

Expected Competencies of Construction Management Graduates Working in China

Yi Wang and Kam Cheng

Abstract—Construction manager competencies in today's construction industry are the key factors of project success. Compared to traditional roles, they are faced with a situation showing a gradual shift in their roles and functions especially projects nowadays are encountering more and more complicated issues during construction phase and the increasing complexity of projects poses huge demand for construction managers possessing competencies capable to adapt to this changing industry environment by their knowledge and skills gained through training especially during their early years of construction management education received in polytechnics or universities. Such kind of training builds the foundations for construction managers enabling to develop further a way to adapt to the escalating expectations of the clients and more important related to the development of leadership, management and problem-solving skills construction organisations are looking for. This paper aim to evaluate the expected competencies of construction management graduates in China focusing on the development of construction manager during their early training and how the education institutes can make sure their curriculums capable to prepare learners for the changing needs of construction industry in China. The result of this study is to provide a theoretical basis for the excellent construction management curriculum design, thus encouraging education institutes to adopt industry-oriented approach to deal with ever-changing construction industry.

Index Terms—Benchmarking, competencies, construction management education, project management training.

I. INTRODUCTION

In the 21st century, China's market economy has been basically perfected, and the construction and management of engineering projects are gradually being brought into line with international practice. With the strengthening of the world economy and trade, the economic exchanges among countries are increasingly close, tertiary sector of the economy and new technologies. Nowadays, scientific and technological means are updated continuously, and the level of modern mechanization is raised continually. In the face of the high competitiveness of the international market, in order to better adapt to the development environment, China has not only strengthened the reform of its construction projects, but it has also continuously improved the training of construction project management personnel and provided strong support for the development of China's construction industry. With the continuous improvement of the

construction industry's related work, the construction industry's disadvantages become apparent. As the construction enterprise's soul, the project manager's ability directly impacts project delivery quality [1]. Therefore, it is necessary to study the coordination between the existing construction manager training course and the project's management and control ability to fill the gap between them.

Simultaneously, with the rapid development of the social economy, resource shortage and environmental degradation have become the main obstacle to social development [2]. [3] points out that Between 2010 and 2050, demand for cooling and heating in residential buildings worldwide will increase by 79 percent, while demand for commercial buildings will increase by 84 percent . In developing countries, construction activities are the main sources of waste generation, material losses, noise, water, and environmental pollution [4]. As a developing country, China also faces the challenge of balancing future urbanization with resource protection and environmental protection. The Chinese government has identified the promotion of sustainable construction as an essential strategy to address these challenges and realize sustainable urban development. It is necessary to promote sustainable construction in the process of urban development, and the construction industry needs to make the transition to sustainable development, to support China's future urban development [5]. Sustainable buildings will face more diversified problems than traditional buildings, including energy, water, land, materials conservation, environmental friendliness, and the additional objectives of being completed as planned. The construction manager will face additional challenges. Because construction managers play an important role in the transition to sustainable construction, it is crucial to study China's current construction management education system to promote the construction industry's sustainable development.

II. LITERATURE REVIEW

A. The Definition of Competence

In psychological perspective, competence is defined as the psychological characteristics necessary for an individual to accomplish an activity [6]. According to the performance of different activity areas, it can be divided into general ability and special ability. General ability refers to the ability expressed in many basic activities and must be possessed in all kinds of activities, such as observation ability, memory ability, and thinking ability. Special ability refers to the ability shown in a particular professional activity [7]. From a sociological perspective, competence is the ability to

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The authors are with Engineering and Architectural Studies, Ara Institute of Canterbury, Christchurch, New Zealand (e-mail: wy569966651@gmail.com, kam.cheng@ara.ac.nz).

complete a specific activity. It is a kind of strength. Any type of activity requires participants to have a particular ability, directly affecting the activity's efficiency [8]. For example, to engage in diplomatic work, one must have flexible and agile thinking, good language expression, and strong memory; to engage in management work, one must have a certain organization, communication, propaganda, and persuasion abilities, only if they are competent enough for the job that they can achieve good job performance. Otherwise, there will be obstacles in the way of progress [9]. When a person's abilities are discussed, most people usually think it refers to their professional knowledge in a certain field. Therefore, in the pursuit of capacity growth, the focus is only on the continuous absorption and improvement of expertise level. Competence is also defined as an actor's effective performance in a specific institution or country context. This ability depends on circumstances. It is determined in specific practical activities. It can be attributed to individuals, teams, or organizations [10].

