EXPECTED ACHIEVEMENT LEVELS AND THE CURRENT EFFECTIVENESS OF CE&M GRADUATES: A CASE OF PAKISTAN CONSTRUCTION INDUSTRY

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THESIS ACCEPTANCE CERTIFICATE

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DEDICATION

This thesis is dedicated to my family for always being a source of love and encouragement.

&

To Rida Hameed Lodhi for her unending support throughout this research work.

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All praises to Allah Almighty, the merciful and the most beneficent who showers his blessings upon us every day. He beholds all the knowledge of the universe and beyond.

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ABSTRACT

The construction industry is a vital asset for a country's success in a globally competitive market that also deals with problems and challenges. Construction industry performance is backed by the capability and skills imparted by CE&M programs in the graduates. However, the skillset of CE&M graduates is not effective in countering the dynamic and ever-changing demands of the construction industry. Motivated to contribute in this direction, the current study evaluated the effectiveness of CE&M graduates against the demands of the construction industry. In this study, the key CE&M knowledge areas and their constituting learning outcomes were identified from top-ranked universities offering CE&M programs globally. Based on the identified learning outcomes, a questionnaire was developed and used to measure the graduates' effectiveness against the industry's demands. The questionnaire was used to obtain the response of the graduates and the industry using the relative importance index (RII) at two-time intervals i.e. at master's degree completion and after 5 years of graduates' industry experience. The results showed that the graduates' effectiveness is not sufficient enough to meet the prevailing demands of the construction industry neither at degree completion nor after the industrial exposure. This highlighted a need for a detailed revisit of the existing CE&M modules through industry-academia synchronization. This study contributes to both the industry and academia by providing a clear picture of the existing industry-academia gap and the overall preparedness of the CE&M graduates practicing in the industry.

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Chapter 1

INTRODUCTION

1.1 Background

Construction engineering is among numerous early civil engineering programs (Bhattacharjee, Ghosh et al. 2013). Within the civil engineering degrees, individual programs aiming at construction started to develop from the twentieth century as knowledge of construction started to develop. Early in the 1920s, specializations in the domain of construction like structural engineering and other areas began to offer by civil engineering degree programs (Abudayyeh, Russell et al. 2000). In the later part of the 1940s, undergraduate construction degree programs are formed as a result of the increasing demand for specialization (Bhattacharjee, Ghosh et al. 2013). Because of the rising trend, in many universities graduate programs on construction started in the twentieth century's second half (Bhattacharjee, Ghosh et al. 2013). Construction engineering, since the 1970s, was known as a separate profession with the development of the AIC, AIB, and CIOB as professional organizations, and a few more in the world backing and identifying their part in industry. Different universities in countries like Australia, China, Hong Kong, United States, United Kingdom, and Singapore began to grow with graduate and undergraduate degrees in the construction domain since construction engineering was acknowledged as a separate distinct discipline professionally (Love, Haynes et al. 2001).

Construction education emphasizes the facilities' life cycle completely, which takes account of construction, conception, operation, design, maintenance, and procurement (Bhattacharjee, Ghosh et al. 2013). The graduates having a construction

degree will have to face challenging, difficult, and greatly mutually dependent situations that ask for a thorough knowledge of construction along with managerial skills (Love, Haynes et al. 2001). Therefore, construction experts are required to be well placed to execute their projects professionally to the customers (Kinman 2001). Basic knowledge regarding estimation, scheduling, and cost control are the required knowledge areas that are considered to be the essentials of construction engineering education (Ahn, Annie et al. 2012).

Everywhere around the globe construction industry deals with problems and challenges. These difficulties and challenges are present together with a state of socio-economic pressure, institutional weaknesses, and lasting resource limitations to go with an overall inability of facing the main issues in developing countries. There is also an indication that these problems have grown in degree and severity during recent years in recent years (Ofori 2000). Construction is a constantly growing industry. Because construction is a significant percentage of the global economic boom, there is undoubtedly a need for specialists having skills required for effective management in construction projects. Drive behind this demand are several problems. Firstly, construction projects are complex to go with high cash flows involving various players like the insurance department, from lawyers to engineers and, of course, skilled and unskilled workers. Secondly, the construction industry is a vibrant field which is also multidimensional. It is constantly adapting to fresh technologies and methods of construction that are innovative. Projects vary considerably, from being simple and residential types to very large and complex engineering structures, from engineering-rich facilities to architectural structures having traits of uniqueness. Therefore, flexibility is necessary for substantial

achievement in the construction industry. Construction companies, constructors, executives need to properly manage every kind of project to efficiently complete it. Third, with passing years, evolution in the construction industry has gone from the direct trend of ownership relationships, architects, engineers, or entrepreneurs to various more multifaceted kinds of project implementation techniques. Fourth, the construction industry, in today's dynamic world is becoming increasingly composite in face of challenges related to effectiveness, efficiency, and litigation. Lastly, several developers are currently trying to sublet different segments of projects in the construction industry, which in turn increases the requirement of professional management of projects.

In construction projects, construction managers act as mediators among owners, quantity inspectors, architects, engineers, contractors, sub-contractors, and representatives from insurance companies. The success of the project is mainly governed by the set of skills a construction manager possesses. This highlights the importance for managers in the construction industry to develop such skills as quickly as possible. Besides, Ahmed, Yaris et al. (2014) states that university-led training no longer prepares project specialists for their future roles adequately, and it is very difficult for companies to fill vacancies with competent students (Schäfer and Richards 2007). Thus, the above-mentioned factors, therefore, strengthen the necessity to improve the curriculum of educational institutions to develop future graduates for roles students will undertake after entering the market.

While globalization affects companies and the construction sector, the project management specialist role now comprises several services at a higher level, which

escalates the skill level demanded of fresh graduates (Choudhury 2000). Alternate contract delivery, collaborative partnerships, fresh management developments, and worldwide product markets need professionals and graduates to learn more about methods of construction and issues regarding project management, which furthermore develops the skills needed. An increasing percentage of a typical company's effort is being spent on projects. The future assures to grow the significance and projects role in adding to the organizations' strategic management (Arain 2005). In developed countries, many disciplines, regardless of whether they participate in project management training or not, have effectively utilized study programs overseas as a successful way to broaden the student's worldview in academic and professional management (NAFSA 2003). Bryde (2003) presented various terminologies to define the approach to construction management. These terminologies comprise modernized project management, project culture (project management), and outside the Gantt chart. To succeed in the construction sector it is obvious that a wide range of skills is needed.

The construction industry is a vital asset for a country's success in a globally competitive market (Abudayyeh, Russell et al. 2000). The lifeline of industry's survival and development depends upon education programs of construction management offered (Slattery and Sumner 2011). The construction industry requires the management programs to not only offer an ample amount of graduates but also suitably develop its upcoming front-runners in the skillset needed to achieve better productivity (Ofori 2000). Construction industry performance to a larger extent in Pakistan is backed by the capability and skills imparted by CE&M programs offered by the Pakistani universities (Naveed, Thaheem et al. 2017). There is an immense

need to investigate and strategically update the curriculum of CE&M graduate programs in Pakistan such that it manifests, skillset desired by the industry. It is now imperative for institutes offering CE&M programs to have a prudent plan to effectively train potential construction managers and meet industry needs (M. Khalid Huda, Farooqui et al. 2008). In modern times, Civil engineering and management as a profession emphasize the need to raise the quality of young engineers so that it is easy for them to enter the professional fields (Scott and Yates 2002). The present agreement of engineering professions is that every young engineer should have a masters' degree or equivalent to meet the increasing demand for a complete and thorough knowledge of the work (Balogh and E. Criswell 2014). This research focuses on the preparation of master's level graduates in the CE&M field with the scope of civil engineering. The results obtained from this study will be helpful to numerous people which will ensure better preparation of future construction engineers at the master's level. This study aims to help in evaluating the expected achievement levels of CE&M post-graduates to fit in modern construction trends and meet standards in the construction industry of Pakistan. The study may help in ascertaining the current effectiveness of CE&M graduates, from different universities across Pakistan.

1.2 Problem Statement

The expectations from a construction engineer are highly increasing in our global and high technology environment. There are quite a few forums that are researching the concerns highlighted by the professionals regarding the adequacy with which the graduates of engineering programs are trained for the initial stages in their career after their graduation. The preparation, both academic and professional, graduates

need to have immediately after master's completion and after working experience of few years in professional construction, management field is a question that needs to be answered. Constructions education programs are not meeting the demands of the construction industry. The Skillset of CE&M graduates is not effective in countering the dynamic and ever-changing demands of the construction industry. The study aims to evaluate the demands of the construction industry against the current effectiveness of CE&M graduates. The reason to run this research is to gather information regarding the expected achievement levels in CE&M topics using a Likert scale for the young engineers at 2 points in their career i.e. at the time of degree completion and after 5 years of specialized experience. The construction industry of Pakistan and the CE&M programs being carried across universities in Pakistan will be the area of application for this research. This study will give, both academia and the construction industry of Pakistan, a clearer picture of where the construction engineers and construction industry's expectations stand.

1.3 Research Objectives

1. To identify key construction management knowledge areas and their learning outcomes through extensive literature review.
2. To examine the difference between
   i. expected achievement levels for CE&M graduates by industry
   ii. effectiveness of CE&M graduates

   by ascertaining the learning outcomes of CE&M knowledge areas after graduation and 5 years of industry experience
3. To recommend the solutions for minimizing the existing gaps through improvements in the current CE&M curriculum.

1.4 Scope of Study

The scope of this study is limited to the CEM graduates of universities in Pakistan offering a master's degree in CE&M for more than 7 years that include 2 years of CE&M training and 5 years of industry experience by the CE&M graduates. The universities shortlisted for this study are NEDUET (2004), MUET (2008), and NUST (2009), and Superior University (2012). An effort is made to collect the data/responses from the graduates of the above-mentioned universities along with the faculty members and employers in the construction industry of Pakistan.

1.5 Significance of Study

Construction industry performance highly depends on the capability and expertise created by CE&M programs offered by universities around the globe. The construction industry and construction management programs offered by universities are of great importance for mutual support. This is why the functioning of institutes requires that only qualified graduates be produced in quantity as well as properly trained (TACHE 2010). M. Khalid Huda, Farooqui et al (2008) explained that Pakistan’s construction industry has grown enormously in recent years. Our construction professionals must immediately be trained and educated on new building trends to comply with international requirements without foreign assistance. In the universities of Pakistan, there is a dire need for a construction management program. Therefore, to get maximum out of construction management programs, it is pertinent to evaluate what are the expected achievement levels that the construction industry of Pakistan demands from the CE&M graduates for them to fit in modern construction trends and meet international standards.

1.6 Organization of Thesis

This thesis has been organized into five chapters.

Chapter 1 is 'Introduction'. It explains in general, the concept of knowledge required by the construction managers in the context of academia and industrial practices, why the need was felt for this study, the importance of the study for the construction industry of Pakistan, and the objectives behind the study.

Chapter 2 is 'Literature Review'. This chapter discusses the construction industry's dependency on CE&M graduates and why it is necessary to address the existing industry-academia gap. This chapter is also based upon the identification of CE&M knowledge areas and the constituting learning outcomes to assess the expectations of the construction industry of Pakistan against the effectiveness of CE&M graduates. For this purpose this chapter explains in detail the sources shortlisted and reviewed followed by the shortlisting of 7 knowledge areas for this research study.

Chapter 3 is the 'Methodology' of the research. This chapter briefs about the general procedure and methods which will be adopted to achieve the objectives of the study. The chapter starts with a section describing the possible tools and techniques to achieve the objectives. The proceeding section demonstrates the overall research strategy using a flow chart.

Chapter 4 is 'Data Analysis and Results'. The chapter discusses how the objectives of this research study have been achieved through analyzed data. The graphical representation, as well as the tables related to this study, have been included in this chapter. The chapter also explains how our data after collection and analysis is interpreted to achieve the intended objectives of this research study.

Chapter 5 is ‘Conclusions and Recommendations’. This study is expected to be proved instrumental in assessing the existing ap between the construction industry and the construction academia of Pakistan. Moreover, this study would also provide recommendations to how the existing gap can be minimized thus enabling construction academia to meet the demand or expectation of the construction industry through updating the existing curriculum of the CE&M program being offered across Pakistan.

