ITU A|Z • Vol 21 No 1 • March 2024 • 1-14

Skills, competencies and knowledge for construction management graduates

Ecem TEZEL[1]*, Pınar IRLAYICI ÇAKMAK[2]
[1] tezele@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Turkey
[2] irlayici@itu.edu.tr • Department of Architecture, Faculty of Architecture, Istanbul Technical University, Istanbul, Turkey

*Corresponding author
Received: June 2023 • Final Acceptance: September 2023

Abstract
The ever-changing nature of the Architecture, Engineering and Construction (AEC) industry requires construction management (CM) professionals to be competitive in both theoretical knowledge and management abilities. CM programs are responsible to equip their graduates with the right knowledge and fundamental skills for their future careers. This study identifies skills, competencies and core knowledge for construction management graduates through a quantitative approach. A purposive sampling procedure targets the AEC professionals with an established academic background in the CM field. The relative importance index (RII) analysis reveals that project managers should be highly skilled in communication, problem-solving and decision-making, leadership, and ethical practices. Moreover, there is a need to demonstrate a sound knowledge of time management, project and construction management, decision-making, and cost management. A prominent finding from the Kruskal-Wallis test shows that higher-level managers considerably appreciate time management knowledge over other domains of CM. Overall, the outcomes not only guide CM programs to align their curricula with the industry requirements but also support future CM professionals to decide on the right program among numerous alternatives.

Keywords
Competency, Construction management, Graduate program, Knowledge, Skill.

doi: 10.58278/0.2024.38

1. Introduction

The concept of project management, which is used synonymously with construction management (CM) in the Architecture-Engineering-Construction (AEC) industry, is defined as the use of specific knowledge, skills, tools, and techniques to deliver something of value to people (PMI, 2017). According to the Construction Management Association of America (CMAA), which sets the standard for managing capital construction projects since 1982, construction management is a professional service that provides a project's owner with effective management of the project's schedule, cost, quality, safety, scope, and function. As stated by the Chartered Institute of Building (CIOB), construction management is the improvement of the built environment through professionals working together to meet the changing needs of the global society by including a wide range of specialist services together with support from an independent academic discipline. Therefore, in addition to being a profession, construction management is also an established academic and research area that has evolved and expanded over the years (Pietroforte and Stefani, 2004; Arditi and Polat, 2010; Harty and Leiringer, 2017).

The new era of technological developments and evolving knowledge triggers the need for competent professionals for all industries, and AEC is no exception. Construction management programs correspond to the industry's needs by providing prevalent knowledge to their students and promoting critical skills (Ahmed et al., 2014; Benhart and Shaurette, 2014; Aliu and Aigbavboa, 2023). Similar to the AEC industry, CM education has to reflect the changes due to a shift toward digitalization, a dynamic economy, new sector forces, updated regulatory requirements and innovative ways of doing business. Recent evidence suggests that these drivers reinforce programs to assess and restructure their academic curriculums (Ahmed et al., 2014; Benhart and Shaurette, 2014; Wu et al., 2015; Vaz-Serra and Mitcheltree, 2021). Yet, there is a limited research effort on CM curriculum development (Posillico et al., 2022).

This study, therefore, explores the skills, competencies and core knowledge areas of construction managers through a two-fold approach. The paper initially reviews the top CM programs offered by architecture and civil engineering departments of well-known universities worldwide. The courses introduced in these programs are thoroughly examined and grouped into thematic categories to determine the core subject areas of CM education. Then, a questionnaire survey with CM students and graduates is applied to identify the distinguishing skills, competencies and knowledge domains for professional construction managers. Finally, a detailed discussion on the most valued CM skills and knowledge is presented to guide CM programs to align with the industry expectations. The present research contributes to CM knowledge as it addresses the gap between academic programs and industry by revealing the core knowledge areas and essential competencies of CM professionals and deriving actionable conclusions for CM curriculum enhancement.

2. Construction management education and knowledge

Since the 1970s, construction management has been recognized as a research domain mainly within the engineering departments of universities (Arditi and Polat, 2010; Harty and Leiringer, 2017). The inclusion of construction management expertise in education programs started about 50 years ago with pioneering master's programs at a number of universities in the United States, and soon followed by doctoral programs (Carr, 1997). In the mid-1990s, there was a significant increase in the number of CM graduate programs not only in the United States but also all over the world (Atalah and Muchemedzi, 2006). Today, numerous undergraduate and graduate programs worldwide are training future professionals who specialize in scheduling construction works, controlling project budgets, ensuring safety and quality, enhancing efficiency, and avoiding disputes.