When defining a student's learning outcomes, there are many terms used to describe "ability"; sometimes, it is called a goal, skill, trait, characteristic, or domain. According to the US Department of Education (2001) definition, competence is the combination of skills, abilities, and knowledge required to perform a specific task. Competence means that the student or candidate has acquired the skills and knowledge to perform tasks, skills, or functions correctly according to the required standards. It includes applying the needed skills, knowledge, and attributes in the work environment (called employability skills) [10].

B. Competencies of Construction Manager

The construction project is a special commodity, and it has the characteristics of a long construction cycle, large investment, intense sequence and fixed, independence, diversity, and so on. Construction management can also be called project management. Because of this industry's particularity, there are professional requirements for the construction industry's ability, especially the construction management personnel's ability [11]. Regarding the definition of "project," different institutions and professional organizations have different expressions. The Project Management Institute (PMI) of the United States defines a project as a temporary effort to provide a unique product, service, or result. PMI believes that the project has the characteristics of temporary, unique, and gradual improvement. The international quality management standard ISO 10006 defines a project as a specific process composed of a set of coordinated and controlled activities with a start and end time. The process must meet the specified requirements, including time, cost, resources, and constraints.

In the implementation of a construction project, the person in charge of the project is the construction manager, who plays a decisive role. He/She needs to have professional technical skills, project management knowledge, and communication skills and is responsible for project planning, fund preparation, project construction, production and marketing, and debt liability. The construction manager also needs to have the ability to coordinate the relationship

between the client and the construction party to ensure the smooth delivery of the project [12]. The ability to integrate is also an essential ability for project managers. Construction project performance depends on different construction management dimensions, and effective construction management begins with the integration of process and personnel. Project integration ensures proper coordination between project activities [13]. Project Integration Management was listed as the first area of knowledge involving the portfolio, alignment, and coordination processes of construction management. The construction manager integrates project staff into the current project process, and the effectiveness of teamwork is enhanced through integration. Therefore, the construction manager's ability to actively coordinate the project's various activities is an essential element of the project to achieve the desired objectives.

Construction Management under sustainable development will consider social benefits, environmental benefits, and public interests. Management of this type of building requires construction managers to have both green knowledge and green attitudes and be able to use green technologies based on their ability to manage traditional building projects [14]. The construction manager must learn new construction skills and master the use of new environmentally friendly materials so that the project can be completed successfully while maximizing energy conservation [15]. Suppose a project requires the integration of sustainability into a construction project. In that case, the construction manager needs to use sustainability as a criterion for the project's successful delivery except for time, cost, and quality [16].

C. The Relationship between Educational Training and Competencies

Competence can also be understood as working ability. Working ability refers to the required ability for any occupation or industry job, has universal applicability and transferability, and plays a dominant and leading role in professional activities [17]. It is an essential element of professional activities. Vocational training is the most direct way to obtain working ability. Conceptually, training is an organized knowledge transfer, skill transfer, standard transfer, information transfer, belief transfer, management and admonition behavior, so that students can achieve expected learning goals through specific educational and training techniques, and have Specific work ability [18]. In the context of competency-based learning, educational training can potentially influence the assessment and recognition of employment-related skills. It can be considered as an integral part of organizational learning and change. The definition of educational training includes a comprehensive plan aimed at equipping individuals with specialized skills to play a role in a given environment, involving learning new skills or updating existing knowledge and skills. Therefore, education curriculum planners should take a proactive approach and make education curricula more responsive to the changing needs of the construction environment so as to include the competencies required by graduates [19]. Each job requires a specific set of knowledge and skills. It depends on the type and complexity of the work.

Construction is more challenging than other operations regarding the complexity, dispersion, and dynamics that characterize construction projects. It requires cooperation and collaboration among different parties and effective process management. It also requires well-developed strategies and practices to address the uncertainties and risks that are highly likely to be encountered in the process. The education and training for construction managers' competency work are essential [20].