Chapter 2

LITERATURE REVIEW

2.1 General

The construction industry and businesses have updated dramatically as new dimensions have been introduced into construction activities that require the development of new skills to manage such diversity (Egbu 1999). As the construction industry gradually changes according to the changing technological patterns, thus staying viable in the market, managers depend mainly on the knowledge and skills they have obtained through different pieces of training and work experience (Edum-Fotwe and McCaffer 2000). The majority of project manager's training focuses on honing professional skills. such as estimation, evaluation, control, planning, and assignment, etc., but the implementation of particular skills is highly based on the project's complexity (Norback 2009). Construction projects are specialized that require specific technical knowledge to handle them. This is the reason why a project manager may know of infrastructure projects but may not be an expert in building-related construction work.

Project managers develop specialized construction expertise in each field and develop specific types of abilities. Such key competencies enable an individual to further enhance project management skills (KEVEN JOHN. 2011). So it is important to answer questions like graduates of Construction Engineering and Management (CE&M) have achieved their professional goals so far? Are these graduates performing in the field as they predicted? The literature review has shown that there is an inherent limitation in studies that assess the performance of graduates with respect to possessing mandatory skills to deliver the appropriate level of operational

performance(Ahmed, Yaris et al. 2014). (Pheng and Chuan 2006) stated that human skills, conceptual skills, and technical skills are the three main classes in which all skills lie. He concluded that a project manager's ability in these three fields is critical to his or her effectiveness.

Since Pheng and Chua's proposal for the three-skill concept was further described by different authors, it has been applied to the management of industrial projects. It is appropriate for universities to revise the current CE&M curriculum given the circumstances facing the construction industry today (Love, Haynes et al. 2001). The curriculum needs to be changed, when necessary, to equip graduates with better skills so that they can meet the challenges they will face. Expectations from young engineers are very high in the industry (Edward Back and Sanders 1998). Individuals can harm themselves, the company, or even the entire industry if they have graduated from the profession of construction management without the necessary skills for success. There should be a level of satisfaction among construction management students that they can boldly depend on the experience of the university that it possesses, to develop skills in such a manner that the industry’s expectations can be accomplished. Therefore, employers can get regular feedback on the expectations of graduates. It will serve as a quality assurance tool for obtaining important information that can be used to improve the existing curriculum.

(C. Nielson 2000). This research would focus on the existing gap in the expectations from CE&M graduates in the construction industry of Pakistan at the initial stages of their career and after 5 years of professional experience. As a result, both academia and the construction industry of Pakistan will get a clearer picture of where the construction engineers and construction industry’s expectations stand.

The existing literature expresses conflicting opinions about the role of education in construction programs for students. According to (Farrell and Gale 2000), education meant that students formulated skills like problemsolving, thoughtful eva luation, and theability to understand theoretical concepts, while training focused on student productive work. (Haltenhoff 1986) argued that skilled workers with formal education are less productive at the outset of employment, but take on more responsibility over the years than trained professionals who focus on their area of expertise. Previously, construction graduates began their careers at construction sites with features such as layout and surveying (Souder April, 2006). Currently, many construction companies prefer to perform such a task with artisans and the graduate is used to perform cost control functions and to present or reduce quantities (Souder April, 2006). In the late 1980s, ASTD and the US Labour department identify the basic skills that employers require of their employees. To completely reverse the expected outcome, employers say that sustainable education and interpersonal skills are the most popular traits among employees (Gianelly 1998).

2.2 Construction Industry & Its Dependency Upon CE&M Graduates

The construction industry experiences gradual changes due to changing dynamics and evolving trends of technologies (Ahmed, Razak Bin Ibrahim et al. 2010). Therefore, the managers considerably depend on the knowledge and skills developed through training and experience to remain competitive in the market (Chan, Darko et al. 2017, Xu, Wang et al. 2019). Project managers' development typically depends on the acquisition of technical skills such as forecasting, planning, estimation and control, etc (Ramazani and Jergeas 2015). Moreover, the application of the specific skills also depends upon the nature of the project (Hwang and Ng 2013). This can be

understood by the study of Eriksson, Larsson et al. (2017) according to which the construction manager of an infrastructure project may lack skills to execute a building project in the construction industry. Construction projects also require specific technical knowledge of the managers related to construction contracts, engineering economics, risk management, etc. for the identification of project information (Chan, Scott et al. 2004), the risks and issues that may occur during the execution of a construction project (Thamhain 2013) and to figure out the best possible way to proceed for efficient project delivery (Kent and Becerik-Gerber 2010). This specific knowledge required from construction managers for the successful delivery of the construction project relies heavily on the formal education and training of CE&M graduates (Thunberg, Rudberg et al. 2017).

2.3 Need For Addressing the Existing Construction Industry-Academia Gap

It is important to answer questions like have Construction Engineering and Management graduates (CE&M) met their professional objectives up till now? Secondly, it is also vital to know how well these graduates are performing in the construction industry per their acquired skills? Pheng and Chuan (2006) stated that conceptual skills, human skills, and technical skills are the main divisions inside of which all the skills exist. He claimed that the capability of a construction project manager in these three divisions is very vital to be efficient. There is a need to evaluate if construction management graduates use their acquired skills and apply the learned theory in practice and are performing according to the expectations of the industry. (Affandi, Hassan et al. 2015). Moreover, Farooqui and Ahmed (2009) also questioned the ability of academia to determine the skills required by construction management graduates for their success in the future. This demonstrates that there

exists a difference between the expectations of graduates and industry from construction management education as also envisaged by (Bhattacharjee, Ghosh et al. 2013)). The addressal of such difference may prove to be a vital input for the development of an outcome-based curriculum. The CE&M graduates in the industry are always expected to perform as per specific objectives that are not essentially congruent with the skills acquired from CE&M education (Ramadi, Ramadi et al. 2016). Moreover, the importance of a specific course for an organization may not necessarily be the same as accessed by a graduate (Hasan, Ahamad et al. 2011). Therefore, it is now pertinent for the universities to revisit the current curriculum of CE&M due to the above-mentioned desynchronization among the construction industry and the academia (Zhang, Xie et al. 2019). The curriculum needs to be modified, where necessary, to equip the graduates with better skills to cope with future challenges (Pathuri, Killingsworth et al. 2020). On the other hand, expectations from young engineers are very high in the ever-growing and dynamic construction industry (Eldeen, Abumalloh et al. 2018). To meet such expectations, there should be a feeling of satisfaction among CE&M graduates that they can confidently rely on their attained skills to meet the industry's expectations (Mengistu and Mahesh 2019). For this, employers' feedback can be collected regularly about their expectations from construction graduates (Aliu and Aigbavboa 2019). This can act as a measure of quality assurance in getting important information that can be used to improve the existing curriculum (Vaz-Serra and Mitcheltree 2020). In Pakistan, construction is one of the important industries and a critical asset in aiding the country to prosper at an international level (Farooqui, Ahmed et al. 2008). In order to access the existing needs and developments of the industry, the construction

industry in Pakistan does not have any institute or professional organization (Naveed, Thaheem et al. 2016). Therefore, this research is focused on the existing gap in the expectations of CE&M graduates and their current effectiveness in the construction industry of Pakistan. For this purpose, the timelines for the expectations of graduates and their current effectiveness are targeted at their employment stage after graduation and after 5 years of professional experience respectively. As a result, both academia and the construction industry of Pakistan will get a clearer picture of where the construction engineers' effectiveness and the construction industry's expectations stand.

2.4 Identification of The CE&M Knowledge Areas

The term body of knowledge (BOK) is frequently used while referring to a set of ideas and techniques inside the subject's domain (ASCE 2008). The BOKs have been formulated to define the skills, knowledge, and attitudes that are needed to become licensed and/or certified for practicing within the discipline professionally (Shah and Nowocin 2015). The guide to the Project Management Body of Knowledge (PMBOK Guide) documented nine knowledge areas for standardizing generally accepted project management knowledge and practices in 1987. The documented knowledge areas are Cost, Time, Integration, Procurement, Quality, Communication, Human Resource, Risk, and Scope in 1987 (Zwikael 2009). The purpose of documenting the nine knowledge areas was to standardize generally accepted project management knowledge and practices (Krishnaswamy and Selvarasu 2016). "A Knowledge Area is a comprehensive collection of principles, terminology, and activities that comprise a technical field, project management field, or field of expertise" (Institute 2013). These knowledge areas are usually represented by the

courses present in the curriculum of a program (Evans, McReynolds et al. 2019). For this study, CE&M knowledge areas are required to be identified as there is no existence of any Bok in the domain CE&M. Therefore the CE&M knowledge areas are identified from three sources collectively that include (i) the curriculum of universities offering postgraduate CE&M programs, (ii) research articles, and (iii) relevant reports and publications. For shortlisting, the top 50 Quacquarelli Symonds (QS) ranked universities offering CE&M postgraduate programs from all around the world are identified. The reason for opting for QS World University rankings is its focus on four aspects namely research quality, undergraduate, teaching quality, and international perspectives. The region-wise distribution of shortlisted universities is shown in Table 1.

Table 1: Regional Division of Top 50 Universities offering CE&M

S. No	**Region**	**Number of Universities in top 50**
1	North America	20
2	Oceania	07
3	Europe	14
4	Asia	9
		Total = 50

The table below shows the top universities that are offering postgraduation programs in the domain of CE&M. the QS ranking of the shortlisted universities is also mentioned in the table.

Table 2: List of shortlisted universities for the identification of knowledge areas

S.no	University name	Country	Region	Qs ranking
1	Columbia University	USA	NORTH AMERICA	18
2	University of Michigan	USA		21
3	New York University	USA		39
4	Carnegie Mellon University	USA		48
5	University of Washington	USA		68
6	Georgia Institute of Technology	USA		72
7	University of Illinois	USA		75
8	University Of British Columbia	CANADA		101
9	Washington university in st. Loius	USA		108
10	Purdue University	USA		111
11	University of Alberta	CANADA		113
12	University of Southern California	USA		129
13	Pittsburg State University	USA		140
14	Michigan State University	USA		144
15	Texas A&M University	USA		189
16	Vanderbilt University	USA		200
17	Arizona State University-Tempe	USA		215
18	Virginia Polytechnic Institute And State University	USA		327
19	University of Kansas	USA		372
20	Central Connecticut State University	USA		377

S.no	University name	Country	Region	Qs ranking
21	University of New South Wales	AUSTRALIA	OCEANIA	38
22	University of Melbourne	AUSTRALIA		40
23	University of Auckland	NEW ZEALAND		88
24	The University of Adelaide	AUSTRALIA		106
25	University of Canterbury	NEW ZEALAND		227
26	Deakin University	AUSTRALIA		271
27	Massey University	NEW ZEALAND		287
28	Eth Zurich - Swiss Federal Institute of Technology	SWITZERLAND	EUROPE	6
29	Kth Royal Institute of Technology	SWEDEN		36
30	Delft University of Technology	NETHERLAND		50
31	University of Sheffield	ENGLAND		78
32	University of Birmingham	ENGLAND		81
33	Newcastle University	ENGLAND		146
34	University of Twente	NETHERLAND		166
35	Queens University Belfast	ENGLAND		173
36	Technische Universitat Dresden	GERMANY		179
37	University of Reading	ENGLAND		205
38	Loughborough University	ENGLAND		222
39	Heriot-Watt University	SCOTLAND		314
40	Aalborg University	DENMARK		324

S.no	University name	Country	Region	Qs ranking
41	City University of London	ENGLAND		349
42	Nanyang Technological University Singapore	SINGAPORE	ASIA	11
44	Tsinghua University	CHINA		17
43	The University of Hong Kong	HONG KONG		25
46	Kyoto University	JAPAN		33
45	Asian Institute of Technology	THAILAND		101
47	Indian Institute of Technology Dehli	INDIA		182
48	Universiti Teknologi Malaysia	MALAYSIA		217
49	National Taiwan University of Science And Technology	TAIWAN		251
50	Indian Institute of Technology Madras	INDIA		271

The academic curriculum of the above-shortlisted universities along with additional 15 research articles and 2 reports were reviewed for the identification of CE&M knowledge areas. Identified CE&M knowledge areas and their frequency from all three sources are as shown in Table 4.