Each construction project is inherently unique, and academic programs in the construction management discipline are only able to provide a broad perspective on the subject. As a result, CM professionals have to improve their knowledge and skills by experiencing a myriad of different cases throughout their careers. However, while working experience is of great importance for project managers to develop and maintain business competency, that has to be built upon a profound academic background (Edum-Fotwe and McCaffer, 2000). Previous studies indicate several areas of knowledge to include in CM education. For instance, Tatum (1987) advocates that a technical understanding of construction engineering, methods and technology, together with the managerial understanding of planning, directing and monitoring construction operations, legal aspects, financial issues, and human relations in project execution are the key needs in a CM curriculum. In line with this scheme, a longitudinal study by Arditi and Polat (2010) reveals that contract administration, project management, scheduling, equipment management, construction technology, and construction engineering management research are the most common course subjects of the CM master's programs in the United States. This being said, a recent study with mid and upper-level construction managers adds cost and finance, company organization and management, risk management, and business acumen as the essential knowledge competencies for senior-level construction managers (Pathuri et al., 2022). On top of all, the Construction Extension to the Project Management Body of Knowledge (PMBOK) Guide launches construction-specific knowledge areas for professional construction managers; namely, project health, safety, security, and environmental management, project financial management, and management of claims in construction (PMI, 2016).

In short, the changing dynamics of the AEC industry also change the knowledge expected from prospective managers. Graduate programs in the CM field need to closely monitor these fluxes and restructure themselves to ensure their graduates are well-prepared for the unpredictable industry conditions (Farooqui and Ahmed, 2009; Benhart and Shaurette, 2014; Vaz-Serra and Mitcheltree, 2021).

3.Construction management skills and competencies

Managerial roles demand cooperation between advanced knowledge in that particular field and various supervising abilities. There is extensive literature on a project manager's skills, yet not all those skills can be directly attributed to construction managers because CM requires a particular technical understanding of the construction process together with a general sense of project management (Vaz-Serra and Mitcheltree, 2021). As a result, there is a great effort to identify the specific skills for construction project management. Among them, for instance, the American Council for Construction Education (ACCE) claims that accredited master's programs in construction should equip their graduates with the following abilities, namely: communications, critical thinking, problem-solving, decision-making, research, advanced communication technology, professional ethics, advanced construction management practices, risk management, and leadership (ACCE, 2021). Likewise, the Chartered Institute of Building (CIOB) in the United Kingdom indicates that critical thinking and creativity, complex problem solving and decision making, effective communication, competent use of computer applications, leadership, industry analysis, and learning from industry practices are the required skill outcomes for all built environment master's programs graduates (CIOB, 2019). Moreover, CIOB customizes the list with additional technical, legal, advanced project management, and high-level planning and programming skills for project management master's programs (CIOB, 2019). As the principal accrediting bodies for the built environment and construction programs, ACCE and CIOB emphasize similar skill sets for graduate degree alumni (see Figure 1).

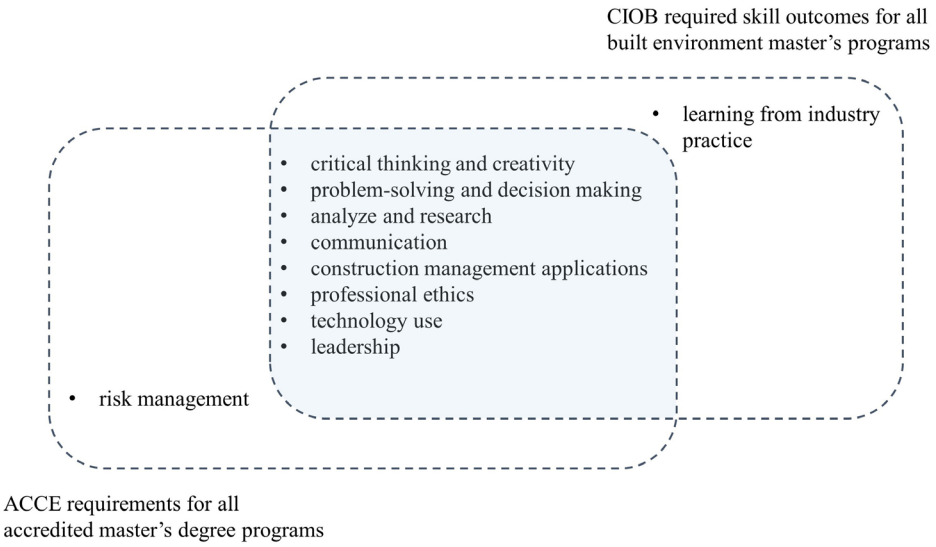

Figure 1. *ACCE and CIOB skills for master's degree program graduates.*

In addition to the institutions above, several researchers focus on the question of what are the essential skills for a construction manager to work efficiently in the industry. Earlier, Odusami (2002) shows that decision-making is the most important skill perceived by the construction industry actors followed by communication, leadership and motivation, and problem-solving. A few years later, Russell et al. (2007) expanded the list of skills by adding managing cultural diversity in a multidisciplinary environment. In a further study, both employers and students agree that problem-solving, teaming and adapting to changing environments as the top skills for career success (Bhattacharjee et al., 2013). Today, built environment graduates are expected to demonstrate leadership, critical thinking and analytics, problem-solving, and entrepreneurship skills to succeed in business (Aliu and Aigbavboa, 2023).