III. EXISTING CONSTRUCTION MANAGER EDUCATION SYSTEM IN CHINA

The current training for construction managers in China is mainly based on professional education in colleges and universities and vocational courses for in-service construction managers. According to Architecture professional education in national colleges and universities Evaluation Document [21], construction undergraduate education must meet the four basic professional requirements, including architecture design, construction-related knowledge, construction technology, and construction management practice knowledge. Use the three words (phrase) "familiar," "mastery," and "able to" to determine the grade a student must get before graduation. "familiarity" means having basic knowledge; "mastering" means having a more comprehensive and in-depth understanding of knowledge in the field and being able to explain and apply it; "able to" means being able to use the knowledge learned to analyze and solve problems and be creative. The specific teaching content details are as follows:

- 1) Architectural design: through the teaching of architectural design, students need to be familiar with the purpose and meaning of the architectural design, familiar with the function, technology, art, economy, environment, and other factors on the building and the dialectical relationship between them, and master principles and analysis methods of building function. According to urban planning and urban design requirements, reasonable layout and design of individual buildings and groups can be carried out, and general site design can be carried out. In addition, students also need to be familiar with sustainable architectural design concepts and theories and master the design principles of saving land, energy, and other resources.
- 2) Construction-related knowledge: students need to be able to conduct the architectural survey, surveying, and mapping, and preliminary protection or renovation design; familiar with the basic knowledge of environmental psychology, have a specific ability to identify and judge whether the built environment is suitable for human behavior; familiar with economic knowledge related to construction and basic principles of construction-related regulations, codes, and standards, have the ability to comply with and use current building design codes and standards in architectural design.
- 3) Construction technology: graduates can be familiar with the critical role of the structural system in ensuring the safety, reliability, economy, applicability of the building, grasp the relationship between the structural system and

the architectural form, and be able to carry out architectural design proper structure selection, able to estimate the size of standard structural components to meet the requirements of scheme design; familiar with the design principles and methods of building energy-saving and green buildings; familiar with the construction system and composition rules of standard buildings, and master common construction methods and construction techniques; familiar with the scope and corresponding requirements of building safety, master the principles of building fire protection and seismic design and its relationship with building design.

- 4) Construction management practice knowledge: graduates can be familiar with the registered construction management system, master the work responsibilities and professional ethics of construction managers; familiar with the current architectural engineering design procedures and approval system, familiar with the current management organization and system related to construction; familiar with the basic content of the architectural design contract and the responsibility of the construction manager to fulfill the contract; familiar with the basic principles of construction site organization and general construction process, familiar with the construction manager's responsibility for supervision and service of construction.

The vocational course system of in-service construction manager includes the following training contents: 1) architectural design: familiar with the building drawing standard, accurately draw the 3D of various three-dimensional buildings; building load analysis ability, building material performance analysis ability, the ability to select common engineering materials and read structural drawings, multi-storey and high-rise reinforced concrete structure design ability, foundation soil analysis ability, foundation type and its construction drawing reading ability. 2) managing the construction project and solving the construction's common technical issues. 3) having the capability of compiling bidding and bidding documents for construction projects. 4) compilation of Project construction supervision documents: having the essential ability of investment control, quality control, and schedule control of construction projects. 5) having the ability to use the software to make general construction project costs [22].

IV. RESEARCH METHODOLOGY

The research method is based on quantitative analysis and collects data in the form of questionnaires. Researchers use uniformly designed questionnaires to learn about the situation or seek opinions from selected respondents. Quantitative research mainly uses methods such as statistical analysis and model building. The advantage of this method is that data can be collected and analyzed relatively quickly, and the research results are more reliable and objective [23]. If the survey sample is an effective random sample, then the researcher can extend the research results to the entire population. The advantage of the questionnaire survey is that it can be used to test a large number of targets at the same time, which takes a short time and has a large amount of data

[24].

Through the literature review, different countries' requirements have been obtained for construction managers' professional competence. After comparison and analysis, 40 relatively essential requirements were summarized (as shown in Table I below), and a preliminary questionnaire was compiled. Then, relevant persons engaged in construction manager work for more than 20 years and teachers involved in construction manager education were interviewed separately and asked to conduct a preliminary analysis. The requirements of the relevant construction manager's competencies in the table are analyzed and evaluated. Afterward, the content of the questionnaire was adjusted according to the interview results to generate a formal questionnaire. The formal questionnaire consists of two main parts. The first part is the respondent's general information, such as age, gender, and years of employment. The second part uses the Likert scale to score 20 requirements of the construction manager's professional competencies. (1 point: very unimportant; 2 points: not important; 3 points: moderate importance; 4 points: important; 5 points: very important).