Table 3 List of research articles reviewed for the identification of knowledge areas

Sr.No	Research Articles	Year	Journal	Authors
1	Industry's Expectations of Construction School Graduates' BIM Skills	2011	Journal of Construction Education	Mojtaba Taiebat
2	Green Construction: Contractor Experiences, Expectations, and Perceptions	2007	Journal of Green Building	Yong Han Ahn
3	What does the Construction Industry expect from recent Construction Management Graduates?	2006	Journal of Managerial Psychology	Chris Souder, Dennis M. Gier
4	Skills, knowledge and competencies for managing construction refurbishment works.	1999	Construction Management & Economics	Charles o. Egb
5	Perceptions of construction professionals concerning important skills of effective project leaders.	2002	Journal of Management in Engineering	KT Odusami
6	Project management knowledge and skills for green construction: Overcoming challenges	2013	International Journal of Project Management	BG Hwang
7	Construction Engineering and Management Undergraduate Education	2000	Journal of Construction Engineering And Management	O Abudayyeh, J Russel

Sr.No	Research Articles	Year	Journal	Authors
8	Key Competencies for US construction graduates: Industry Perspective	2012	Journal of Professional Issues In Engineering Education And Practice	YH Ahn, RP Annie
9	Desirable Attributes and Skills for Graduating Construction Management Students	2011	6th International Conference on Construction Challenges At: Kuala Lumpur, Malaysia	Sarosh Lodi, Rizwan U.Farooqui, S.M Ahmed
10	Technical Competency of Construction Manager in Malaysian Construction Industry	2014	Engineering Construction & Architectural Management	Siti Khalijah Yaman, Abd Halid Abdullah, Hairuddin Mohammad
11	Ranking Construction Superintendent Competencies and Attributes Required for Success	2015	Engineering Construction & Architectural Management	David e. Gunderson
12	Construction Management Engineer Education with Focus on Competencies Requested by the Construction Industry	2010	Conference: CIB Proceedings, Building a Better World 2010	Soren Wandahl
13	Performance Assessment of Construction Engineering and Management (CEM) Degree Program in Developing Countries: Case of Pakistan	2016	International Journal of Construction Education and Research	Mian Hassan Naveed, M.Jamaluddin Thaheem

The CE&M knowledge areas were identified from the different sources i.e top ranked universities around the world, research articles and relevenat reports/publications. The catergorized frequency of the idenfified knowledge areas is shown in Table. 4

Table 4: Individual Frequency of knowledge areas from Universities/Research articles/ Reports

S.No	**Identified Knowledge Areas**	**Frequency**		
		Universities	Research Articles	Publication/Reports
1	Planning & Scheduling	43	14	2
2	Estimation	38	13	2
3	Construction Contracts	38	10	2
4	Sustainability	33	8	1
5	Construction Quality and Techniques	27	8	2
6	Building Information Modeling	25	7	1
7	Safety	21	10	2
8	Construction Law	15	4	1
9	Engineering Economics	15	2	2
10	Risk Management	12	2	2
11	Construction Procurement	12	0	0
12	Construction Professional Practices	7	2	2
13	MEP	5	4	4
14	Data management	5	0	0
15	Supply Chain Management	5	0	0
16	Lean Construction	4	0	0
17	Construction Equipment Management	3	4	2

After the identification of CE&M knowledge areas, *cumulative frequency (Cf)* from all three sources was calculated. This resulted in the calculation of *nominal frequency (Nf)* for each knowledge area and the *nominal Gap (Ng)* between them. The first seven identified knowledge areas i.e. *Planning & Scheduling, Estimation, Construction Contracts, Sustainability, Construction Quality and Techniques, Building Information Modeling,* and *Construction Safety* were shortlisted for this study based on the highest value of the nominal gap .i.e 0.031 between safety and construction law as shown in table 5.

Table 5: Cumulative frequency of knowledge areas from Universities/Research articles/Reports

S.No	Identified Knowledge Areas	Cf	Nf	Ng
1	Planning & Scheduling	59	0.1408	
2	Estimation	51	0.1217	0.0191
3	Construction Contracts	50	0.1193	0.0024
4	Sustainability	42	0.1002	0.0191
5	Construction Quality and Techniques	37	0.0883	0.0119
6	Building Information Modeling	33	0.0787	0.0096
7	Construction Safety	33	0.0787	0
8	Construction Law	20	0.0477	0.031
9	Engineering Economics	19	0.0453	0.0024
10	Risk Management	16	0.0381	0.0072
11	MEP	13	0.0310	0.0071
12	Construction Procurement	12	0.0286	0.0024
13	Construction Professional Practices	11	0.0262	0.0024
14	Construction Equipment Management	9	0.0214	0.0048
15	Data management	5	0.0119	0.0095
16	Supply Chain Management	5	0.0119	0
17	Lean Construction	4	0.0095	0.0024

2.5 Identification of Learning Outcomes From CE&M Knowledge Areas

2.5.1 Definition of Learning Outcomes

Learning outcomes are responsible to identify the meaningful and significant learning that students have accomplished, which could be verified after the term or program. Learning outcomes highlight what a student know and will also be capable to do after a course or program.

Spadi (1994), an educational researcher who directs the development of results-based learning, suggests that the ability to demonstrate learning is essential. This presentation of learning is relevant or important, which includes any form of actual learning achievement. He claims that meaningful content is important, but that the content itself is insufficient. Content information will necessarily be displayed by means of an exhibition method.

Spady also prposes the context or setting of the performance in which the performance takes place. It addresses a variety of performance contexts from demonstrations of classroom learning to those who live positively in a broader society. Therefore, its results provide general skills at the highest level, such as student development as planners, problem solvers, creators, students and thinkers, communicators, etc., regardless of the subject areas studied. Learning outcomes are visible and calculable knowledge, attitudes and skills as shown in Figure 2.1

Figure 2.1 Synergy between knowledge, skills, and attitude

2.5.2 Characteristics of Learning Outcomes Statements

Learning outcomes should:

- indicate wide-ranged conceptual knowledge and adaptive professional and generic skill
- indicate critical attitudes, skills, and knowledge
- concentrate on *results* of learning experiences;
- indicate the anticipated conclusion of the learning experience, not the means or process;
- signify the *minimum* performances that necessarily be accomplished to complete a course or program;

2.5.3 Overview of Learning Outcomes Structure

The Figure 2.2 shows the flowchart for the structure of learnings outcomes. Learning outcomes are the statements that inform the learners about what they will learn and will be able to do upon the conclusion of the time period. Learning outcomes are discussed in the background of program-wide evaluation, but they can be valued constituents of any lerning environment because of the contribution towards an emphasis on student learning.

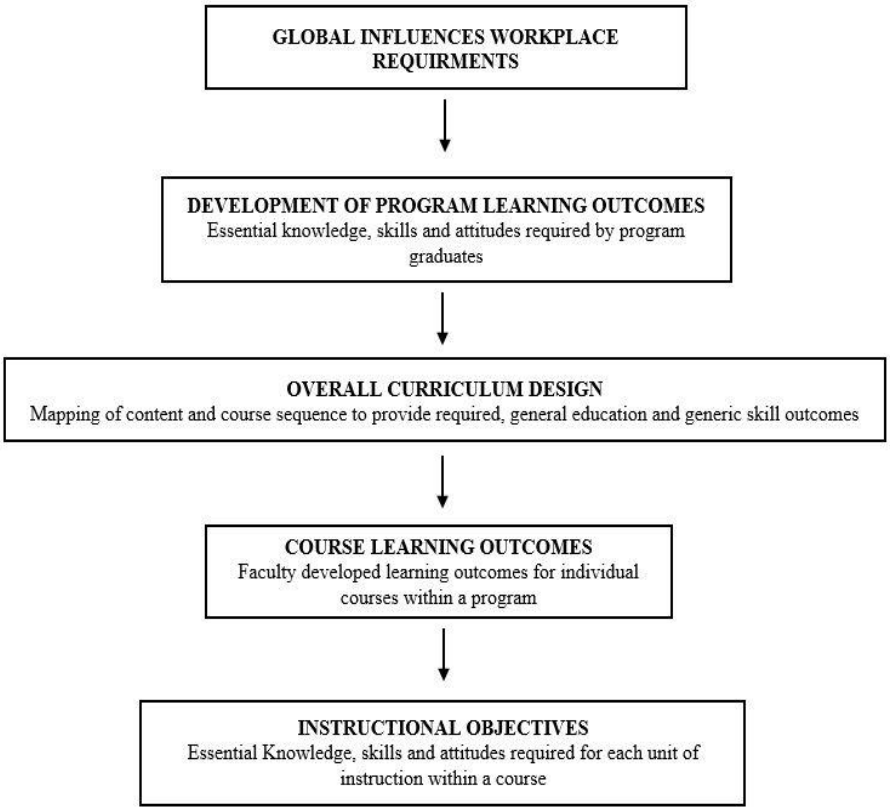

Figure 2.2 Overview of learning outcomes structure

Education and training are affiliated with bringing about a change in students, and the use of outcomes-based models to outline such changes is not uncommon (Keshavarz 2011). In recent years, the higher education sector has witnessed the introduction of outcome-based models (Tam 2014). These outcome-based models focus on how teaching and learning should be approached, managed, and assessed so that high-quality education can be ensured (Killen 2007). The induction of outcome-based models in higher education endeavored to make it further transparent for graduates and other involved stakeholders (Tam 2014). According to Carey and Gregory (2003), outcome-based models were introduced in the US during the 1930s for educational purposes. However, a significant contribution in the evolution of curriculums based upon outcomes was made by Benjamin Bloom in 1956 famously regarded as Bloom's Taxonomy (Bloom 1956). Bloom's taxonomy classified

learning in cognitive terms by providing a framework that demonstrated various levels of learner's thinking (Harden 2007). These levels include analysis, knowledge, application, comprehension, evolution and synthesis (Bloom 1956). In 2001, Bloom's taxonomy updated by Anderson and Bloom (2001) forms the basis of many outcomes-based curriculums around the world using intended learning outcomes (Coates, 2000). For the design of an outcome-based curriculum, learning outcomes highlight what a learner will know and will be capable to do upon the conclusion of a course or a program (McKeachie and Svinicki 2013). Learning outcomes denote noticeable and computable knowledge, attitudes, and skills (Laurillard 2013). The course learning outcomes focus upon the overall academic achievement of the student and its demonstration in the assessment instead of generalized statements of teaching activities (Laurillard 2013). For success in any specific course, the course learning outcomes demonstrate the required minimum achievement levels (Mintz and Tal 2014). The weightage should be provided to the achievement levels of students undertaking the course along with the level of presumed knowledge needed for following courses in deciding the minimum achievement level required for a course (Baeten, Kyndt et al. 2010). These connected set of outcomes deliver a systematic and progressive approach to the program and makes the student learning more efficient (Brockbank and McGill 2007). These arguments make the basis for the identification of learning outcomes for shortlisted knowledge areas of CE&M to access the current effectiveness of CE&M graduates against the demand of the construction industry. The learning outcomes for the shortlisted knowledge areas were identified through an extensive review of course curriculums for the top 50 QS-ranked universities offering CE&M postgraduate

programs. The identified learning outcomes for each knowledge area and their frequency of existence in the top 50 ranked universities are shown in Table 6. To elaborate the table for proper interpretation, it can be seen that the first learning outcome i.e. *identification of project activities and their relationships* under the planning and scheduling knowledge area, appeared in the course curriculum of 31 universities among the selected pool of varsities.