It is evident that skills and competencies are the foundation for the CM curriculum (Pathuri et al., 2022; Posillico et al., 2023). As noted by Magano et al. (2020), Generation Z members, as the "promissory assets" in the project management field, are arriving in the labor market. Thus, CM programs should align themselves to promote skills and competencies valued by the industry.

4. Research framework

This paper concentrates on the skills, competencies and core knowledge of CM professionals and provides insight into the future strategies for graduate programs that aim to train well-educated and competent professionals. Figure 2 illustrates the two-fold process adopted in this study. First, in addition to the graduate skills and competencies identified by ACCE and CIOB, what core knowledge to include in the CM curriculum was determined based on a systematic review of top CM programs. Then, a questionnaire

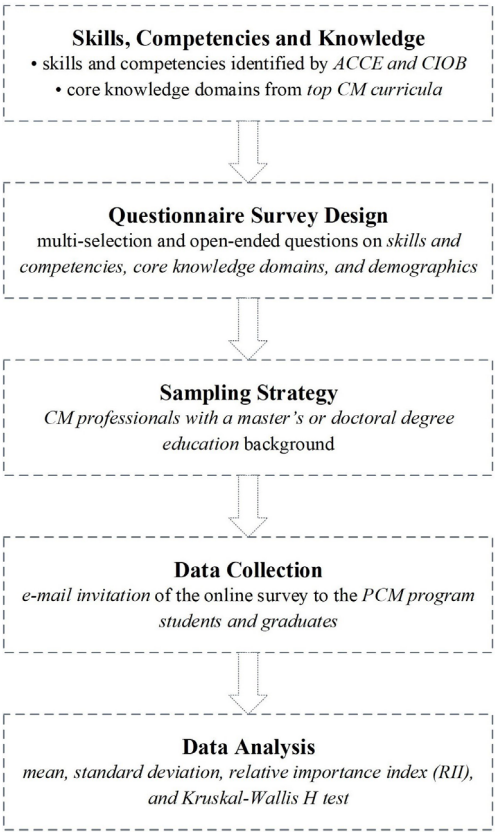

Figure 2. *Research framework.*

survey was designed to identify the desired skills and competencies for CM professionals as well as the knowledge domains supporting these skills.

4.1. A systematic review on CM knowledge

The top CM graduate programs were identified based on global university rankings. QS and Times Higher Education are the two well-known assessment systems for higher education institutions across the globe. The former system compares university performance using six indicators: academic reputation, employer reputation, faculty/student ratio, citations per faculty, international students' ratio, and international faculty ratio (QS Top Universities, 2022). The second system assesses universities based on thirteen performance indicators under five categories: teaching, research, citations, international outlook, and industry income (Times Higher Education, 2020). This study acknowledges QS world university rankings since it assesses the reputation and performance of the institutions that are highly respected by the industry and academic community.

It is a fact that both architecture and civil engineering schools taught CM-related topics in graduate programs. Therefore, all universities in architecture and civil engineering fields were listed using the subject area filter, and 18 universities were shortlisted depending on whether they have CM programs. Then, the curriculum of each selected program was examined to spot the necessary subjects to specialize in the CM field. Initial outcomes disclosed 317 courses on different aspects of CM. Finally, the courses were grouped according to course contents and represented by their occurrence within programs' curricula to identify the core knowledge for CM professionals. Table 1 below shows the selected universities and a detailed list of courses within their CM graduate programs.

As seen in Table 1, Europe is the prime continent that hosts well-respected CM programs, accompanied by the United States, Asia, and Oceania. In a general sense, top CM programs seem to comprise 18 different subject domains within their curricula. Whilst university-based differences are observed, overall, most programs provide a similar knowledge basis to their students. Unsurprisingly, legal

