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Training and Education in Project Management Principles in the Hong Kong Construction Industry*

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Today, professionals in the construction industry feel that civil engineering programmes in universities should be kept general as they find many engineers narrowly focused. They feel that the present curricula provide too much specialisation and lean heavily on mathematics and sciences. Experience with recent graduates suggests weaknesses in grasping broad concepts and interdisciplinary considerations. Project management, over the last 20-25 years, has developed into a methodological and systematic way of dealing with all aspects of construction projects. The wide range of topics that are now the domain of project management is a far cry from the earlier emphasis on scheduling, cost control and resource management. They include, but are not limited to, engineering economic analyses, project screening and selection, life-cycle costing, internationalisation, human resource management, etc. This paper presents the results of a study carried out to identify some of the core issues in project management as seen by experienced project managers in the Hong Kong construction industry, and also highlights the significance of training needs of mid and top level managers to strengthen their knowledge and understanding of these areas. The methodology used for this study is the collection of data in the shape of a questionnaire survey, followed by data analysis which included a statistical comparison of means and interpretation. It is expected that this study will enable educators and trainers to better equip middle and top level managers in the construction industry with the state-of-the-art tools, techniques and methodologies of project management.

INTRODUCTION

A survey carried out by the authors revealed that young engineering professionals in the Hong Kong construction industry feel that the most important managerial skill required by them is leadership, followed by strategic planing and human resources allocation [1]. Further, most respondents indicated that management should be an important subject in their university curricula; about 70% of respondents agreed that the University programme leans heavily on mathematics and sciences.

Engineers exist and work in an interdisciplinary world, but the curriculum generally restrains them to narrow disciplines [2]. The civil engineering curriculum, for instance, must prepare graduates:

- for real jobs and tasks now and for a rapidly changing future;
- to approach their profession from a systems point of view;
- to accomplish design and construction in a way that makes them productive as well as precise;
- to interact and communicate with others both in speaking and writing;
- to play an increasingly key role in the continuous development and improvement of our society.

Projects and project management are the wave of the future in the global business environment. Increasingly, technically complex projects and the need for cross functional expertise make project management an important and powerful tool in the hands of an organisation that understands its use. Unfortunately, and perhaps ironically, it is the very popularity of project

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management that presents many civil engineering organisations with their most severe challenges. They often belatedly discover that they simply do not have sufficient numbers of the sort of project managers who can satisfy the time, quality, safety and time requirements. Senior managers in many companies readily acknowledge the *ad hoc* manner in which most project managers acquire their skills, but they are unsure how better to develop and provide for a supply of well-trained project leaders for the future [3].

Civil engineers analyse, design and construct facilities for energy exploration and production; habitation and public use; transportation of people and goods; waste collection, containment and treatment; and water-resources preservation and utilisation. Because of the unforeseen consequences of previous actions and growing societal concerns, problems are becoming increasingly complex and their solutions require interdisciplinary teamwork [4]. Text books, however, suggest that the framework of civil engineering instruction is broadly similar to what it was forty years ago.

Does the current system of engineering education meet the needs of tomorrow's project managers? This question often evokes a passionate and emotional response from all sides of the issue. The practitioner calls for civil engineers better trained in leadership, people skills, teamwork, marketing and other management skills, but not at the expense of technical skills. Construction industry professionals feel that programmes should be kept general as they find many engineers narrowly focused. They feel that the present curricula provide too much specialisation. Experience with recent graduates suggests weaknesses in grasping broad concepts and interdisciplinary considerations [2]. Industry needs employees to design, build and sell in a changing environment. These needs are not satisfied by the current programmes [5].

BACKGROUND

Research and observation of industry practices suggest that the fundamental cause of project failure can be reduced to two general areas. First, projects are successful because the expectations of the stake-holders are met. Thus, conversely, projects are unsuccessful if such expectations are not met. The more expectations are missed, or greater the extent that these expectations are not met, the greater is the perceived failure of the project. Second, projects fail because communication within and on the project failed. In many instances, effective project communications and meeting expectations are closely linked.

A study by Thompson and Perry showed that of 1,778 World Bank funded projects between 1974 and 1988, 63% overran their budget. Of 1,627 projects over the same period, where data were available, 86% overran their schedule. Clearly, the World Bank funded projects are not unique and the tendency of time and cost overruns is commonplace [6].

Project managers are a special breed. Managing projects is a unique challenge that requires a strategy and methodology all its own. Perhaps most importantly, it requires people willing to function as leaders in every sense of the word. They must not only chart the appropriate course, but provide the means, the support and the confidence for their teams to attain these goals.