Table 6: Cummulative frequency of Identified Learning outcomes from Top Universities

S. No	CE&M Knowledge Areas	Statement ID	Identified Learning Outcomes	Frequency
1	Planning & Scheduling	PS 1	Identification of project activities and their relationships	31
2		PS 2	Schedule development, updating.	29
3		PS 3	Knowledge about allocation and leveling of resources for a project.	34
4		PS 4	Ability to apply crashing techniques for project duration reduction (time-cost trade-offs)	32
5		PS 5	Knowledge about Software package for schedule development.	32
6	Construction Contracts	CC1	Ability to interpret construction document	27
7		CC2	Understanding the elements of a construction contract	29
8		CC3	Understanding payment, performance, and bid bond.	28
9		CC4	Preparing construction contract documents	27
10		CC5	Interpret the contractual implications of changes made to the variables in a construction project	25

S. No	CE&M Knowledge Areas	Statement ID	Identified Learning Outcomes	Frequency
11	Estimation	EN1	knowledge of broad principles and processes of construction cost estimating	24
12		EN2	Understanding about Components of bid documents	29
13		EN3	Read and interpret the drawings and specifications	26
14		EN4	Perform quantity takeoffs based on the drawings and specifications	30
15		EN5	Knowledge Software package for estimation	30
16	Sustainability	SY1	Basic knowledge about sustainability	19
17		SY2	Sustainable construction materials and methods	23
18		SY3	In-depth knowledge about sustainability principles & design applications.	23
19		SY4	LEED process and requirements	23
20		SY5	Ability to evaluate the economic feasibility of green building	24
21	Construction Quality and Techniques	CQT1	Understanding of Quality Control	20
22		CQT2	Residential /commercial techniques	21
23		CQT3	Apply and use basic knowledge to practice	16
24		CQT4	Design and evaluate solutions	19
25		CQT5	Reflect upon relevant quality management systems in construction projects	21
26	Building Information Modelling	BIM1	Prepare a BIM implementation/execution plan	18

S. No	CE&M Knowledge Areas	Statement ID	Identified Learning Outcomes	Frequency
27		BIM2	Development of a building information model.	17
28		BIM3	Apply BIM software tools	15
29		BIM4	Command basic skills of BIM software operation for scheduling, estimating, construction, and operation and maintenance	20
30		BIM5	Apply BIM skills to critically reflect on the current state of CE&M practices and conduct design or improvement activities in a particular industry context	19
31	Safety	ST1	OSHA regulations about construction-related safety hazards.	16
32		ST2	Recognize effective management practices that favorably impact safety performance	15
33		ST3	Prepare a site-specific safety program	16
34		ST4	Assess the level of performance of a firm in the area of safety and health	17
35		ST5	Safety record keeping	17

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction

This chapter briefs about general procedure and approaches which will be adopted to complete the objectives of this study. This chapter starts with a section describing the possible tools and techniques to accomplish the objectives. The proceeding section demonstrates the overall research strategy using a flow chart.

As shown in Figure 3.1, the study is conducted in multiple stages to determine the gap between the existing demands of the construction industry and the current effectiveness of CE&M graduates; thus identifying the specific knowledge areas that demand consideration. The stages of the methodology are elaborated below:

3.2 Stage:1 Literature Review

The top-ranked universities were identified that offer a postgraduate program in CE&M to achieve the objectives of this study. For this purpose, firstly a total of 520 universities were identified under the category of Engineering. From the list, a manual filtered search was conducted to identify the top 50 universities that offer a graduate CE&M program. Afterward, the curriculum of the CE&M programs offered by each of the shortlisted universities was reviewed for the identification of CE&M knowledge areas. This step was further complemented by the study of 17 research papers and reports, searched online using Scopus libraries, Science Direct, Google Scholar, ASCE, Emerald Insight, and GLF-CEM, with the keywords including *CE&M competencies, construction management knowledge areas, and CE&M curriculum*. Through the detailed literature of the above-mentioned sources, 17 knowledge areas of CE&M were identified, out of which a total of 7 knowledge areas

were shortlisted for this study based on the nominal gap. After this shortlisting, the course contents of the shortlisted knowledge areas were reviewed from the same pool of universities, and the course learning outcomes were identified. A thorough study resulted in the classification of 5 learning outcomes for each of the shortlisted knowledge areas to proceed further with the questionnaire development.

3.3 Stage: 2 Data Collection

3.3.1 Development of Targeted Questionnaire

The questionnaire survey is the most appropriate medium of inquiry in conditions where personalized data collection is required for studies (Maghiar, Sturges et al. 2015, Bigelow, Bilbo et al. 2016). The studies of Naveed, Thaheem et al. (2016) and Bhattacharjee, Ghosh et al. (2013) were thoroughly examined for the purpose due to their contribution to the performance assessment and key competencies of CE&M programs and graduates respectively Thus, a suitable questionnaire instrument was developed to evaluate the current effectiveness of CE&M graduates against the expected needs of the Pakistan construction industry. For this study, the construction industry in Pakistan is represented by the employers that employ the CE&M graduates to enhance the productivity and the CE&M academicians as they are connected with the industry and are responsible to synchronize and update the course contents according to the needs of the industry. Keeping in view the precedence, separate questionnaires were developed for the three types of respondents i.e. the CE&M graduates, construction employers, and the CE&M faculty members. Therefore, the questionnaires depicted a similar pattern but specific demographic questions for each type of respondent. There were two categories of questions in each questionnaire where one relates to the respondent's profile and the other contained

5-point Likert scale questions. In the questionnaire developed for graduates, 35 double sectioned questions were asked for the evaluation of the effectiveness of CE&M graduates at the time of graduation and after 5 years of graduate's industry experience. Likewise, the questionnaire for employers and the CE&M academicians in the industry was intended to determine the expected achievement levels of CE&M graduates necessary for the construction industry.

3.3.2 Distribution of Questionnaire to Target Respondents

The developed questionnaires were sent to CE&M graduates, employers in the industry, and CE&M faculty members through emails, e-survey forms, and personal interactions. For the case of CE&M graduates, only the graduates who possess 5 years of industry experience post completion of their master's degree were targeted. Therefore, the universities offering CE&M postgraduate programs in Pakistan for more than 7 years (2 years of MS CE&M education + 5 years of post-graduate experience) were required to be shortlisted in the first step. The table below shows the universities offering CE&M postgraduate programs in Pakistan and the eligibility of their graduates for this study. The questionnaire was sent only to CE&M graduates of universities that are shown eligible in table 8.

Table 7 Universities offering CE&M program in Pakistan

S.No	University Name	Offering MS CE&M Since	Eligibility of Graduates for this study
1	Ned University of Engineering & Technology	2004	Eligible
2	Mehran University of Engineering & Technology	2007	Eligible
3	National University of Sciences And Technology (NUST)	2009	Eligible
4	The Superior University	2012	Eligible

S.No	University Name	Offering MS CE&M Since	Eligibility of Graduates for this study
5	Quaid-e-Awam University Of Engineering, Sciences & Technology	2015	Ineligible
6	Capital University of Science & Technology (CUST)	2017	Ineligible
7	CECOS University	2019	Ineligible
8	University of Wah	2017	Ineligible
9	CECOS University	2019	Ineligible
10	UET Lahore	2019	Ineligible

Afterward, for the collection of data from the industry, questionnaires were distributed among construction contractors, consultants that are registered in Pakistan Engineering Council (PEC). Moreover, participation from Government Organizations representing the clients was also ensured. For questionnaire distribution among contractors, PEC's database was used to obtain responses from the large and SME construction employers to ensure a response from all major employers. The questionnaire was distributed among those who held a managerial position in the contracting firm. For the collection of data from the academia, questionnaires were distributed among the faculty members of all the universities shown in table 5.

3.3.3 Stage: 3 Data Analysis Strategy

To measure the perceived importance level in construction research, the RII ranking technique is widely used as suggested by the studies conducted by Assaf and Al-Hejji (2006), Wong, Holt et al. (2000), and Holt (1998). The RII ranking technique was used for the evaluation of industry's expectation and graduates' effectiveness at the time of master degree completion (Eq. 1) and after 5 years of industry experience

(Eq. 2) post master's degree completion. The expected achievement levels and the graduate effectiveness were measured from 1 to 5, where 1 = very low and 5 = very high on an ordinal scale as every respondent was requested to give a level of importance to the identified learning outcomes. From this, the value of RII for each learning outcome at two stages was calculated. The formulas given below were used for the calculation of RII.

$$\mathrm{RII}_0 = \sum \frac{\mathrm{A}_0}{\mathrm{B} \times \mathrm{N}} \; ; (0 \leq \mathrm{RII}_0 \leq 1) \qquad \textit{Eq. 1}$$

$$\mathrm{RII}_{0+5} = \sum \frac{\mathrm{A}_{0+5}}{\mathrm{B} \times \mathrm{N}} \; ; (0 \leq \mathrm{RII}_{0+5} \leq 1) \qquad \textit{Eq. 2}$$

Where, A_0 and A_{0+5} ranging from 1 to 5, are the weightage given to each item by the respondents at the time of master degree completion and after 5 years of industry experience respectively, B is the maximum weight (5 in this study); and N represents the total number of respondents for each category i.e. graduates and the industry.

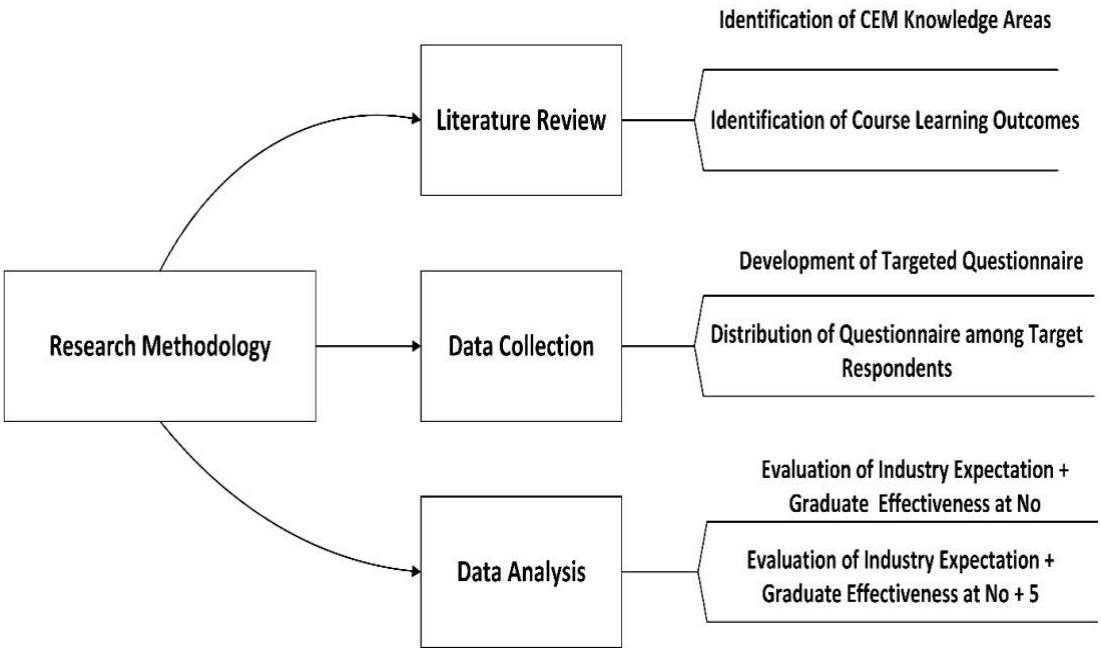

Figure 3.1 Flow chart of the research methodology

Chapter 4

RESEARCH FINDINGS AND DISCUSSION

4.1 Introduction

This chapter is based upon the summary of responses, respondents profiles, and the detailed discussion on the results interpreted from the data collected using a survey questionnaire to meet the objectives of this research.

4.2 Summary of Responses

The response sample from respondents was divided into three groups: CE&M graduates, employers in the industry, and CE&M faculty members. 108 complete responses were received from the 146 targeted respondents, yielding a response rate of 74%. There were about 110 CE&M graduates across all the eligible universities. However, due to multiple reasons like immigration of graduates, unavailability of contact details, and change of profession in fields not related to construction, etc., it was difficult to reach everyone. Therefore, 71 graduates were contacted after getting the correct contact details. Similarly, after looking at the pool of large and SME construction employers registered with PEC and the CE&M academicians, a total of 75 questionnaires were distributed for evaluation of the industry's expected achievement levels. 50 (67%) questionnaires were sent to construction firms whereas 25 (33%) were forwarded to faculty members. For the construction employers, special attention was given while distributing the questionnaires to persons having a managerial position in the contracting firm.

4.3 Respondents Profile

4.3.1 Profile CE&M Graduate

From the 71 graduates contacted, a total of 53 (75%) responses were received. The number of responses received from NUST, NEDUET, and MUET was 27, 25, and 1 respectively. A simple majority i.e. 66% of graduates completed their master's degree between 2012 and 2014 while the remaining 33% completed before 2012 in varying intervals. Of the respondents, 94% were civil engineers and 6% were from an architectural background. As shown in fig 4.1, the graduates were working as Planning Engineer (14%), Site Engineer (9%), Project Manager (18%), Project Management Officer (27%), and Project Engineer (16%) The average experience of the graduates were found to be 6.5 Years.