TABLE I: CONSTRUCTION MANAGER COMPETENCIES

1	Analyzing design solutions
2	Acquire knowledge of Construction
3	Cost control reporting and management
4	Understand and apply standard phraseology
5	Survey and analysis of construction site
6	Project brief preparation
7	Project development appraisal
8	Knowledge of regulations, law, and guidelines in the Construction Industry
9	Apply project management techniques to construction projects
10	Managing project variations
11	Project final accounts preparation
12	Cashflow forecasting and monitoring
13	Insurance claims management
14	Administering, managing subcontracts
15	Knowledge of forms of building and construction contracts
16	Conflict avoidance and management
17	Client's care
18	Resource management
19	Knowledge of procurement
20	Review the qualifications of subcontractors
21	Managing of bidding and tendering process
22	Preparing for bidding and tendering document
23	Selecting tenderers
24	Acquire knowledge of Interpreting drawings, specifications, and other documents
25	Acquire knowledge of designing and installing services
26	Knowledge about the source and use of building materials
27	Acquire knowledge of the principle of building science
28	Master the knowledge of building demolition, formwork design and installation process, plant and equipment use, and management
29	Ability to lead and manage a team
30	Communication and presentation skills
31	Monitor Program and Prepare Project Progress Analysis Report
32	Knowledge of sustainability in Construction
33	Tax knowledge related to Construction
34	Maintenance and quality management
35	Pre-contract planning and programming
36	Risk management
37	Knowledge of safety, health requirements in Construction
38	Understand and apply computer skills
39	Ethics and due diligence
40	Closing preparations before project delivery

This study uses purposeful sampling as a strategy to select respondents [25]. The target respondents include students of

construction education, construction managers, and other practitioners in the construction industry who have more than 20 years of experience, 10-20 years, 5-10 years, and less than 5 years, to meet the diversity of the surveyed personnel. A total of 101 questionnaires were sent, and 42 valid responses were received. The effective response rate was 42%. Firstly, from the questionnaire respondents' industry distribution, the respondents to the 42 valid questionnaires come from various construction industry sectors, including client/developer, contractor/builder/ Subcontractor, suppliers/manufacturers, QS consultant, academic, etc. As shown in Fig. 1 below, the largest proportion (40%) of the respondents are from the contractor/builder/ Subcontractor, who have the most say in the survey content, thus demonstrating the survey results' validity. Secondly, Fig. 2 shows that 31% of respondents have 0-5 years of experience, and 14% have 6-10 years of experience. More than half of the respondents (54% in total) have more than 10 years of experience, of which 26% have 10-20 years, and 29% have more than 20 years of work experience. This proportion of respondents' work experience distribution also shows the relevance and value of the research results.



Fig. 1. Respondents' distribution in various construction industries in China.

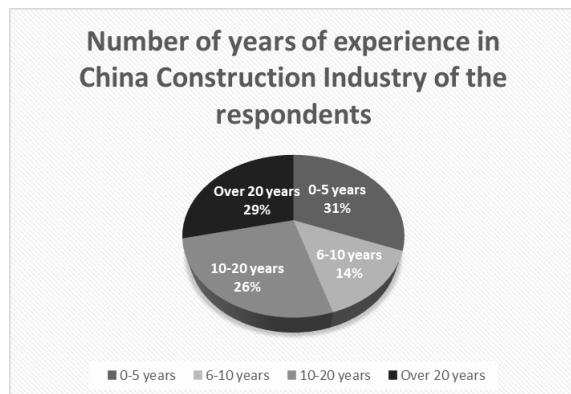


Fig. 2. Number of years of experience in the China Construction Industry of the respondents.

V. ANALYSIS

A. Thematic Analysis

This study matches data related to the research questions to determine the competencies common to construction managers' competency frameworks. Other independent

capacities are also subsumed under different capacities or separately under other capabilities. Finally, summarize and list the competencies to identify various titles related to those competencies. For example, because they all have similar functions, we group "Conflict management", "Problem-solving and conflict avoidance, management and dispute resolution procedures" under a common title "Conflict avoidance and management." Due to the construction industry's nature, construction management graduates need to possess many technical capabilities to

participate in the whole project [26]. These construction manager competencies include processes, materials, methods, equipment, plans, safety, schedules, cost and control, IT skills, etc., they can be divided into four groups: general competency, affective competency, technical competency, and cognitive competency [27].

According to the above methodology, this study groups the 40 construction manager competencies shown in the questionnaire into four themes, as shown in Fig. 3 below.

