only to faculty members who teach disciplines closely related to construction.
2. This study was limited only to the CEOs of companies that provide both design and construction management services.

II. Research Methodology

Data Acquisition

A total number of 50 faculty members were randomly selected from universities in Bangladesh that offer courses closely related to construction (e.g. architecture and engineering). Another 60 were randomly selected from companies in Bangladesh that were involved with design and construction management. A structured survey instrument was prepared to collect the data. It was delivered personally by the author. Respondents were given two weeks to respond. The total number of responses was 100—42 from the faculty and 58 from the industry.

Data Analysis

The statistical method adopted for testing hypothesis 1 was one-sample *t*-test. A one-sample *t*-test compares a mean score of a sample to a known value. A General Linear Model was used for testing hypothesis 2. The *p*-value for testing both the hypotheses was set at 0.05.

Variables

Importance of Construction Education (IMPCONED): It is the reported importance of construction education in Bangladesh.

Affiliation (AFFIL): It is the affiliation of the respondents. This was a class variable consisting of two categories: (1) respondents from the academia and (2) respondents from the construction industry.

Communications, Humanities, and Social Sciences (GENED): It is the reported importance of the ability of construction graduates in Bangladesh to communicate with people and understanding of ethical issues.

Mathematics and Science (MATHSCI): It is the reported importance of the ability of construction graduates in Bangladesh to control the technical processes in construction by applying the principles of mathematics, statistics, and physical sciences.

Business and Management (BUSMAN): It is the reported importance of the ability of construction graduates in Bangladesh to manage the principal resources of the industry.

Architectural and Engineering Design disciplines (DESIGN): It is the reported importance of the ability of construction graduates in Bangladesh to understand of the processes of architectural and engineering design disciplines.

Construction Practice (CONPRAC): It is the reported importance of the ability of construction graduates in Bangladesh to understand of the principles of materials takeoff, scheduling, project controls, contracts, and construction safety.

The variables were measured on a Likert scale ranging from 1 to 5. The respondents were asked to reply in terms of whether they agree or disagree with a particular statement related to the above variables. Values were assigned to the responses as follows:

TABLE 1

Assigned Values to Different Responses

Response	Assigned value
Strongly Agree	5
Agree	4
Undecided	3
Disagree	2
Strongly Disagree	1

III. Results

Null Hypothesis 1

The teaching of construction science at an undergraduate level in Bangladesh universities is not essential for the development of the country.

A one-sample *t*-test was first performed to test this hypothesis. The data measured for the variable IMPCONED was used for the purpose. The mean score for the variable was found to be 4.72. The *t*-test was performed on the mean score against a specified value of 3, which is the value for "undecided." The results are shown in Table 2.

TABLE 2

Results of One-sample T-test for Null Hypothesis 1

Variable	*N*	*df*	Mean	*t*-value	*p*-value
IMPCONED	58	57	4.72	26.90	<0.0001

The results indicate that *t*-value obtained for the test was 26.90 for IMPCONED mean score at a level of significance of less than 0.0001. It signifies that the mean score measured for this variable is significantly different from and higher than (since the *t*-value is positive) the value against which they was tested.

Null Hypothesis 2

It is not essential for a construction graduate in Bangladesh to have knowledge of

a) Communications, humanities, and social sciences,
b) Mathematics and Science,

c) *Business and Management,*
d) *Architectural and Engineering Design Disciplines, and*
e) *Construction Practice.*

The hypothesis was tested using a General Linear Model. It is an extension of linear regression model that allows analyzing the effects of class variables on the criterion variables. The following model was used for the analysis:

$$IMPCONED = \beta_0 + \beta_1 AFFIL + \beta_2 GENED + \beta_3 MATHSCI + \beta_4 BUSMAN + \beta_5 DESIGN + \beta_6 CONPRAC + \xi \quad (1)$$

where β_0 = intercept,
$\beta_1, \beta_2, \beta_3,$ etc. = regression coefficient, and
ξ = error term in the equation.

The results of the analysis are shown in Table 3.