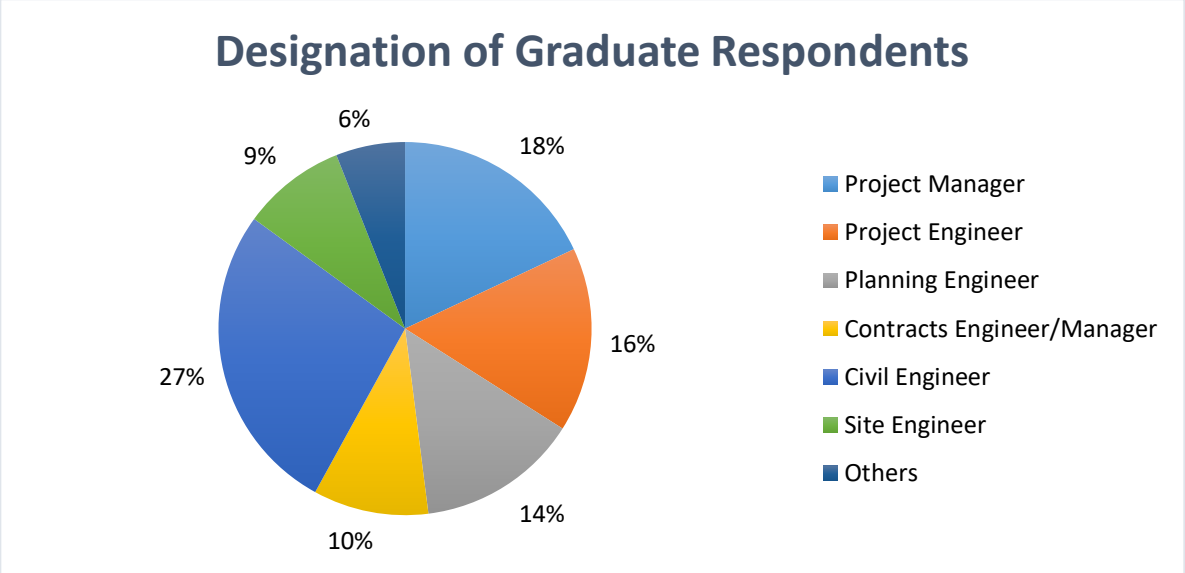

Figure 4.1 Designation of Graduate Respondents

Figure 4.2 shows the respondent's graduation year in which they have completed their masters degree. It is evident from the pie chart that most of the respondents (56 percent) were graduated in 2014 or after. 27 percent were graduated in the years 2012

to 2013. Very low percentage of respondents which is only 2 percent were graduated in 2007 or before.

Figure 4.2 Graduation year

4.3.2 Profile of Employers

From the 50 questionnaires forwarded to the employers, 40 responses were received. The employers in the industry belonged to four categories i.e. *general contractor* (42%), *Construction Consultant (42%), Government Organization (13%), and Builder Developer (3%)* as shown in fig 4.3.

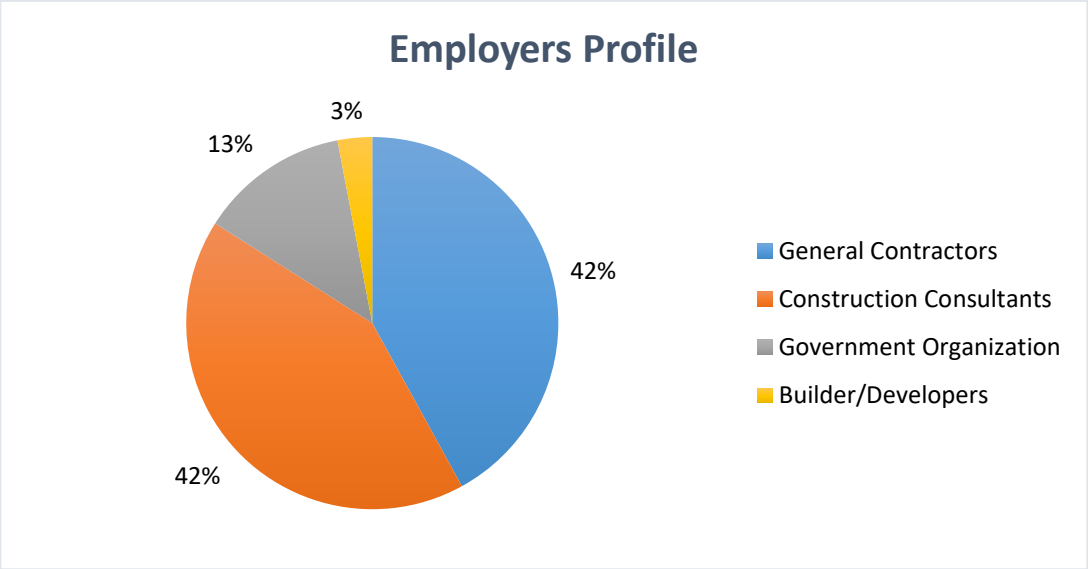

Figure 4.3 Employer's Category

Table 9 shown below represents the salient features of the construction firms represented by the respondents that include the range of annual work volume, the number of employees, and the involvement in private vs public projects. This shows that the firms that participated represent various tiers thus representing the whole of the construction industry in Pakistan.

Table 8 Employer's Professional Background

Background	**Firms Responded (%)**
Range of annual volume of work in millions (Rs)	
Between 100 M – 500 M	5%
Between 500 M – 1000 M	8%
Between 1000 M – 5000 M	30%
More than 5000 M	57%
Number of employees	
Under 50	13%
Between 50 – 149	27%

Background	Firms Responded (%)
Between 150 – 299	5%
300 or above	55%
Sector in which organization perform	
Public	27%
Private	8%
Both	65%

4.3.3 CE&M Faculty

15 responses were received from the faculty out of the total 25 targeted. Amongst the respondents, 33% were assistant professors, 27% were associate professors, 27% were lecturers and 13% were professors as shown in fig 4.4. The majority of the respondents (75%) were Ph.D. scholars whereas 25% have a master's degree in CE&M as shown in 4.5.

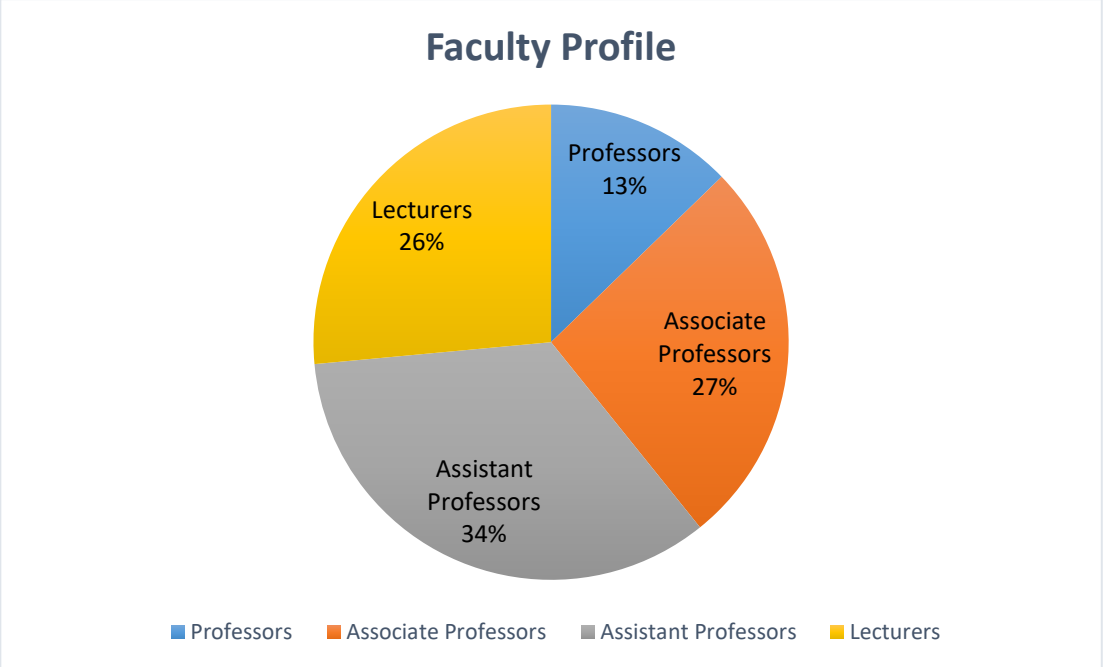

Figure 4.4 CE&M Faculty Profiles

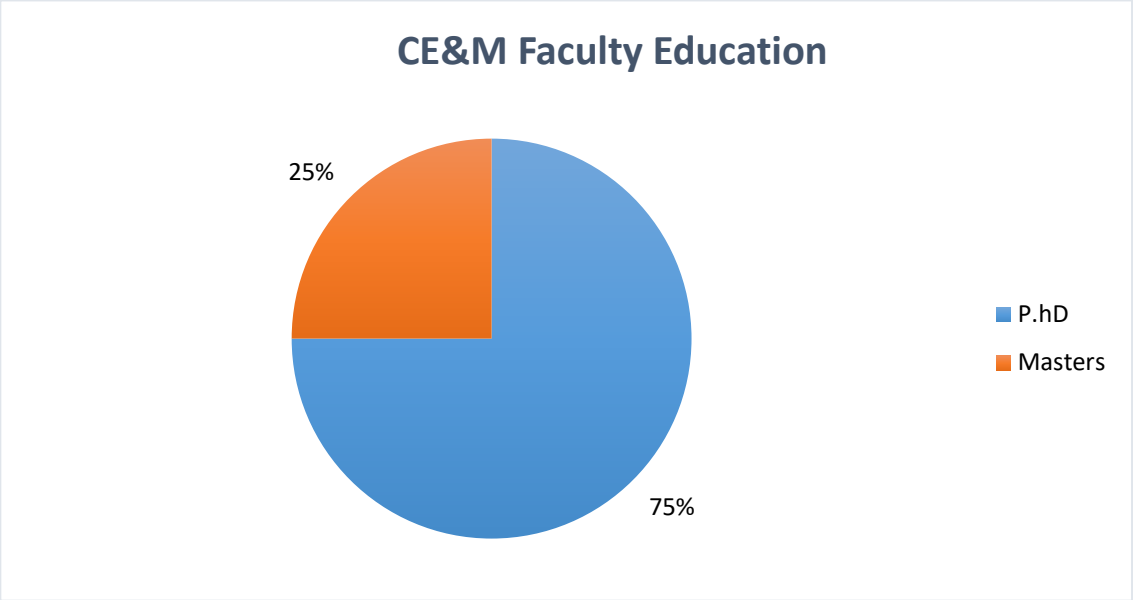

Figure 4.5 CE&M Faculty Education

Figure 4.6 shows teaching experience of CEM faculty respondents. It is evident from the figure that most of the respondents (38 percent) were having teaching experience between 2 to 4 years. 31 percent having less than 2 years and only 6 percent having between 8 to 10 years and more than 10 years respectively.