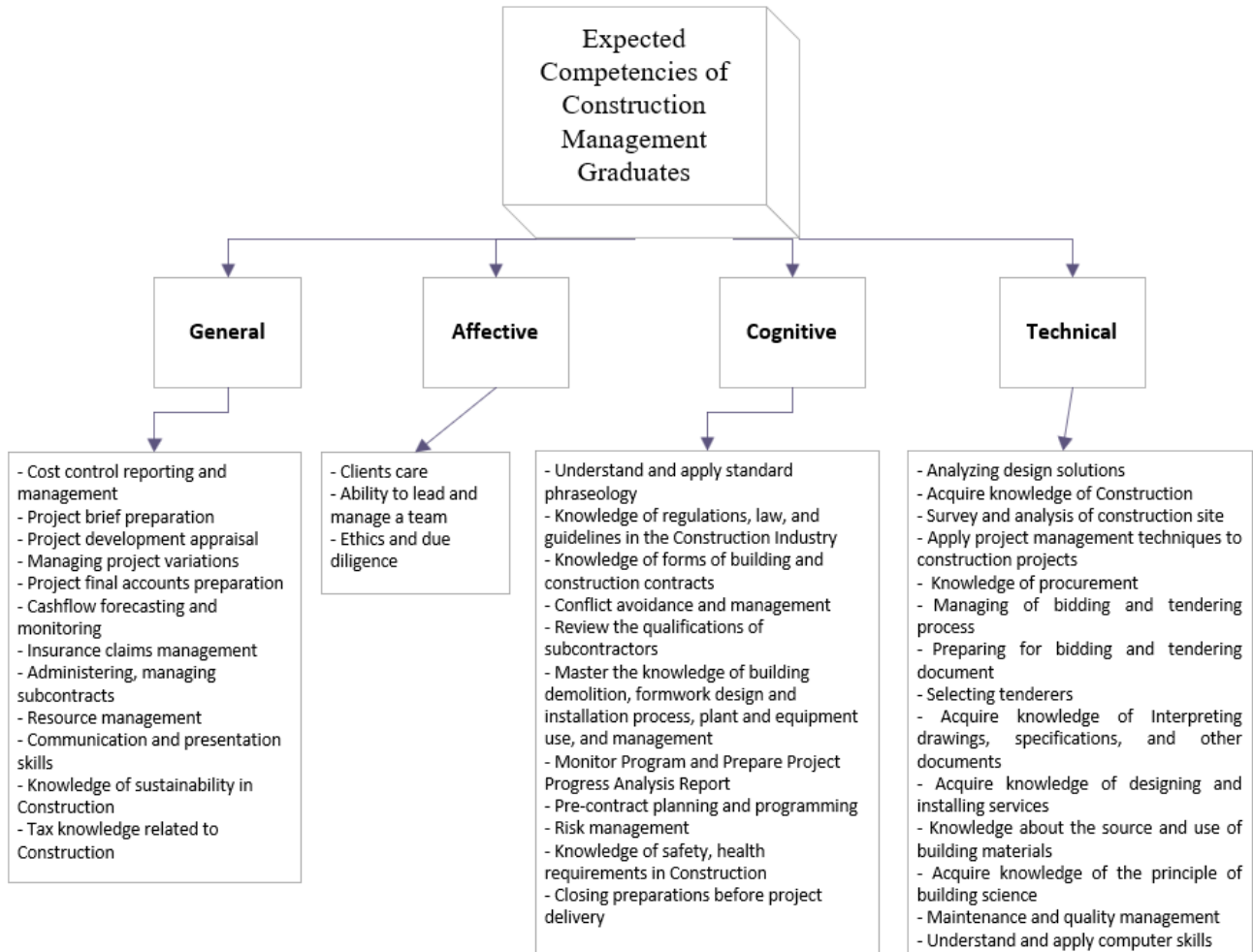


Fig. 3. Grouped competencies of construction management graduates.

B. Comparison of Competencies Listed in the Questionnaire

The questionnaire question setting, and the survey respondents' selection are to compare and analyze the gap between the construction management graduates' competencies and the construction manager's expected competencies from the industry perspective. We make a statistical comparison of the data of the valid questionnaires we received and list the difference between the two levels, the gap rate (divide difference by level expected to get), and the ranking according to the size of the difference (as shown in table II below).