It is quite clear from the above discussion that project management is an intrinsic part of civil engineering education and as such deserves the serious attention and consideration of educators and practitioners.

Civil engineering and project management education

The American Society of Civil Engineers (ASCE) has held the *Civil Engineering Education Conferences* in 1979, 1985, 1990 and 1995. The aims and objectives of these conferences are to put forward recommendations and guidelines to continuously improve engineering education to assure a bright future for the engineering profession in an ever-changing global workplace. The main objective of the *1995 Civil Engineering Education Conference* (CEEC'95), held in Denver, USA, was to obtain an array of educational initiatives, institutional barriers and recommended actions for the further improvement of civil engineering education. These initiatives included:

- Faculty development
- Communication skills
- Project management
- Teamwork and leadership skills
- Integrated and interdisciplinary learning
- Practitioner participation in education
- Pre-professional and professional degrees

Project management was identified as one of the educational initiatives by the CEEC'95. Some of the institutional barriers to effective project management education identified at this conference are:

- Lack of qualified faculty
- Faculty resistance
- Insufficient time in curricula
- Availability of teaching materials

Recommended action includes:

- development of educational materials;
- setting up information on the world wide web and other electronic media;
- reviewing available materials from the Institute of Professional Practice; and
- interested faculty seeking additional training, etc [7].

International Project Management Association (IPMA) global qualification, certification and accreditation

At around the same time that the CEEC'95 was taking place in Denver, the International Project Management Association (IPMA), at its Board meeting in St Petersburg on 17 September 1995, committed itself to establishing a programme for:

- qualification of project management professionals;
- certification of project managers;
- accreditation of qualifying and certificating bodies.

The main goal of this programme is to make project management a global profession, and thereby encourage free movement of labour within the project management profession. In order to achieve this it is necessary to achieve:

- an internationally accepted statement of the *Project Management Book of Knowledge* (PM BOK);
- internationally accepted competency standards, against which to measure the performance of project managers and project management professionals;
- an internationally accepted structure for the stages of career progression of project managers and project management professionals, and associated definitions of qualification and certification;
- internationally accepted certification bodies to accredit national and international qualifying and certificating bodies, which currently do not exist in any form in the project management profession.

The first step towards obtaining international recognition and certification is agreeing on an internationally recognised and accepted *Book of Knowledge*. A comprehensive list (discussed in the next section) of the areas of knowledge that project managers may need to know has been developed by the IPMA. Project managers may or may not need to know all the items listed, depending on the industry and the level of competence desired. The line items in the list have been developed from the more widely accepted texts on project management, and also reference the Project Management Institute (PMI) USA, the Association of Project Managers (APM) UK, and a global framework being developed by the Australian Institute of Project Management (AIPM) in Sydney, Australia [7].

OBJECTIVES

Project management techniques are well known, but until we are able to take further steps towards formalising training and teaching the necessary skill set, the problems with efficiently developing, implementing and gaining client acceptance for these projects are likely to continue to grow. There is currently a true window of opportunity in the field of project management. Too often in the past, project managers have been forced to learn their skills the hard way, through practical experience coupled with all the problems of trial and error.

Experience is certainly a valuable component in learning to become an effective project manager, but it is by no means the best.

This study is based on the CEEC'95 identification of project management as an important educational initiative, and the development of a set of universal project management functions by the IPMA. Now that the leading educators and practitioners of civil engineering have highlighted project management as an area to be developed, there is a need to further study it as it relates to civil engineering education and the construction industry.

The primary focus of this study, keeping in mind the above, is to:

- solicit the views and opinion of senior project management professionals in the construction industry regarding the degree of importance of the universal project management functions developed by the IPMA with reference to the Hong Kong construction industry;
- gauge the degree of agreement or disagreement with regard to some of the skills that are generally considered very important for a project manager;
- utilise the results to provide an improved framework for civil engineering education and training.

The need for formalised project management education and training is now well documented. Systems now need to be in place to make sure that engineering education in general, and civil engineering education in particular, prepare future project managers who are well prepared to lead the construction industry into the next millennium. Project man-

agement should no longer be considered an *accidental profession*.

THE SURVEY

The main focus of this survey was experienced project managers in the Hong Kong construction industry. A total of 75 questionnaires were mailed out, of which 30 were completed and returned. This gives a response rate of 40%, which is quite good considering the very busy schedule that most project managers have to follow in Hong Kong. The average number of years that the project managers had held their position was 6.5.