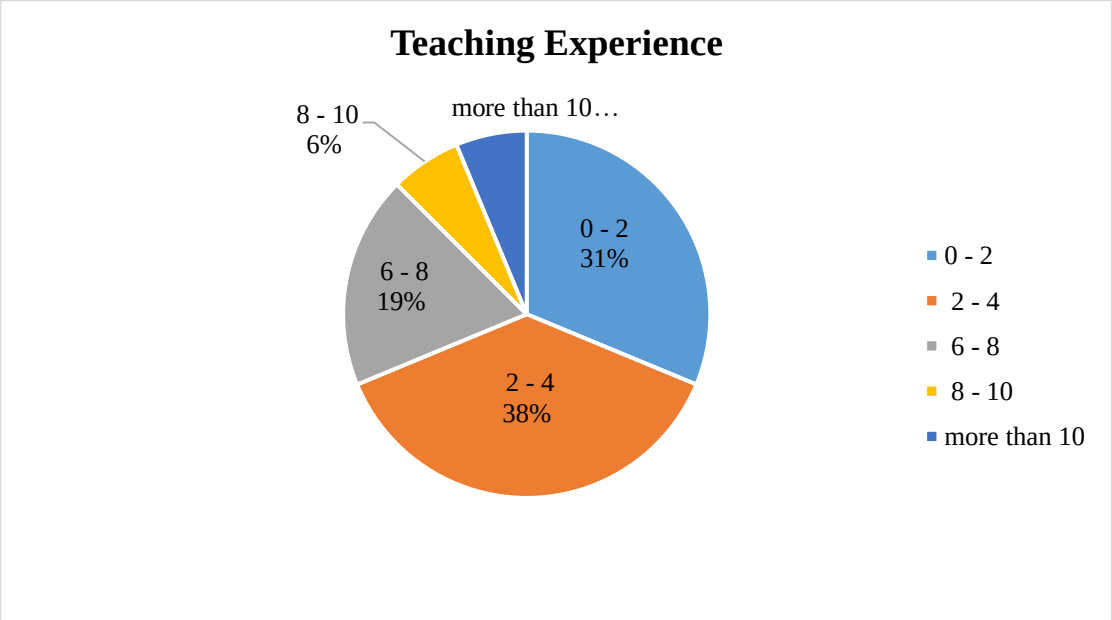

Figure 4.6 teaching experience of CEM Faculty

4.4 Results Discussion

The results received from the graduates and the industry, represented by employers and academia, showed a significant difference in the effectiveness of CE&M graduates and the expected achievement levels as shown in Table 9. As elaborated below, the results highlighted a need to address existing the difference between the graduates' effectiveness and the industry's expectations for the efficient delivery of construction projects.

Table 9 RII of the industry expectation and the effectiveness of CE&M graduates

Learning OutcomesStatement ID	Graduates Effectiveness after MS (RII)	Industry Expectation after MS (RII)	Graduates Effectiveness after 5 years of experience (RII)	Industry Expectation after 5 years of experience (RII)
PS-LO1	.4887	.6327	.9217	.8872
PS-LO2	.4867	.6000	.9217	.8909
PS-LO3	.4691	.5454	.6689	.8545
PS-LO4	.4248	.5418	.6278	.8109
PS-LO5	.5359	.6254	.7169	.8763
CC-LO1	.4178	.5418	.9571	.8581
CC-LO2	.4486	.5490	.6845	.8545
CC-LO3	.4012	.5563	.6398	.8436
CC-LO-4	.3865	.5018	.6145	.7818
CC-LO5	.3710	.5454	.6087	.8218
EST-LO1	.4578	.6145	.6849	.8727
EST-LO2	.4265	.5963	.6578	.8690
EST-LO3	.5010	.6218	.9565	.8909
EST-LO4	.4754	.6109	.9244	.8690
EST-LO5	.5188	.6400	.7051	.8654
SBT-LO1	.4591	.5600	.5894	.8036

Learning OutcomesStatement ID	Graduates Effectiveness after MS (RII)	Industry Expectation after MS (RII)	Graduates Effectiveness after 5 years of experience (RII)	Industry Expectation after 5 years of experience (RII)
SBT-LO2	.4462	.5709	.6017	.7927
SBT-LO3	.4355	.5600	.5587	.7781
SBT-LO4	.3592	.5381	.4696	.7454
SBT-LO5	.3412	.5236	.4653	.7600
CQT-LO1	.4471	.6400	.6689	.8763
CQT-LO2	.4415	.6072	.6812	.8763
CQT-LO3	.4722	.5890	.6348	.8363
CQT-LO4	.4442	.5745	.6686	.8472
CQT-LO5	.4261	.5890	.6511	.8254
BIM-LO1	.3211	.5127	.3478	.7236
BIMLO2	.3266	.5200	.3665	.7236
BIM-LO3	.3082	.4981	.3578	.7090
BIM-LO4	.2916	.5163	.3723	.7309
BIM-LO5	.3044	.5163	.3492	.7018
SFY-1	.4066	.5672	.5456	.7927
SFY-2	.4688	.5890	.5574	.8400
SFY-3	.4481	.6290	.6136	.8509
SFY-4	.4966	.5927	.6248	.8472
SFY-5	.4898	.6145	.6688	.8654

In the planning and scheduling knowledge area, the industry expectations were high at the time of graduation as compared to the graduate's effectiveness, as shown in Fig 4.7. For PS-L01, high industry expectations (0.6327) were recorded at the time of graduation in comparison to the low graduate effectiveness (0.4887). However, the graduate effectiveness for the same learning outcome exceeded after 5 years of industry experience (0.9217) against the expectations of the industry (0.8872). This

positive growth is mainly because the graduates are exposed to construction projects having tons of activities related to one and another as also highlighted by (Wang, Abdallah et al. 2019), and the progress through on-the-job training. A similar trend is witnessed in the PS-L02. After showing less effectiveness at the time of master's degree completion, the *g*raduates exceeded the expectations of the industry after 5 years of industry experience (0.9217 vs 0.8909). The reason behind this improvement is the continuous monitoring and evaluation of work progress by graduates to achieve the efficient delivery of a construction project. Moreover, the requirement to submit the planned and as-built work schedules under the conditions of the contract (Türkakın, Manisalı et al. 2020) also acts as a learning factor in this domain. For the PS-L03, graduates failed to meet the industry expectation even after the 5 years of industry experience (0.8545 vs 0.6689). The existing literature states that resource allocation helps in allocating the correct amount of time to the available resources along with providing an insight into the progress of the team whereas resource-leveling is a useful tool to set realistic project deadlines based on capacity and optimize resource schedules (Hussain, Trivedi et al. 2015). This highlights the need to address this LO to ensure the quality and productivity on the project (Heon Jun and El-Rayes 2011). Similarly, graduates' ability to apply crashing techniques for project duration (PS-L04) has been found lagging behind the expectations even after 5 years of industry exposure. The prevalent delays in the construction industry of Pakistan (Haseeb, Bibi et al. 2011) highlight the need to address this area to enable the industry in compressing the schedules for meeting the deadlines as envisaged by Mahmoudi and Feylizadeh (2017). A similar response was received for PS-L05. The graduates' exposure to scheduling software in their training is evident in simplifying

the decision-making process (Herroelen 2005) that signifies the addressal need. Therefore, is it necessary for CE&M programs to incorporate the modules in the curriculum to address the graduates' lack of skills to use software and their overall ability to manage any project.

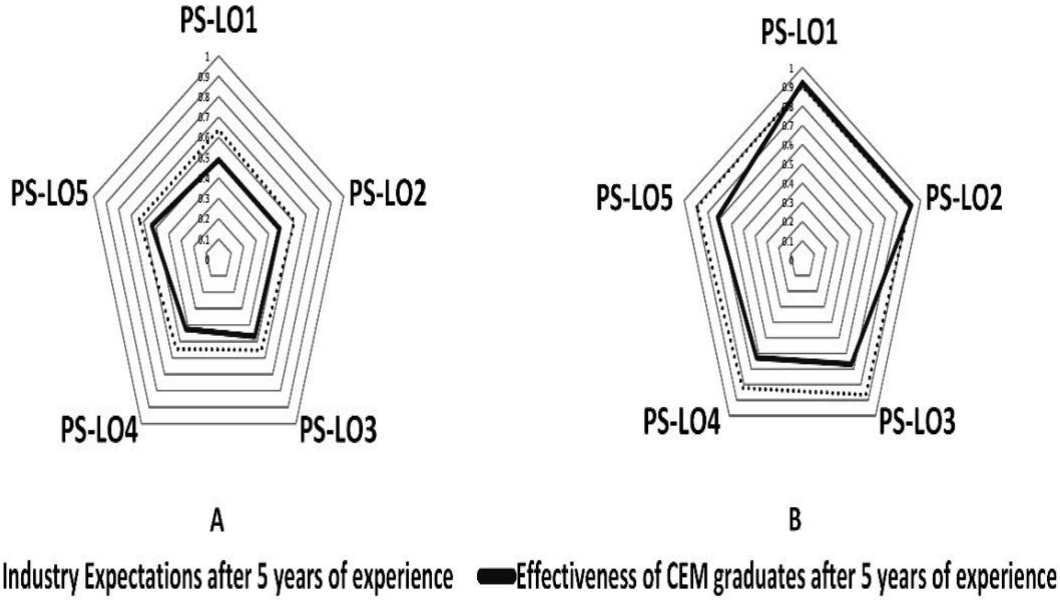

Figure 4.7: Expectations vs effectiveness in planning and scheduling at graduation (A) and after 5 years (B)

As shown in fig 4.8, graduates' effectiveness for estimation did not meet the industry's demands in all of the shortlisted learning outcomes at the time of master's degree completion. This highlights the need to synchronize the industry expectations in the course curriculum. Moreover, the results show that the effectiveness in the ability to read and interpret drawings (EST-LO3) and perform quantity take-off (EST-L04) improved after 5 years of industrial experience as shown in fig 4.8. This is mainly because the two learning outcomes are basic tasks of a construction engineer on the job and the skills develop quickly. However, other remaining outcomes failed to meet the industry expectations and form the basis of revisiting the existing CE&M curriculum to address the industry's demands to help in decision making during the project development stage Fazeli, Dashti et al. (2020).

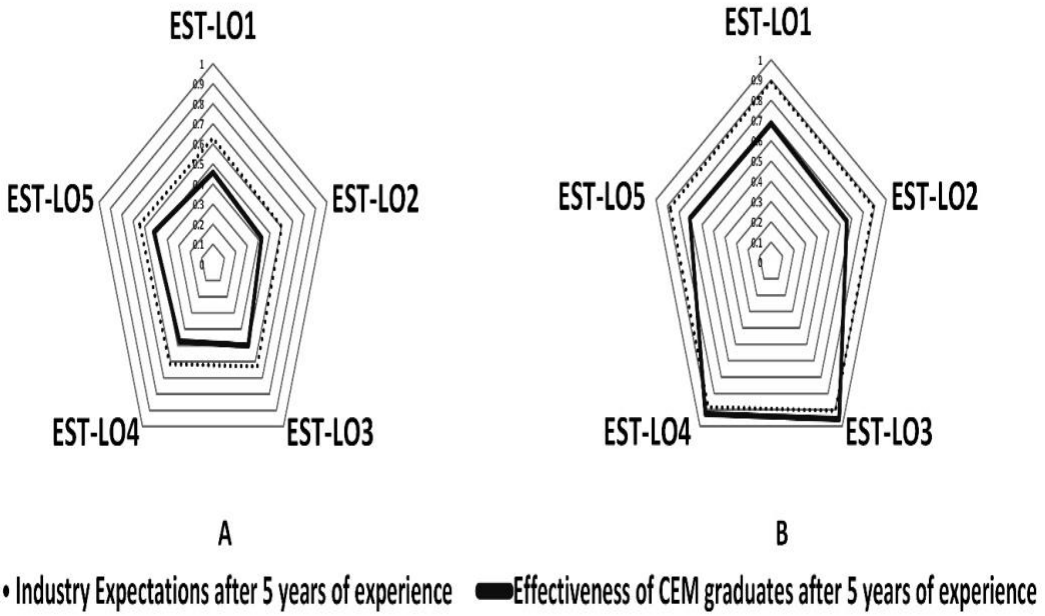

Figure 4.8: Expectations vs effectiveness in estimation at graduation (A) and after 5 years (B)

In the knowledge area of construction contracts, graduates lagged behind the industry expectations in all the learning outcomes after master's degree completion, presented in fig 4.9. This speaks for the need to streamline the course contents in accordance with the industry demands. Contract management is equally crucial to the success of every business process due to the rapid increase in multiple contracts (Zhang, Chen et al. 2020). Thus it is now imperative for CE&M academicians to formulate and develop the strategies to overcome the existing gap as shown in fig 4.9. as only one learning outcome i.e. interpretation of construction documents the industry, exceeds the expectations after 5 years of industry exposure.