Table 1. *Top PCM programs and core subject areas.*

	Project and Construction	Contemporary Mng	Decision Making	Cost Management	Time Management	Quality Management	Risk Management	Design Management	Legal & Contractual	Financial Issues	Information Technologies	Construction	HR & Org. Behaviour	Health, Safety, and	Sustainability, Energy, &	Prof. Practice & Ethics	Research & Thesis	Seminar
Chalmers University of Technology, Sweden	•			•				•	•	•			•		•		•	
Delft University of Technology, Netherlands	•	•		•			•	•	•	•	•	•	•			•	•	
Illinois Institute of Technology, United States		•	•						•			•						
Istanbul Technical University, Turkey	•	•	•	•	•	•	•		•	•	•		•		•	•	•	•
Michigan State University, United States	•	•		•	•				•	•	•				•	•	•	
Middle East Technical University, Turkey	•	•		•	•		•		•	•	•	•		•	•	•	•	•
National University of Singapore, Singapore	•			•	•			•	•	•	•					•	•	
Texas A&M University, United States	•	•		•	•		•		•	•	•	•			•	•	•	•
The University of Melbourne, Australia	•	•		•	•		•	•	•	•	•	•	•		•	•	•	
The University of New South Wales, Australia	•	•		•	•		•		•	•	•				•	•	•	•
Tsinghua University, China	•	•	•	•					•	•						•	•	
Universitat Politècnica de Catalunya-BarcelonaTech, Spain	•	•	•	•	•	•			•	•	•		•		•		•	
University College London, England	•	•		•					•	•	•		•		•	•	•	
University of California, Berkeley, United States		•			•				•		•				•		•	•
University of Cambridge, England	•	•		•	•				•	•		•				•		
University of Michigan-Ann Arbor, United States	•	•	•	•	•		•			•	•	•			•	•	•	•
University of Reading, England	•	•		•				•	•	•	•	•	•		•	•	•	
University of Salford, England	•			•	•		•		•	•				•	•	•	•	

Note. Mng. denotes Management, HR denotes Human Resources, Org. denotes Organizational, Env. denotes Environment, and Prof. denotes Professional

and contractual issues are the most common course subject in CM curricula that covers construction laws and regulations, international contracts, reasons for disputes in construction projects along with resolution techniques. This is followed by project and construction management, contemporary management practices, cost management, financial issues, and research and thesis courses. Project and construction management is a generic title for the courses that introduce management concepts, functions and principles of management, major actors of construction projects along with their roles and responsibilities in the project process, and basic project delivery methods of construction works. On the other hand, contemporary management practices focus on recent management approaches at company and project levels such as strategic management, supply chain management, and lean methodology. Cost management and financial issues are two distinguishing subjects in CM education and practice. While the former concept directly refers to the processes required to maintain monetary control of a project throughout the project life cycle, the latter is more related to economics and economic decisions. Finally, the research and thesis course aims to guide students to conduct scientific research in the CM domain. Although many programs request students to submit a thesis study as a part of a graduate degree, few of them offer non-thesis graduate program alternatives.

It is interesting to note that, although quality management is one of the core knowledge areas in project management, most CM programs do not offer a separate course solely focusing on quality subjects; instead, they introduce the concept, tools and techniques of quality management within other associated courses. A similar case is also valid for health, safety and security subjects. Even though it is a distinctive knowledge area for construction projects' management, only two of the selected programs have modules specifically encapsulating HSS-related topics. Seeing Table 1, it can be concluded that a typical CM graduate curriculum involves (1) project and construction management in general terms, (2) contemporary management practices, (3) scheduling and time management, (4) cost management and financial issues, (5) legal and contractual issues together with dispute resolution, (6) prevalent information technologies, (7) sustainability and environmental issues, (8) professional practice and ethics, and (9) research methods to support thesis/dissertation studies.

4.2. Quantitative survey on CM skills, competencies and knowledge

The survey consists of three major sections. The first section aims to understand the importance of having a set of skills that ACCE and CIOB commonly suggest. In this section, respondents were asked to indicate the level of importance of 8 different skills on a five-point Likert scale (from 1-not important to 5-very important). The second section identifies how important it is to receive an education in different subject areas. Again, respondents were asked to indicate the level of importance of 18 different course subjects for CM graduates, observed in the top CM curricula, on a five-point Likert scale (from 1-not important to 5-very important). The final section of the survey collects a set of personal information regarding the respondents' job titles, years of industry experience, and educational levels.

4.3. Sampling

Following the survey development, a purposive sampling strategy was adopted to collect quantitative data on the importance of specific skills, competencies and knowledge for CM professionals. Purposive sampling is a non-random sampling method that enables individuals who may be associated with the questioned phenomenon to be present within the sample (Robinson, 2014). Even though it is primarily preferred in qualitative studies (Teddlie and Yu, 2007), the rationale for employing purposive sampling in this paper is to congregate the opinions of the most convenient group of people with knowledge and experience in the CM

field. The online survey invitation has been sent via email to 220 individuals who are studying or have studied the Project and Construction Management graduate program at Istanbul Technical University. The survey was available for data collection between June and July 2022 and a total of 80 valid responses were received. The limited response rate (36%) might question the representativeness of the results. However, when working with purposive sampling the major concern is to ensure that the sample involves suitable respondents rather than to meet a specific sample size (Mason, 2018). Table 2 represents the respondent characteristics.