It can be seen from the data in Table II that there is a positive gap between the industry employability of the construction management listed in the questionnaire and the ability that they can achieve after graduation. In other words,

the competencies of graduates majoring in construction management have not yet met the construction managers' requirements for the industry.

Among the 40 competencies listed in the questionnaire, the ability to lead and manage a team (gap rate is 27.63%), managing of bidding and tendering process (gap rate is 26.75%), and risk management (gap rate is 26.42%) are the top three with the most significant difference between professional expectations and abilities achieved after graduation. This result is quite reasonable because in most cases, competencies such as leadership and risk management just can be effectively improved after going through the repeated process of encountering problems, analyzing problems, and solving problems in actual work. In addition to the three competencies mentioned above, the gap rates of the other 23 competencies, including knowledge of procurement, knowledge of safety, health requirements in construction, etc.,

also have exceeded 20%.

Within the remaining 14 competencies, such as computer skills, knowledge of sustainability in construction, and acquire knowledge of the principle of building science, their

gap rates are all more than 10%. There is only one competency (ethics and due diligence) with a gap rate of less than 10% (8.44%).

TABLE II: GAP RATES AND RANK BETWEEN THE LEVELS OF COMPETENCIES EXPECTED AND GRADUATED

Competency	Level achieved: Graduate	Level expected	Difference	Gap rate	ranking
Analyzing design solutions	3.48	4.12	0.64	15.53%	34th
Acquire knowledge of Construction	3.36	4.10	0.74	18.05%	29th
Cost control reporting and management	3.19	4.05	0.86	21.23%	20th
Understand and apply standard phraseology	3.55	4.12	0.57	13.83%	38th
Survey and analysis of construction site	3.38	3.93	0.55	13.99%	37th
Project brief preparation	3.33	4.10	0.77	18.78%	28th
Project development appraisal	3.14	3.76	0.62	16.49%	33rd
Knowledge of regulations, law, and guidelines in the Construction Industry	3.40	4.26	0.86	20.19%	24th
Apply project management techniques to construction projects	3.36	4.26	0.90	21.13%	22nd
Managing project variations	3.19	4.07	0.88	21.62%	19th
Project final accounts preparation	3.07	4.00	0.93	23.25%	12th
Cashflow forecasting and monitoring	2.98	3.73	0.75	20.11%	26th
Insurance claims management	2.93	3.67	0.74	20.16%	25th
Administering, managing subcontracts	2.95	3.81	0.86	22.57%	15th
Knowledge of forms of building and construction contracts	3.19	4.19	1.00	23.87%	10th
Conflict avoidance and management	3.21	4.21	1.00	23.75%	11th
Clients care	3.26	4.31	1.05	24.36%	9th
Resource management	3.17	4.05	0.88	21.73%	18th
Knowledge of procurement	2.93	3.88	0.95	24.48%	8th
Review the qualifications of subcontractors	2.98	3.83	0.85	22.19%	16th
Managing of bidding and tendering process	2.93	4.00	1.07	26.75%	2nd
Preparing bidding and tendering document	2.98	3.98	1.00	25.13%	5th
Selecting tenderers	3.00	3.98	0.98	24.62%	7th
Acquire knowledge of Interpreting drawings, specifications, and other documents	3.60	4.24	0.64	15.09%	36th
Acquire knowledge of designing and installing services	3.14	3.83	0.69	18.02%	30th
Knowledge about the source and use of building materials	3.19	3.86	0.67	17.36%	31st
Acquire knowledge of the principle of building science	3.31	3.90	0.59	15.13%	35th
Master the knowledge of building demolition, formwork design and installation process, plant and equipment use, and management	3.00	3.78	0.78	20.63%	23rd
Ability to lead and manage a team	3.17	4.38	1.21	27.63%	1st
Communication and presentation skills	3.62	4.48	0.86	19.20%	27th
Monitor Program and Prepare Project Progress Analysis Report	3.17	4.02	0.85	21.14%	21st
Knowledge of sustainability in Construction	3.26	3.93	0.67	17.05%	32nd
Tax knowledge related to Construction	2.90	3.76	0.86	22.87%	14th
Maintenance and quality management	3.26	4.17	0.91	21.82%	17th
Pre-contract planning and programming	3.10	4.17	1.07	25.66%	4th
Risk management	2.98	4.05	1.07	26.42%	3rd
Knowledge of safety, health requirements in Construction	3.21	4.17	0.96	23.02%	13th
Understand and apply computer skills	3.48	3.98	0.50	12.56%	39th
Ethics and due diligence	4.12	4.50	0.38	8.44%	40th
Closing preparations before project delivery	3.05	4.07	1.02	25.06%	6th

C. Themes Comparison and Analysis

Table III below shows in detail the mark results of the combined construction manager's competencies under the themes categorization and the result of each theme.