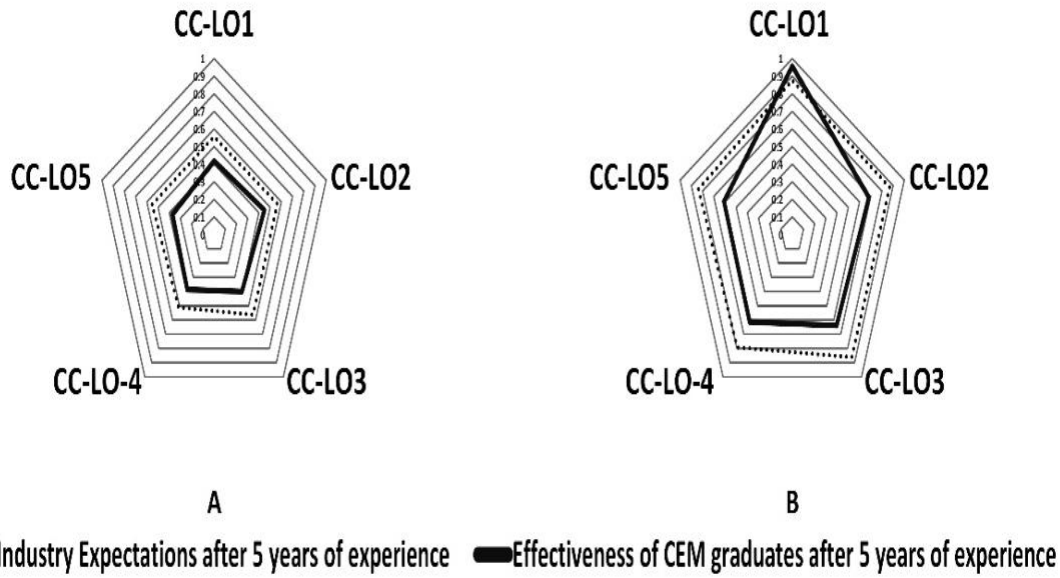

Fig. 4.9. Expectations vs effectiveness in Construction Contracts at graduation (A) and after 5 years (B)

For the knowledge area of sustainability, construction quality and techniques, BIM, and construction safety, industrial demands are neither met at the time of degree completion nor after the industrial exposure that can be visualized through fig 4.10. In sustainability, the graduates are lagging behind the expectations of industry because in any project the local stakeholders do not intend to opt for sustainable practices since the local policies and regulations permit the unsustainable options (Azeem, Naeem et al. 2017). This addresses the need for the governing bodies to revise the related policies and construction academicians to address these issues in the course curriculums to promote the sustainability culture and grooming of CE&M graduates. Moreover, the major reason for lagging in construction quality and techniques is the prevalent practice of shortlisting the lowest responsive bids. For the sake of quality improvement, the lowest bidder cannot put in extra resources as the incurred cost reduce the profit margin (Khan and Khan 2015).

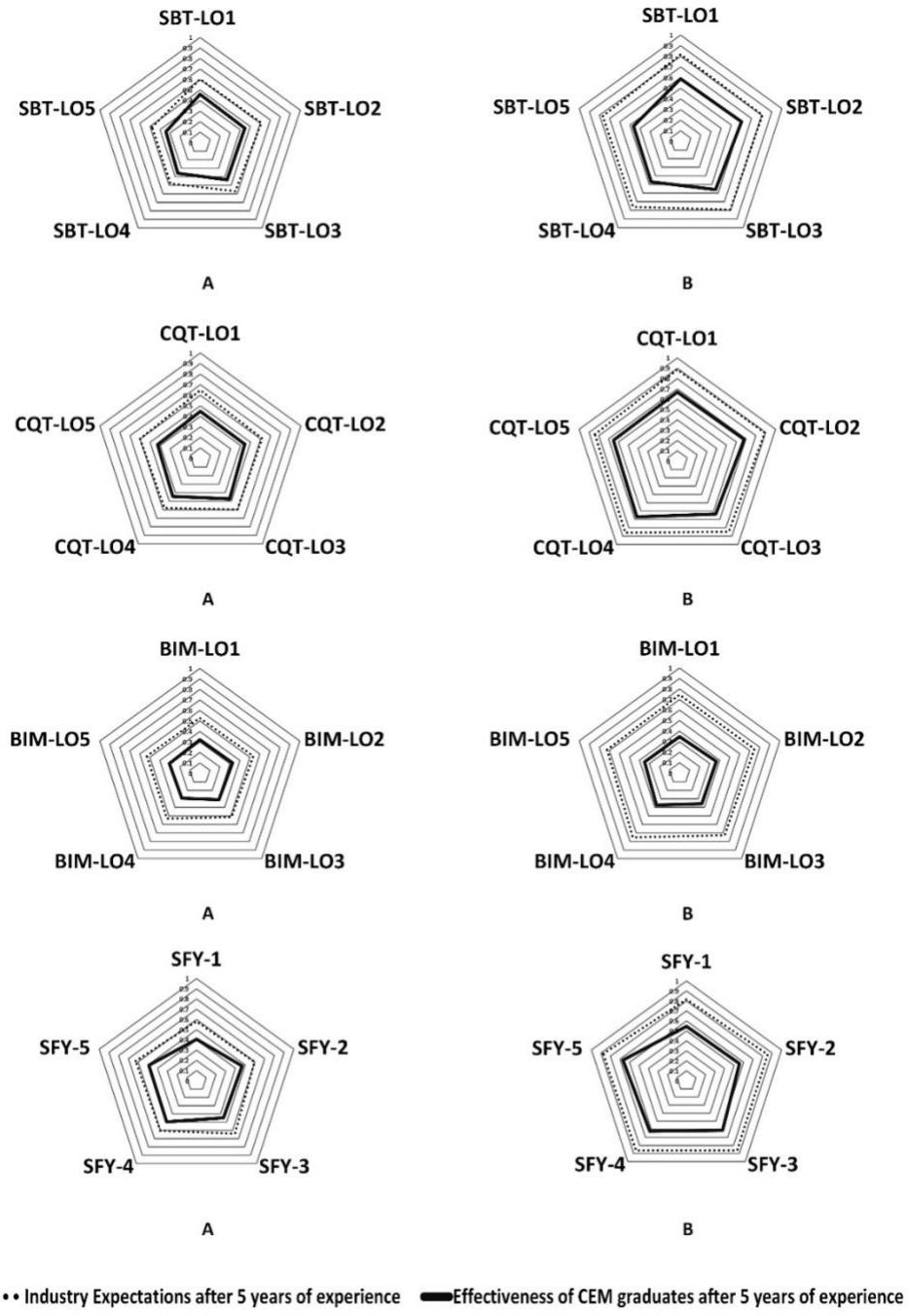

Fig. 4.10. Expectations vs effectiveness in Sustainability, Construction Quality & Techniques, BIM & Construction Saftey at graduation (A) and after 5 years (B)

BIM is a relatively new concept being understood by the graduates and industry for adoption, whereas the industry also lacks professionals having expertise in BIM (Masood, Kharal et al. 2014). Moreover, BIM is not currently being offered as a regular post-graduate course in all CE&M offering universities due to which the

graduates are not properly being trained in its learning outcomes. More emphasis on BIM in the curriculum design and industry-academia collaboration can pave a way to enable the graduates in meeting the industry demands.

For the case of construction safety, below-par performance by CE&M graduates is due to the lack of any stringent construction safety laws and policies in the construction industry of Pakistan (Zahoor, Chan et al. 2015). Due to the absence of such construction safety regulations, the safety culture is not matured which results in the low interest of graduates in the subject domain (Azhar and Choudhry 2016). Therefore, the CE&M graduates practicing in the industry do not possess firm command over the constituting learning outcomes of construction safety. The highlighted issues are required to be solved by the concerned authorities along with the addressal of requirements for safety culture development. The adoption of safety practices in the construction industry can lead to the improvement of CE&M graduates learning in this domain (Raheem and Issa 2016).

In a nutshell, the industrial demands are neither met by the graduates at the time of graduation nor after the industry exposure in any of the knowledge areas. Although the existing gaps show a decreasing trend after the 5 year period, there is still a need for an in-depth addressal of the constituent modules through industry-academia synchronization to minimize their gaps.

Chapter 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions & Recommendations

This study intended to develop an understanding of the construction industry's expectations in Pakistan from the graduates practicing in the industry after specializing in the CE&M discipline to assist both the construction industry and CE&M academicians. The findings of this study would assist the associated educational institutes in their planning to effectively deliver the required knowledge for this specific practice area in the domain of civil engineering. The information on the effectiveness of CE&M graduates in the industry resulting from this study describes the overall preparedness level in this dynamic and ever-changing engineering field. The following are the observations based on the results of this study along with the related future requirements.

1. The results from the study showed that the graduates met the expectations in some of the learning outcomes, however, it was only after the industrial exposure which shows that the competencies need to build during their training for their efficient performance in the industry. As a part of efficient training, extensive training modules based on the identified learning outcomes need to be introduced to bridge the existing gap. Moreover, industrial demands are required to be addressed in the semester projects for graduates along with their physical exposure to the industry in the form of field tours.
2. The industry expectation levels as identified by this research should be used with the other relevant information on the requirements of the profession,

available resources, and existing constraints, to assist the improvement of the curriculum for CE&M education which would address the requirements of the construction industry.

3. The findings of this study, existing literature along with the overview of current practices suggest that during the development of course modules, representation from industry professionals would further strengthen the industry-academia partnership as the targetted skills can easily be incorporated in the training modules.
4. The increasing trend in the expectations of industry from experienced CE&M graduates as observed from the findings of this research suggest that for continuous improvement of the CE&M graduates in the industry, there is a need to regularly assess if graduates are meeting the demand of the construction industry or not by the construction academicians of the program offering institutes.

5.2 Future Directions

Based upon the findings of this research, a thorough plan can be developed for the improvement of the postgraduate CE&M curriculum that would bridge the existing gap between the construction industry and construction academia in Pakistan by addressing the needs and demands of the construction industry from CE&M graduates.

5.3 Limitations

This research was limited to the 4 universities offering postgraduate CE&M in Pakistan for more than 7 years. However, about 10 universities are offering the CE&M program in Pakistan including the universities that recently started the

offering of the CE&M program. Therefore after some time in the future, a clearer picture of the industry’s expectations against the graduates' effectiveness can be determined by introducing the graduates of other universities as well.

References

Abudayyeh, O., J. Russell, D. Johnston and J. Rowings (2000). "Construction Engineering and Management Undergraduate Education." Journal of Construction Engineering and Management **126**(3): 169-175.

Affandi, H. M., F. Hassan, Z. Ismail, M. M. Kamal and A. A. Aziz (2015). Roles and Tasks for Malaysian Entry Level Construction Managers. Proceedings of the Colloquium on Administrative Science and Technology, Springer.

Ahmed, S. M., C. Yaris, R. U. Farooqui and M. Saqib (2014). "Key Attributes and Skills for Curriculum Improvement for Undergraduate Construction Management Programs." International Journal of Construction Education and Research **10**(4): 240-254.

Ahmed, Z. U., A. Razak Bin Ibrahim, M. H. Roy and G. Imtiaz (2010). "Analyzing the dynamics of the global construction industry: past, present and future." Benchmarking: An International Journal **17**(2): 232-252.

Ahn, Y. H., R. P. Annie and H. Kwon (2012). "Key Competencies for U.S. Construction Graduates: Industry Perspective." Journal of Professional Issues in Engineering Education and Practice **138**(2): 123-130.

Aliu, J. and C. O. Aigbavboa (2019). "Employers' perception of employability skills among built-environment graduates." Journal of Engineering, Design and Technology.

Anderson, L. W. and B. S. Bloom (2001). A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, Longman.

Arain, F. (2005). Strategic Management of Variation Orders for Institutional Buildings: Leveraging on Information Technology.

ASCE (2008). Civil engineering body of knowledge for the 21st century: Preparing the civil engineer for the future, American Society of Civil Engineers.

Assaf, S. A. and S. Al-Hejji (2006). "Causes of delay in large construction projects." International journal of project management **24**(4): 349-357.

Azeem, S., M. A. Naeem, A. Waheed and M. J. Thaheem (2017). "Examining barriers and measures to promote the adoption of green building practices in Pakistan." Smart and Sustainable Built Environment.

Azhar, S. and R. M. Choudhry (2016). "Capacity building in construction health and safety research, education, and practice in Pakistan." Built Environment Project and Asset Management **6**(1): 92-105.

Baeten, M., E. Kyndt, K. Struyven and F. Dochy (2010). "Using student-centred learning environments to stimulate deep approaches to learning: Factors encouraging or discouraging their effectiveness." Educational research review **5**(3): 243-260.

Balogh, Z. and M. E. Criswell (2014). Framework of Knowledge for Master's-Level Structural Engineering Education.