The questionnaire was divided into three sections. The first asked about respondents' experience, the second was based on the universal project management functions developed by the IPMA and asked respondents to indicate the degree of importance they attached to these functions, and the third section asked respondents to indicate their level of agreement to some generally accepted project management skills. The project management functions used for the survey are given in Table 1.

Table 2 lists project management skills that are generally considered very important for a project manager to possess [8].

For project management functions, the questionnaire was designed to gauge the degree of importance with respect to civil engineering and construction. The respondents were asked to indicate their response (for sub-categories) by noting any number from 1-5, with 1 being least important and 5 very important. For project management skills, the participants were asked to respond (again for sub-categories) by noting a number from 1-5, with 1 signifying total disagreement and 5 total agreement.

Table 1: Project management (PM) functions.

1. General	**5. Commercial**
Implementation	Managing Finance
Managing Programmes	Managing Alliances
Managing Projects	Defining Responsibilities
Managing the Process	Managing Procurement
Using Breakdown	Managing Contracts
Conducting Audits	Managing Claims
2. External	Understanding Law
Managing Context	**6. People**
Managing Finance	Organising Projects
Managing Strategy	Managing Teams
3. Internal	Managing Individuals
Managing Scope	Managing & Leading
Managing Organisation	**7. General management**
Managing Quality, Time	Managing Operations
Managing Risk & Safety	Managing Resources
4. Life-cycle	Managing Markets
Project Start-up	Managing Strategy
Managing Proposal	
Managing Design	
Managing Implementation	

Table 2: Project management (PM) skills.

1. Communication Skills	**5. Coping Skills**
· Listening	· Flexibility
· Persuading	· Creativity
2. Organisational Skills	· Patience
· Planning	· Persistence
· Goal-setting	**6. Technical Skills**
· Analysing	· Experience
3. Team Building Skills	· Project Knowledge
· Empathy	
· Motivation	
· Esprit de Corps	
4. Leadership Skills	
· Set Example	
· Energetic	
· Vision (Big Picture)	
· Delegates	
· Positive	

RESULTS OF THE SURVEY

Project management functions

Table 3 lists the results of the survey regarding the importance of the project management functions with relevance to the Hong Kong construction industry.

Table 3: Analysis of PM functions.

PM Function	Mean	Standard Deviation
General	3.78	0.3289
People	3.80	0.4284
External	3.82	0.4769
General management	3.89	0.6089
Commercial	3.96	0.5026
Life-cycle	4.09	0.4708
Internal	4.20	0.2861

Project management skills

Table 4 lists the results of the study with respect to the project management skills.

Table 4: Analysis of PM skills.

PM Skill	Mean	Standard Deviation
Team Building	4.00	0.5198
Coping	4.17	0.4499
Leadership	4.32	0.2297
Organisation	4.42	0.3663
Technical	4.63	0.3994
Communication	4.67	0.4419

ANALYSIS OF RESULTS

A statistical comparison was performed among the means of project management functions given in Table 3 and among the means of project management skills given in Table 4.

A null hypothesis was tested such that:

$$\mu_1 = \mu_2 = \mu_3 = \ldots\ldots = \mu_n$$

$$\therefore \mu_i - \mu_j = 0 \qquad \text{where, } 1 \le i \le n\ ;\ \ 1 \le j \le n$$

The alternative hypothesis is that at least one of the means is different.

Then, to compare any pair of means μ_i & μ_j, J.W. Tuckey advocates the following calculation [9]:

$$\left|\mu_i - \mu_j\right| \le q_{2\alpha} \frac{s}{\sqrt{\bar{n}}}$$

where s is the estimate of the sum of squares within all data groups (either PM functions or PM skills) based on $k(\bar{n}-1)$ degrees of freedom. k denotes the number of data groups and $\bar{n}$ denotes the average number of responses per data group. $q_{2\alpha}$ is the upper $100(2\alpha)\%$ probability point for the range of k observations from a normal population divided by an independent estimate of standard deviation based on $k(\bar{n}-1)$ degrees of freedom.

Project management functions

There are seven project management functions to be compared (k = 7) and the number of aspects queried under each function was different, as shown in Table 1. As 30 questionnaires were returned, the average number of responses per data group was calculated to be $\bar{n} = 137$

Further, it was calculated that:

$s = 0.207$

From the statistical tables [10]:

$q_{2\alpha} = 3.81$

at 95% confidence for k = 7 and for over 120 degrees of freedom.