Fig. 4 compares the data results under different themes. As mentioned above, the results of this questionnaire show that under the four themes of general, affective, cognition, and technical, the competency's level of Chinese construction management graduates does not meet the industry expectations of employment, and the differences are respectively 0.81, 0.88, 0.91 and 0.71. The most obvious gap is the competencies to subordinate to the theme of cognitive. Cognitive ability is the ability of people to absorb and process information received from different sources (such as

perception, experience, belief) and convert them into knowledge [28]. Therefore, the acquisition of cognitive ability is inseparable from the accumulation of practical experience. This should be the reason for the biggest gap between graduation competency and professional demand competency under this theme.

In contrast, the gap between the competency to graduate and the competency to professionally demand under the technical theme is the smallest. Those technical abilities are generally relatively easy to master after professional education and training in schools and corresponding assessments. Of course, this aspect also requires practice to be competent for specific tasks.

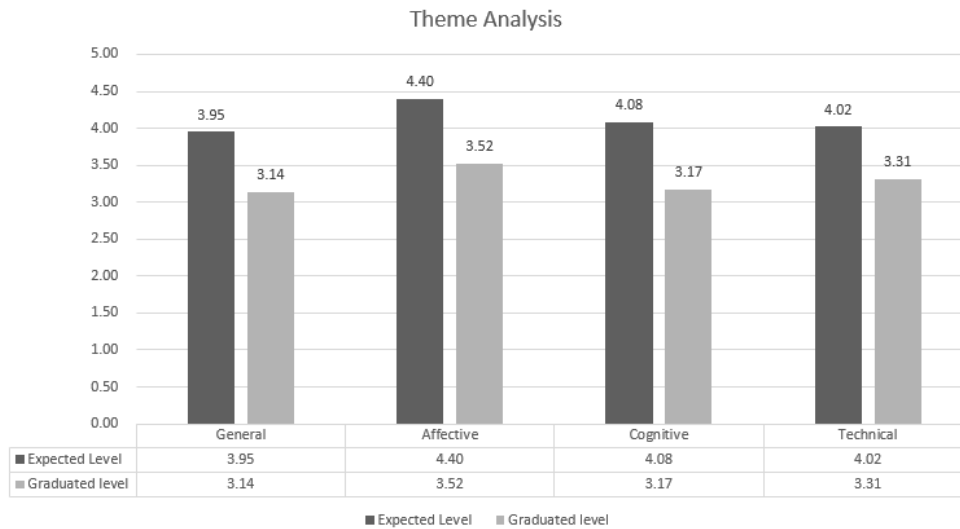


Fig. 4. Comparative analysis based on theme.

TABLE III: THEME CATEGORIZATION OF EXPECTED AND GRADUATED LEVELS OF COMPTENCIES

Theme	Competency	Expected level (Median)	Expected Level - Theme	Graduated level (Median)	Graduated level - Theme
General	Cost control reporting and management	4.05	3.95	3.19	3.14
	Project brief preparation	4.10		3.33	
	Project development appraisal	3.76		3.14	
	Managing project variations	4.07		3.19	
	Project final accounts preparation	4.00		3.07	
	Cashflow forecasting and monitoring	3.73		2.98	
	Insurance claims management	3.67		2.93	
	Administering, managing subcontracts	3.81		2.95	
	Resource management	4.05		3.17	
	Communication and presentation skills	4.48		3.62	
	Knowledge of sustainability in Construction	3.93		3.26	
Tax knowledge related to Construction	3.76		2.90		
Affective	Clients care	4.31	4.40	3.26	3.52
	Ability to lead and manage a team	4.38		3.17	
	Ethics and due diligence	4.50		4.12	
Cognitive	Understand and apply standard phraseology	4.12	4.08	3.55	3.17