The respondents who participated in the questionnaire survey were AEC professionals with a graduate education background in the Project and Construction Management (PCM) program at Istanbul Technical University. PCM provides each of two levels of graduate education, namely, master's degree and doctoral degree, within the body of the architectural department. As a result, architects were the major respondents (89%) of the survey compared to civil engineers (11%). The respondents were able to select their industry experience among the following categories: (1) less than 2 years, (2) 3-5 years, (3) 6-10 years, (4) 11-15 years, and (5) more than 15. Almost half of the respondents (49%) have more than 10 years of experience in the AEC industry, while only 11% of them have been working for less than 2 years. The smallest group of the respondents (11%) were either the founders, co-founders and top-level managers or first-line managers within their companies, whereas the largest group (31%) were mid-level managers. In addition to that, 20% have been working in non-managerial (or operational) positions and 26% were academicians. As previously mentioned, this study invited master's/doctoral students and graduates of the PCM program. Of these respondents, MSc graduates were the largest group (36%), followed by PhD students (31%), MSc students (20%), and PhD graduates (13%), respectively. Overall, the survey data were collected from professionals who have notable experience in a variety of roles in organizations with an established CM education. Therefore, it is evident that this study will provide a reliable understanding of the required skills, competencies and knowledge for CM professionals to work in a challenging environment.

5. Results and discussion

Internal consistency analysis of the survey items was carried out using Cronbach's alpha method. Cronbach's alphas for the skills and competencies

Table 2. *Characteristics of survey respondents.*

Demographic variable	Categories	Number of responses (n)	Percentage of responses (%)
Profession	Architect	71	89%
	Civil engineer	9	11%
Years of experience	≤ 2 years	9	11%
	3-5 years	14	18%
	6-10 years	18	23%
	11-15 years	20	25%
	> 15 years	19	24%
Educational background	MSc student	16	20%
	MSc graduate	29	36%
	PhD student	25	31%
	PhD graduate	10	13%

subscale was .81, and the knowledge domain subscale was .89, respectively. Consequently, the overall survey was found to be highly reliable (α>.80).

Collected data were analyzed using the Relative Importance Index (RII) to prioritize skills and competencies for CM professionals, and to determine the predominance of subject areas pertaining to CM education. RII is calculated as Equation 1

RII =Σ W / A x N

where: W = weighting assigned by respondents on the Likert scale (ranging from 1 to 5); A = the highest weight (i.e. 5 in this study); and N = the total number of respondents. The RII value had a range of 0 to 1; the higher the RII value, the more important the skill and competency and the more dominant the subject area. The RIIs were then ranked, and the results are presented in Table 3 and Table 4.

The RII ranking shown in Table 3 presents that all of these skills and competencies are considered important from the respondents' perspective. Hence, communication with the highest score (RII=0.965), followed by problem-solving and decision-making (RII=0.960), is perceived as the most important one. This is consistent with the findings of Pathuri et al. (2022), who recently identified the knowledge, skills, and abilities required of senior-level construction managers. Not surprisingly, leadership (RII=0.915) is still a predominant skill as noted in previous studies (Back et al., 2012; Slattery and Sumner, 2011). It is followed by professional ethics (RII=0.905), which was also highly ranked in the study of Benhart and Shaurette (2014). These results corroborate the ideas of Hsu et al. (2019), who suggested that a CM curriculum should prioritize leadership and execution, innovation, and ethics and law subjects in the learning hierarchy. Critical thinking and creativity (RII=0.850) have gained much importance, unlike preceding research (Ahmed et al., 2014; Benhart and Shaurette, 2014). Despite their high scores, the reason why skills of construction management practices (RII=0.845) and technology use (RII=0.800) were placed at the bottom could be because they were perceived as knowledge rather than skill.

Table 4 provides RII rankings of knowledge domains supporting the above-mentioned skills. Being one of the critical aspects of managing construction projects, it is not surprising that time management was ranked first with 0.930 RII. This confirms the findings of Bhattacharhjee et al. (2013), who found that identifying project activities and their relationships, and developing and updating a project schedule are the knowledge required to work efficiently in the construction industry. Although senior-level managers are not necessarily expected to have expertise in construction scheduling, it is undoubtedly a knowledge area of a construction manager (Pathuri et al., 2022); moreover, it plays a distinguishing role in the recruitment of new graduates (Vaz-Serra and Mitch-

Table 3. *Relative importance index and rank for skills and competencies.*

	Respondent Scores						
Skills and competencies	≤2	3	≥4	SD	Mean	RII	Rank
Communication	0	0	80	.382	4.83	0.965	1
Problem-solving & decision making	1	0	79	.488	4.80	0.960	2
Leadership	0	2	78	.546	4.58	0.915	3
Professional ethics	0	5	75	.616	4.53	0.905	4
Analysis and research	0	5	75	.591	4.33	0.865	5
Critical thinking and creativity	3	5	72	.738	4.25	0.850	6
Construction management practices	0	8	72	.616	4.23	0.845	7
Technology use	1	13	76	.636	4.00	0.800	8