Bhattacharjee, S., S. Ghosh, D. E. Young-Corbett and C. M. Fiori (2013). "Comparison of Industry Expectations and Student Perceptions of Knowledge and Skills Required for Construction Career Success." International Journal of Construction Education and Research **9**(1): 19-38.

Bigelow, B. F., D. Bilbo, L. Ritter, M. Mathew and J. W. Elliott (2016). "An Evaluation of Factors for Retaining Female Students in Construction Management Programs." International Journal of Construction Education and Research **12**(1): 18-36.

Bloom, B. S. (1956). "Taxonomy of educational objectives. Vol. 1: Cognitive domain." New York: McKay **20**: 24.

Brockbank, A. and I. McGill (2007). Facilitating reflective learning in higher education, McGraw-Hill Education (UK).

Bryde, D. J. (2003). "Project management concepts, methods and application." International Journal of Operations & Production Management **23**(7): 775-793.

C. Nielson, A. (2000). Employer Satisfaction with Graduate Skills.

Chan, A. P., D. Scott and A. P. Chan (2004). "Factors affecting the success of a construction project." Journal of construction engineering and management **130**(1): 153-155.

Chan, A. P. C., A. Darko and E. E. Ameyaw (2017). "Strategies for promoting green building technologies adoption in the construction industry—An international study." Sustainability **9**(6): 969.

Choudhury (2000). "Cross-cultural training of project personnel for implementation of international construction projects by US contractors." International Proceedings of the Associated Schools of Construction: 87–94.

Edum-Fotwe, F. and R. McCaffer (2000). Developing project management competency: Perspectives from the construction industry.

Edward Back, W. and S. R. Sanders (1998). "Industry expectations for engineering graduates." Engineering, Construction and Architectural Management **5**(2): 137-143.

Egbu, C. O. (1999). "Skills, knowledge and competencies for managing construction refurbishment works." Construction Management and Economics **17**(1): 29-43.

Eldeen, A. I. G., R. A. Abumalloh, R. P. George and D. A. Aldossary (2018). "Evaluation of graduate students employability from employer perspective: Review of the literature." International Journal of Engineering & Technology **7**(2.29): 961-966.

Eriksson, P. E., J. Larsson and O. Pesämaa (2017). "Managing complex projects in the infrastructure sector—A structural equation model for flexibility-focused project management." International journal of project management **35**(8): 1512-1523.

Evans, C. A., M. E. J. McReynolds, M. H. Sharifan and J. M. Moore (2019). Connecting Specific Knowledge Areas Throughout Core Courses in Biologi-cal and Agricultural Engineering. Proceedings of the ASEE Annual Conference & Exposition.

Farooqui, R., S. Ahmed and S. Lodi (2008). "Assessment of Pakistani construction industry–current performance and the way forward." Journal for the advancement of performance information and value **1**(1): 51-51.

Farooqui, R. U. and S. M. Ahmed (2009). Key Skills for Graduating Construction Management Students—A Comparative Study of Industry and Academic Perspectives. Construction Research Congress 2009: Building a Sustainable Future.

Farrell, P. and A. Gale (2000). "The site manager: role, education and training in the UK." Journal of Construction Research **1**(1): 43-52.

Fazeli, A., M. S. Dashti, F. Jalaei and M. Khanzadi (2020). "An integrated BIM-based approach for cost estimation in construction projects." Engineering, Construction and Architectural Management.

Gianelly, A. A. (1998). A strategy for nonextraction Class II treatment. Seminars in orthodontics, Elsevier.

Haltenhoff, C. (1986). "Educating professional construction managers." Journal of Construction Engineering and Management **112**(2): 153-162.

Harden, R. M. (2007). "Outcome-based education: the future is today." Medical teacher **29**(7): 625-629.

Hasan, H., H. Ahamad and M. Mohamed (2011). "Skills and competency in construction project success: learning environment and industry application-the GAP." Procedia Engineering **20**: 291-297.

Haseeb, M., A. Bibi and W. Rabbani (2011). "Problems of projects and effects of delays in the construction industry of Pakistan." Australian journal of business and management research **1**(5): 41-50.

Heon Jun, D. and K. El-Rayes (2011). "Multiobjective optimization of resource leveling and allocation during construction scheduling." Journal of construction engineering and management **137**(12): 1080-1088.

Herroelen, W. (2005). "Project scheduling—Theory and practice." Production and operations management **14**(4): 413-432.

Holt, G. D. (1998). "Which contractor selection methodology?" International Journal of project management **16**(3): 153-164.

Hussain, W., M. Trivedi and R. Kansal (2015). "Optimization of construction resource allocation and levelling using genetic algorithm." Int. J. Innovative Res. Sci. Eng. Technol **4**(6): 4573-4578.

Hwang, B.-G. and W. J. Ng (2013). "Project management knowledge and skills for green construction: Overcoming challenges." International journal of project management **31**(2): 272-284.

Institute, P. M. (2013). A Guide to the Project Management Body of Knowledge: PMBOK (R) Guide, Project Management Institute.

Kent, D. C. and B. Becerik-Gerber (2010). "Understanding construction industry experience and attitudes toward integrated project delivery." Journal of construction engineering and management **136**(8): 815-825.

Keshavarz, M. (2011). "Measuring course learning outcomes." Journal of Learning Design **4**(4): 1-9.

KEVEN JOHN. (2011). "Exploring the behavioral competencies of the future project manager: perspectives from a South African. Project management organization." KS. Diss. NorthWest University.

Khan, T. H. and A. Q. Khan (2015). "Effects of lowest bidding bid awarding system in public sector construction projects in Pakistan." Global Journal of Management And Business Research.

Killen, R. (2007). Teaching strategies for outcomes-based education, Juta and Company Ltd.

Kinman, G. R. (2001). "The role of motivation to learn in management education." Journal of Workplace Learning **13**(4): 132-144.

Krishnaswamy, N. and A. Selvarasu (2016). "Exploring interrelationship between three performance indicators with PMI's Nine Knowledge Areas for successful Project Management." Int. J Latest Trends Fin. Eco. Sc. Vol **6**(3): 1162.

Laurillard, D. (2013). Rethinking university teaching: A conversational framework for the effective use of learning technologies, Routledge.

Love, P. E. D., N. S. Haynes and Z. Irani (2001). "Construction managers' expectations and observations of graduates." Journal of Managerial Psychology **16**(8): 579-593.

M. Khalid Huda, S., R. Farooqui and M. Saqib (2008). Finding Ways for Enhancing Postgraduate Level Education in Construction Management in Pakistan.

Maghiar, M., D. Sturges, T. Maurer and M. Jackson (2015). "Exploration of student perceptions, behaviors and academic performance in construction management classes." International Journal of Construction Education and Research **11**(4): 241-256.

Mahmoudi, A. and M. Feylizadeh (2017). "A mathematical model for crashing projects by considering time, cost, quality and risk." Journal of Project Management **2**(1): 27-36.

Masood, R., M. Kharal and A. Nasir (2014). "Is BIM adoption advantageous for construction industry of Pakistan?" Procedia Engineering **77**: 229-238.

McKeachie, W. and M. Svinicki (2013). McKeachie's teaching tips, Cengage Learning.

Mengistu, D. G. and G. Mahesh (2019). "Construction education in Ethiopia." Higher Education, Skills and Work-Based Learning.

Mintz, K. and T. Tal (2014). "Sustainability in higher education courses: Multiple learning outcomes." Studies in Educational Evaluation **41**: 113-123.

NAFSA. (2003). "NASFA Association of International Educators." from http://www.nafsa.org

Naveed, M. H., M. J. Thaheem, M. Khurshid and R. Farooqui (2016). "Performance Assessment of Construction Engineering and Management (CEM) Degree Program

in Developing Countries: Case of Pakistan." International Journal of Construction Education and Research: 1-21.

Naveed, M. H., M. J. Thaheem, M. B. Khurshid and R. U. H. Farooqui (2017). "Performance Assessment of Construction Engineering and Management (CEM) Degree Program in Developing Countries: Case of Pakistan." International Journal of Construction Education and Research **13**(1): 3-23.

Norback, J. S., LEEDS, E. M., AND FOREHAND, G. A. (2009). (2009). " Engineering communication —Executive perspectives on the necessary skills for students. Int. J. Modern Eng., 10(1), 11 –19. ."

Ofori, G. (2000). Challenges of Construction Industries in Developing Countries: Lessons from Various Countries.

Pathuri, R. T., J. Killingsworth and M. S. H. M. Mehany (2020). "Knowledge, Skills, and Abilities for Senior-Level Construction Managers: A US Industry-Based Delphi Study." International Journal of Construction Education and Research: 1-17.

Pheng, L. S. and Q. T. Chuan (2006). "Environmental factors and work performance of project managers in the construction industry." International journal of project management **24**(1): 24-37.

Raheem, A. A. and R. R. A. Issa (2016). "Safety implementation framework for Pakistani construction industry." Safety Science **82**: 301-314.

Ramadi, E., S. Ramadi and K. Nasr (2016). "Engineering graduates' skill sets in the MENA region: a gap analysis of industry expectations and satisfaction." European Journal of Engineering Education **41**(1): 34-52.

Ramazani, J. and G. Jergeas (2015). "Project managers and the journey from good to great: The benefits of investment in project management training and education." International Journal of Project Management **33**(1): 41-52.

Schäfer, A. I. and B. S. Richards (2007). "From concept to commercialisation: student learning in a sustainable engineering innovation project." European Journal of Engineering Education **32**(2): 143-165.

Scott, G. and K. W. Yates (2002). "Using successful graduates to improve the quality of undergraduate engineering programmes." European Journal of Engineering Education **27**(4): 363-378.

Shah, H. and W. Nowocin (2015). "Yesterday, today and future of the engineering management body of knowledge." Frontiers of Engineering Management **2**(1): 60-63.

Slattery, D. K. and M. R. Sumner (2011). "Leadership Characteristics of Rising Stars in Construction Project Management." International Journal of Construction Education and Research **7**(3): 159-174.

Souder, C. a. G., D.M. (April, 2006). "What does the construction industry expect from recent construction management graduates." In ASC Proceedings of the 42nd Annual Conference.

TACHE, C. T. F. (2010). ""Involving Project Leaders within Project Management Teams – Key Factor towards Competitiveness, " REVISTA DE MANAGEMENT COMPARAT INTERNATIONAL/REVIEW OF INTERNATIONAL COMPARATIVE MANAGEMENT, Faculty of Management."

Tam, M. (2014). "Outcomes-based approach to quality assessment and curriculum improvement in higher education." Quality assurance in education.

Thamhain, H. (2013). "Managing risks in complex projects." Project management journal **44**(2): 20-35.

Thunberg, M., M. Rudberg and T. K. Gustavsson (2017). "Categorising on-site problems: A supply chain management perspective on construction projects." Construction innovation.

Türkakın, O. H., E. Manisalı and D. Arditi (2020). "Delay analysis in construction projects with no updated work schedules." Engineering, Construction and Architectural Management.

Vaz-Serra, P. and H. Mitcheltree (2020). "Understanding the Key Master of Construction Project Management Graduate Competencies Required to Meet Industry Needs in Australia." International Journal of Construction Education and Research: 1-20.

Wang, T., M. Abdallah, C. Clevenger and S. Monghasemi (2019). "Time–cost–quality trade-off analysis for planning construction projects." Engineering, Construction and Architectural Management.

Wong, C. H., G. D. Holt and P. A. Cooper (2000). "Lowest price or value? Investigation of UK construction clients' tender selection process." Construction management and economics **18**(7): 767-774.

Xu, X., Y. Wang and L. Tao (2019). "Comprehensive evaluation of sustainable development of regional construction industry in China." Journal of Cleaner Production **211**: 1078-1087.

Zahoor, H., A. P. Chan, R. M. Choudhry, W. P. Utama and R. Gao (2015). Construction safety research in Pakistan: A review and future research direction. 7th International Civil Engineering Congress (ICEC-2015).

Zhang, J., H. Xie and H. Li (2019). "Improvement of students problem-solving skills through project execution planning in civil engineering and construction management education." Engineering, Construction and Architectural Management.

Zhang, S. B., J. Chen and Y. Fu (2020). "Contract complexity and trust in construction project subcontracting." Engineering, construction and architectural management.

Zwikael, O. (2009). "The relative importance of the PMBOK® Guide's nine Knowledge Areas during project planning." Project Management Journal **40**(4): 94-103.