TABLE 3

Summary of General Linear Model analysis for IMPCONED

Parameter	Regression coefficients	*t*-value	*p*-value	Model R^2	Model *F*-value	*p*>*F*
Intercept	-0.268	-0.871	-.0.386	0.83	75.269	<0.0001
AFFIL						
o EDU	-0.133	-2.695	0.008			
o PRO	0					
GENED	0.248	4.914	<0.0001			
MATHSCI	0.378	7.467	<0.0001			
BUSMAN	0.148	2.803	<0.0001			
DESIGN	0.140	2.120	<0.0001			
CONPRAC	0.186	2.856	<0.0001			

The *F*-value of the model was found to statistically significant at less than the 0.0001 level. It indicates that a relationship exists between the importance of construction education in Bangladesh and the predictor variables used in the model. An important aspect of a statistical procedure that derives model from empirical data is to indicate how well the model predicts results. A widely used measure the predictive efficacy of a model is its coefficient of determination, or R^2 value. If there is a perfect relation between the dependent and independent variables, R^2 is 1. In case of no relationship between the dependent and independent variables, R^2 is 0. Predictive efficacy of this particular model was found to be quite high with an R^2 of 0.83.

The results of the General Linear Model procedure also indicated that all the independent variables were correlated with the importance of construction education in Bangladesh (IMPCONED) at less than the 0.0001 level.

Least Squares Means option of General Linear Model was used to find out the perceptual difference, if any, between educators and professionals as to the importance of construction education in Bangladesh. This was done by finding out whether the means of the two levels of the variable affiliation (AFFIL) differed significantly. The results are shown in Table 4.

TABLE 4

Comparison of Means of the Two Levels of AFFIL

Level	Mean	Mean Difference	p-value
EDU	4.543	-0.133	0.008
PRO	4.676		

The results indicate that there is a perceptual difference between educators and professionals as to the importance of construction education. The degree of importance given to the development of a construction education program in Bangladesh by the professionals is significantly higher than that given by the educators.

IV. Summary and Conclusions

Construction is one of the largest industries in Bangladesh, with a share of more than eight percent of the country's gross domestic product. It impacts all other businesses. The industry needs academically skilled professionals trained in managerial, technological, economic, social, and environmental aspects of construction and project development.

This study assessed the need for providing construction education at an undergraduate level in Bangladesh. Along with assessing the importance of teaching construction science, this study also identified the general categories of disciplines that are perceived to be included in a curriculum for such education. Findings of the study indicate that it essential that the country produces professionals with an in-depth knowledge of the processes and management aspects of construction. Such an education program should be multi-disciplinary in nature with emphasis on communications, social sciences, mathematics and science, architectural and engineering disciplines, and construction practice.

It may be desirable in some instances to develop curricula in one or more areas of construction specialization. Such options may be developed as the only program or as part of a multi-option program. Each unit may develop its own program goals and objectives and particular emphasis, and may prescribe the number of courses for graduation, sequencing of study, course numbers, and titles. In line with similar programs existing in other countries, it is proposed to develop the program as a four-year baccalaureate degree course consisting of at least 120 semester credit hours (SCH) or its equivalent. Additional credits to meet graduation may be required to meet the specific objectives, if any, of the institute.

Based on the findings of the study, a detailed curriculum for construction education at an undergraduate level for universities in Bangladesh is recommended to be developed with content requirements within the following subject categories:

a) Communications, humanities, and social sciences,
b) Mathematics and Science,
c) Business and Management,
d) Architectural and Engineering Design Disciplines, and
e) Construction Practice.

V. Recommendations for Further Study

Based on the results of the study, recommendations may be made to the public and private universities in Bangladesh to conduct studies on the feasibility of introducing graduate programs in construction education. In fact, the institutions that already have undergraduate programs in architecture and civil engineering will not have to put much additional resources to start such a program. Courses recommended under each subject category have to be developed to meet the specific economic, social, cultural, and technological conditions prevailing in Bangladesh. A separate study should be conducted for preparation of syllabi for all the individual courses to determine the course contents, learning objectives, and the measures of attainment of the objectives.

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