eltree, 2021). The second most important knowledge domain was project and construction management with an RII of 0.925. This overlaps with the study of Arditi and Polat (2010), which observed a prominent increase in the ranking of project management courses. Courses offering knowledge and technique necessary for decision-making (RII=0.913) was ranked one of the highest ones, in accordance with the rank of its supporting skill. Having one of the highest scores (RII=0.905), cost management was observed as another prevalent knowledge domain. Although this result differs from Arditi and Polat (2010) that presented a drastic fall in raking of cost estimating courses, it is consistent with those of Bhattacharhjee et al. (2013) who reported estimation (i.e., quantity take-off, components of bid documents) has still also been regarded as an important knowledge to work efficiently in the construction industry. In contrast to earlier findings (Arditi and Polat, 2010; Pellicer et al., 2013); risk management (RII=0.895), quality management (RII=0.858), and other management courses cover contemporary practices (RII=0.850) were appeared to be gaining more importance as they have been successfully adapted over the years to the AEC industry. Legal and contractual issues have still been one of the core knowledge domains with an RII of 0.883. This result agrees with the findings of other studies, in which contract administration/legal issues were at the top of CM programs' priority list (Arditi and Polat, 2010), and contract management and legal aspects in construction were highlighted as one of the most needed topics (Pellicer et al., 2013). Although it is included in cost-related courses in some curriculums, financial issues were discussed separately and were listed among the important domains with 0.870 RII. In line with their importance, the rest of the knowledge domains were ranked as follows: human resources and organizational behavior (RII=0.848), professional practice and ethics (RII=0.848), information technologies (RII=0.823), construction technologies (RII=0.808),

Table 4. *Relative importance index and rank for knowledge domains.*

	Respondent Scores						
Core Subject Area	**≤2**	**3**	**≥4**	**SD**	**Mean**	**RII**	**Rank**
Time Management	0	1	79	.506	4.65	0.930	1
Project & Construction Management	1	1	78	.582	4.63	0.925	2
Decision Making	0	3	77	.570	4.56	0.913	3
Cost Management	0	3	78	.573	4.53	0.905	4
Risk Management	1	2	77	.616	4.48	0.895	5
Legal & Contractual Issues	0	7	73	.650	4.41	0.883	6
Financial Issues	0	9	71	.677	4.35	0.870	7
Quality Management	0	8	72	.640	4.29	0.858	8
Contemporary Management Practices	0	8	72	.626	4.25	0.850	9
HR & Org Behaviour	1	8	71	.733	4.24	0.848	10
Prof Practice & Ethics	2	9	69	.799	4.24	0.848	10
Information Technologies	3	14	63	.827	4.11	0.823	11
Construction Technologies	4	14	62	.878	4.04	0.808	12
Health, Safety & Security	3	21	56	.868	3.93	0.785	13
Design Management	3	23	54	.862	3.88	0.775	14
Sustainability, Energy & Environment	1	23	56	.769	3.88	0.775	14
Research and Thesis	6	21	53	.938	3.74	0.748	15
Seminar	12	31	37	.971	3.36	0.673	16

health, safety and security (RII=0.785), and design management (RII=0.775).

The final analysis was carried out to understand whether CM professionals working at different managerial levels have different perspectives on the most important skills and knowledge areas for CM graduates. To this, first, skills, competencies and core knowledge were categorized according to their relative importance. Based on Akadiri (2011), RII values of each skill and knowledge were transformed to important levels, namely, High (0.8≤RII≤1), High-Medium (0.6≤RI<0.8), Medium (0.4≤RI<0.6), Medium-Low (0.2≤RI<0.4), and Low (0≤RI<0.2), and the items with 0.8 or higher RII score were selected for further analysis. The remaining items were not considered since the respondents did not reach a clear consensus. Then, collected data were tested for the violation of normality using IBM SPSS 28.0 software. The results of the Shapiro-Wilk test of normality showed that the data varies significantly from the normal distribution (p<.001). Correspondingly, a comparison of importance among respondent groups was carried out using the Kruskal-Wallis test, a non-parametric equivalent of one-way ANOVA. The decision to use the Kruskal-Wallis test instead of one-way ANOVA was made because the latter assumes that the data follows a normal distribution, which was not met in this case. The results are presented in Table 5 and Table 6.

Results of the Kruskal-Wallis test for CM skills and competencies are as follows: communication (H(4) = 2.181, p = .703), problem-solving and decision making (H(4) = 2.820, p = .588), leadership (H(4) = 4.060, p = .389), professional ethics (H(4) = 1.879, p = .758), analysis and research (H(4) = 5.129, p = .274), critical thinking and creativity (H(4) = 1.022, p = .906), construction management practices (H(4) = 1.975, p = .740), and technology use (H(4) = 2.128, p = .712). Given the results in Table 5, it is evident that there is a complete consensus among respondents on all identified skills and competencies for CM graduates. None of the different managerial levels prioritize one particular skill over others (p>.05).