Applying J.W. Tuckey's calculation:

$$\left|\mu_i - \mu_j\right| \le q_{2\alpha} \frac{s}{\sqrt{\bar{n}}}$$

$$\left|\mu_i - \mu\right|_j \le 0.0672$$

$\therefore \left|\mu_i - \mu_j\right| - 0.0672 \le 0$ if the null hypothesis is true, ie if the means are the same.

Table 5 shows the values of $\left|\mu_i - \mu_j\right| - 0.0672$ for each pair of means. We could observe from Table 5 that the majority of values of $\left|\mu_i - \mu_j\right| - 0.0672 \ge 0$. Hence, we fail to accept the null hypothesis.

Project management skills

Among the 6 (k = 6) project management skills to be compared, the number of aspects queried under each skill was again different, as shown in Table 2. Similarly as above, we could calculate the values of $\bar{n}$ and s to be as follows:

$\bar{n} = 95$

$s = 0.169$

Further, from the statistical tables [10]:

$q_{2\alpha} = 3.71$

at 95% confidence for k = 6 and for 120 degrees of freedom.

Therefore, applying J.W. Tuckey's calculation:

$$\left|\mu_i - \mu_j\right| \le q_{2\alpha} \frac{s}{\sqrt{\bar{n}}}$$

$$\left|\mu_i - \mu_j\right| \le 0.0644$$

$\therefore \left|\mu_i - \mu_j\right| - 0.0644 \le 0$ if the null hypothesis is true, ie if the means are the same.

Table 6 shows the values of $\left|\mu_i - \mu_j\right| - 0.0644 \le 0$ for each pair of means. We could observe from Table 5 that the majority of the values of $\left|\mu_i - \mu_j\right| - 0.0672 \ge 0$. Hence, we fail to accept the null hypothesis.

DISCUSSION OF RESULTS

Project management functions

It can be seen from the results that the senior project managers in the Hong Kong construction industry generally tend to agree with the IPMA listing of universal project management functions. As expected, internal function, comprising scope, organisation, qual-

Table 5: Comparison of means of project management functions: values of $|\mu_i - \mu_j| - 0.0672$.

PM Function		General	People	External	General Management	Commercial	Life-cycle
	Mean	*3.78*	*3.80*	*3.82*	*3.89*	*3.96*	*4.09*
People	*3.80*	-0.047					
External	*3.82*	-0.027	-0.047				
General Management	*3.89*	0.043	0.023	0.003			
Commercial	*3.96*	0.113	0.093	0.073	0.003		
Life-cycle	*4.09*	0.243	0.223	0.203	0.133	0.063	
Internal	*4.20*	0.353	0.333	0.313	0.243	0.173	0.043

Figure 1: 95% confidence intervals for project management functions.

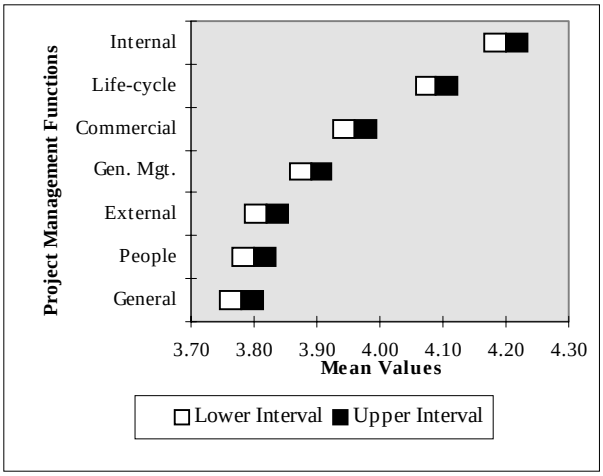
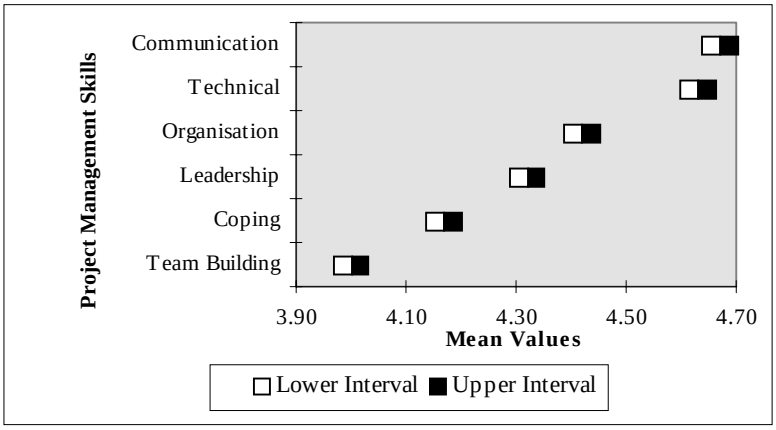


Table 6: Comparison of means of project management skills: values of $|\mu_i - \mu_j| - 0.0672$.