	Knowledge of regulations, law, and guidelines in the Construction Industry	4.26		3.40	
	Knowledge of forms of building and construction contracts	4.19		3.19	
	Conflict avoidance and management	4.21		3.21	
	Review the qualifications of subcontractors	3.83		2.98	
	Master the knowledge of building demolition, formwork design and installation process, plant and equipment use, and Monitor Program and Prepare Project Progress Analysis Report	4.02		3.17	
	Pre-contract planning and programming	4.17		3.10	
	Risk management	4.05		2.98	
	Knowledge of safety, health requirements in Construction	4.17		3.21	
	Closing preparations before project delivery	4.07		3.05	
Technical	Analyzing design solutions	4.12	4.02	3.48	3.24
	Acquire knowledge of Construction	4.10		3.36	
	Survey and analysis of construction site	3.93		3.38	
	Apply project management techniques to construction projects	4.26		3.36	
	Knowledge of procurement	3.88		2.93	
	Managing of bidding and tendering process	4.00		2.93	
	Preparing for bidding and tendering document	3.98		2.98	
	Selecting tenderers	3.98		3.00	
	Acquire knowledge of Interpreting drawings, specifications, and other documents	4.24		3.60	
	Acquire knowledge of designing and installing services	3.83		3.14	
	Knowledge about the source and use of building materials	3.86		3.19	
	Acquire knowledge of the principle of building science	3.90		3.31	
	Maintenance and quality management	4.17		3.26	
	Understand and apply computer skills	3.98		3.48	

VI. CONCLUSION

This research aims to determine the difference between construction management graduates' competencies and the competencies required by their profession in China. This study first reviews the construction manager's competence, the relationship between educational training and competencies, and current construction management curriculum in China. It identifies different competencies for the construction manager profession of China (including Hong Kong), UK, Singapore, and Malaysia. A list of competencies was analysed, and 40 competencies were grouped under general, affective, cognitive, and technical themes.

Referring to the valid questionnaire statistics, the gap between the required competencies and graduation competencies in the 40 occupations listed is positive (the maximum gap rate is 27.63%, and the minimum gap rate is 8.44%). The current education model and curriculum of construction management majors in China need to be improved. At the same time, the results of this survey also show that our research is valuable.

The results of this research reflect that the current construction management curriculum cannot cater for the needs of the industry in China. The curriculum in tertiary

education in China is too theoretical and lacks practicality. Assessment in construction management programme in China is mainly summative based while the construction industry always expects graduates to be able to write technical report, to analyse the technical issues and to provide ongoing feedback to the teams. These skills can be developed only through continuous formative assessment during their schools. Moreover, graduates now only learn theoretical knowledge and have no idea how to apply the rationale or deal with problems in the workplace environment.

Universities and vocational colleges in China should vigorously review the curriculum setting, teaching materials and assessment methods. The theme will focus on industry-oriented approach, so that university education can better meet the needs of economic development and industry expectations. More studies about construction management education can be done in the future to enrich the one currently used in China, such as vocational education in UK, Australia and New Zealand which adopts a workplace-oriented, industry-university integration, school-enterprise cooperation model successfully.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

Yi Wang and Kam Yuen Cheng conducted the research; analyzed the data; wrote the paper and reviewed the paper; all authors had approved the final version.

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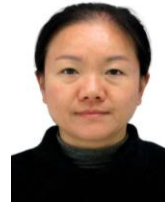
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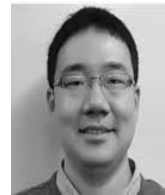
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Y. Wang was born on 03 June 1978. Yi graduated with the diploma in accounting (2003) in Nanjing University of Finance & Economics, Nanjing, Jiangsu, China, and the diploma in civil engineering & project management (1999) in Nanjing Southeast University, Nanjing, Jiangsu, China. Yi currently studies bachelor of construction programme in Ara Institute of Canterbury.

She worked as a finance manager in state owned Nanjing Pencheng Transport and Drainage Engineering Co.Ltd. from 2003 to 2016.

Mrs. Wang is in MNZIQS, MNZIOB.



K. Y. Cheng comes from New Zealand, who was born on 30 December 1978. Kam graduated with the master degree in European union law (2013) in King's College London, London, UK and the master in building services engineering (2008) in Heriot-Watt University, Edinburgh, Scotland, UK.

He currently works in Ara Institute of Canterbury in the capacity of Acting Head of Department – Engineering and Architectural Studies and programme manager – Construction Management, QS and Architectural Technology programme. Previously he worked in Sinopec Hong Kong and UAE in the capacity of Senior Cost Control Manager.

Mr. Cheng is in FRICS, FCABE, MNZIQS, MNZIOB, MNZIA.