A similar conclusion can be drawn for the core knowledge areas except time management. As seen in Table 6, respondents' perception of the importance of time management within the CM curriculum significantly differs depending on their position (H(4) = 11.594, p = .021). That is to say, a top-level manager values time management knowledge more than a first-line

Table 5. *Kruskal-Wallis test results comparing skills and competencies.*

	Position	N	Mean Rank	df	χ^2	p
Communication	Top-level managers	9	38.61	4	2.181	.703
	Mid-level managers	25	39.50			
	First-line managers	9	47.50			
	Non-managerial staff	16	40.00			
	Academicians	21	39.88			
Problem-solving and decision making	Top-level managers	9	43.11	4	2.820	.588
	Mid-level managers	25	39.32			
	First-line managers	9	47.50			
	Non-managerial staff	16	40.09			
	Academicians	21	38.10			
Leadership	Top-level managers	9	39.17	4	4.060	.398
	Mid-level managers	25	37.78			
	First-line managers	9	52.17			
	Non-managerial staff	16	37.44			
	Academicians	21	41.64			
Professional ethics	Top-level managers	9	44.50	4	1.879	.758
	Mid-level managers	25	41.34			
	First-line managers	9	44.50			
	Non-managerial staff	16	35.16			
	Academicians	21	40.14			
Analysis and research	Top-level managers	9	40.00	4	5.129	.274
	Mid-level managers	25	34.54			
	First-line managers	9	37.28			
	Non-managerial staff	16	42.38			
	Academicians	21	47.76			
Critical thinking and creativity	Top-level managers	9	39.44	4	1.022	.906
	Mid-level managers	25	39.96			
	First-line managers	9	45.00			
	Non-managerial staff	16	37.13			
	Academicians	21	42.24			
Construction management practices	Top-level managers	9	40.50	4	1.975	.740
	Mid-level managers	25	38.70			
	First-line managers	9	36.50			
	Non-managerial staff	16	38.81			
	Academicians	21	45.64			
Technology use	Top-level managers	9	36.56	4	2.128	.712
	Mid-level managers	25	37.28			
	First-line managers	9	40.22			
	Non-managerial staff	16	42.25			
	Academicians	21	44.81			

Table 6. *Kruskal-Wallis test results comparing knowledge domains.*

Time Management	Top-level managers	9	49.61	4	11.594	.021
	Mid-level managers	25	40.82			
	First-line managers	9	49.61			
	Non-managerial staff	16	44.13			
	Academicians	21	29.55			
Project and Construction Management	Top-level managers	9	41.00	4	5.483	.241
	Mid-level managers	25	40.44			
	First-line managers	9	32.33			
	Non-managerial staff	16	49.13			
	Academicians	21	37.29			
Decision Making	Top-level managers	9	33.33	4	4.838	.304
	Mid-level managers	25	42.00			
	First-line managers	9	52.22			
	Non-managerial staff	16	38.66			
	Academicians	21	38.17			
Cost Management	Top-level managers	9	45.17	4	7.825	.098
	Mid-level managers	25	42.74			
	First-line managers	9	49.44			
	Non-managerial staff	16	42.47			
	Academicians	21	30.50			
Risk Management	Top-level managers	9	29.72	4	3.450	.485
	Mid-level managers	25	41.76			
	First-line managers	9	46.67			
	Non-managerial staff	16	40.25			
	Academicians	21	41.17			
Legal and Contractual Issues	Top-level managers	9	48.33	4	4.724	.317
	Mid-level managers	25	40.44			
	First-line managers	9	50.17			
	Non-managerial staff	16	36.44			
	Academicians	21	36.17			
Financial Issues	Top-level managers	9	39.89	4	3.517	.475
	Mid-level managers	25	42.94			
	First-line managers	9	50.17			
	Non-managerial staff	16	35.78			
	Academicians	21	37.31			
Quality Management	Top-level managers	9	32.83	4	3.026	.553
	Mid-level managers	25	41.44			
	First-line managers	9	34.28			
	Non-managerial staff	16	45.47			
	Academicians	21	41.55			
Contemporary Management Practices	Top-level managers	9	35.61	4	3.024	.554
	Mid-level managers	25	39.94			
	First-line managers	9	42.50			
	Non-managerial staff	16	47.50			
	Academicians	21	37.07			
HR and Organizational Behaviour	Top-level managers	9	36.39	4	2.698	.610
	Mid-level managers	25	41.08			
	First-line managers	9	49.72			
	Non-managerial staff	16	36.50			
	Academicians	21	40.67			
Professional Practice and Ethics	Top-level managers	9	39.28	4	1.732	.785
	Mid-level managers	25	43.12			
	First-line managers	9	36.00			
	Non-managerial staff	16	43.94			
	Academicians	21	37.21			
Information Technologies	Top-level managers	9	43.17	4	2.782	.595
	Mid-level managers	25	39.14			
	First-line managers	9	30.83			
	Non-managerial staff	16	41.22			
	Academicians	21	44.57			
Construction Technologies	Top-level managers	9	37.83	4	1.048	.902
	Mid-level managers	25	37.90			
	First-line managers	9	41.28			
	Non-managerial staff	16	44.21			
	Academicians	21	41.50			

manager does. There is a reasonable explanation behind this finding. For a first-line manager, the major concern is coordinating day-to-day operations. However, a top-level manager has a great financial responsibility that is directly associated with delays and cost overruns.