PM Skill		Team Building	Coping	Leadership	Organisation	Technical
	Mean	*4.00*	*4.17*	*4.32*	*4.42*	*4.63*
Coping	*4.17*	0.106				
Leadership	*4.32*	0.256	0.086			
Organisation	*4.42*	0.356	0.186	0.036		
Technical	*4.63*	0.566	0.396	0.246	0.146	
Communication	*4.67*	0.606	0.436	0.286	0.186	-0.024

Figure 2: 95% confidence intervals for project management skills.



ity, time, risk and safety, and life-cycle function, comprising start-up, proposal, design, and implementation issues, scored the highest marks. These are factors that are particularly important for construction.

The lowest degree of variability (0.2861) can be noted for internal function and the highest degree of variability (0.6089) can be noted for general management. The results in Table 3 point to the fact that all the project management functions identified by the IPMA are considered important for the Hong Kong construction industry.

Statistical comparison of means also showed that the means of the results of the internal, life-cycle, commercial and general management functions were significantly different from each other. Hence, it could be concluded statistically with 95% confidence that the said means are significantly higher than the rest. This is illustrated in Figure 1. It could also be concluded with 95% confidence that the Hong Kong project managers who responded to the survey agree that internal functions are most important and that life-cycle, commercial and general management functions follow respectively.

Project management skills

Communication skills, technical skills, and organisational skills all score highly. Communication skills, with a mean of 4.67, tops the list. The results highlight the fact that project managers in the Hong Kong construction industry agree that these skills are important and in some cases very important for a project manager to possess. The skill that scored lowest in importance, team building, recorded the highest variability (0.5198). Leadership recorded less variability (0.2297), but was not considered to be as important by many.

Statistical comparison of means showed that at 95% confidence limit, the two higher means are not significantly different from each other. Nevertheless, both of them are significantly higher than means of all other project management skills considered. This is illustrated in Figure 2. Hence, we could again conclude with 95% confidence that communication skills were considered most important by the responding Hong Kong project managers; followed by technical, organisation and leadership skills respectively.

CONCLUSION

The results of this pilot study confirm that project management functions and skills are an important aspect of the civil engineering and construction industry. Further, it has statistically demonstrated that the project management functions - internal, life-cycle, commercial and general management - and the project management skills - communication, technical, organisation and leadership - are important.

The question is whether we as educators are providing our future and present project managers with the necessary tools, techniques and skills to be future project leaders. Clearly, the current undergraduate civil engineering curricula in the authors' institution, and in many other institutions around the world, lack depth in project management education and training.

Rapid changes in technology are contributing to a major evolution of the traditional engineering field of study. The pace of change created by the information revolution has, and will continue to, radically change the engineering profession at an astonishing rate.

The current civil engineering curriculum has served the profession and the public well, as evidenced by the successful completion of many outstanding and unique projects around the globe. Nonetheless, the time has come to give serious consideration to improving it continuously to keep abreast of rapid changes in technology and the environment, and in social, political and economic values.

More emphasis should be placed on teamwork, modern technology, leadership and an integrated and interdisciplinary curriculum. The results of this pilot study are expected to assist in future planning and course development of the undergraduate, graduate and continuing education curricula in civil engineering to meet the needs of the students and the construction industry professionals in Hong Kong.

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BIOGRAPHIES

Syed M. Ahmed has been a lecturer in the Department of Civil and Structural Engineering of the Hong Kong Polytechnic University since September 1995. He obtained his BS in Civil Engineering from the University of Engineering and Technology, Lahore, Pakistan in 1984. After working in the private and public sectors for over three years, he joined the Georgia Institute of Technology, Atlanta, in 1987, from where he completed his MS in Civil Engineering in 1989 and his PhD in 1993. During his doctoral studies he also worked for CRSS, a top construction management firm in Atlanta, Georgia, USA. After completing his PhD he returned to Pakistan where he worked as an Assistant Director (Special Projects Directorate) in the Capital Development Authority (CDA), in Islamabad, Pakistan, before taking up his current assignment. He is a registered Professional Engineer and a Member of the American Society of Civil Engineers (ASCE) and the UNESCO International Centre for Engineering Education (UICEE).

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