Other than time management subject, there is no significant difference among respondents' perceptions towards the following items: project and construction management ($H(4) = 5.483$, $p = .241$), decision making ($H(4) = 4.838$, $p = .304$), cost management ($H(4) = 7.825$, $p = .098$), risk management ($H(4) = 3.450$, $p = .485$), legal and contractual issues ($H(4) = 4.724$, $p = .317$), financial issues ($H(4) = 3.517$, $p = .475$), quality management ($H(4) = 3.026$, $p = .553$), contemporary management practices ($H(4) = 3.024$, $p = .554$), HR and organizational behavior ($H(4) = 2.698$, $p = .610$), professional practice and ethics ($H(4) = 1.732$, $p = .785$), information technologies ($H(4) = 2.782$, $p = .595$), and construction technologies ($H(4) = 1.048$, $p = .902$). In other words, Table 6 claims that each of the given knowledge areas is equally important for a construction manager regardless of being top-level or first-line.

6. Conclusion

Future of the CM profession immensely relies on how well the programs prepare their students for the ever-changing industry conditions, both in terms of theoretical knowledge and managerial skills. Numerous studies investigating the extent of CM knowledge and skills have shown the need for the CM curriculum to be aligned with industry requirements and expectations. In line with the dynamic nature of the AEC industry, CM programs also need to go through regular self-assessment processes and improve their teaching practices.

The present study was designed to determine the desirable key skills, competencies and core knowledge for well-trained and well-educated construction managers. The results of this study further support that identified skills and competencies are of great importance for a construction manag-

er to work efficiently in the industry. The essential skills and competencies -with complete agreement- are, communication, problem-solving & decision-making, leadership, professional ethics, analysis and research, critical thinking and creativity, construction management practices, and technology use. Although there exists some variability in the courses and curricula, construction management programs should ensure that they provide sufficient training and education on each skill and competency. This study has found that project and construction management, decision-making, and cost management are the most important knowledge areas with time management at the top.

The empirical results reported in this study should be considered in light of two major limitations. First, this study did not intend to develop a rigorous CM curriculum, yet it identified the desired skills, competencies and knowledge for professionals in the CM industry. Thus, the authors did not necessarily look for consensus among study respondents. Still, scholars and industry representatives might scrutinize the quantitative findings to refine the absolute must skills and knowledge of CM professionals. Further research is needed to evaluate the effectiveness of existing CM programs in developing those skills, competencies and knowledge. Second, even though the study adopted purposive sampling to reach out to the most relevant respondents of the subject, the representativeness was limited to the students and graduates of a single CM program. Future studies in this field should consider employing larger and more diverse samples of construction professionals, potentially from different regions, to enhance the generalizability and robustness of the findings. It is noteworthy to underscore that approximately half of the study respondents occupy non-managerial roles or are affiliated with academic institutions while they have attained or presently pursuing a graduate degree in the field of PCM. Nevertheless, their responses are in alignment with those of the remaining respondents and offer valuable insights into the future of the CM profession. The findings obtained in this study can guide CM graduate programs to design or re-structure their curricula to ensure that they equip their graduates with the most required knowledge and highly valued skills. This study is of great importance for individuals who are pursuing career development in the AEC industry as well. The findings support prospective construction managers seeking graduate education in the CM field while choosing a suitable program that provides advanced knowledge and promotes skills valued by the industry. Finally, companies seeking to distinguish themselves in the industry can benefit from the results of this study by recruiting graduates of programs that convey these skills and knowledge.

References

Ahmed, S. M., Yaris, C., Farooqui, R. U., & Saqib, M. (2014). Key attributes and skills for curriculum improvement for undergraduate construction management programs. *International Journal of Construction Education and Research, 10*(4), 240-254.

Akadiri O.P. (2011). *Development of a multi-criteria approach for the selection of sustainable materials for building projects* [Doctoral dissertation, University of Wolverhampton].

Aliu, J., & Aigbavboa, C. (2023). Key generic skills for employability of built environment graduates. *International Journal of Construction Management, 23*(3), 542-552.

American Council for Construction Education. (2021). Standards and criteria for the accreditation of construction education programs (Document 103). https://www.acce-hq.org/file-share/48e86a14-cae9-4775-9334-831c94b714f6

Arditi, D., & Polat, G. (2010). Graduate education in construction management. *Journal of Professional Issues in Engineering Education and Practice, 136*(3), 175-179.

Atalah, A., & Muchemedzi, R. (2006). Improving enrolment in the master of construction management program at Bowling Green State University. *Journal of Professional Issues in Engineering Education and Practice, 132*(4), 312-321.

Back, W. E., Macdonald, R., & Grau,

D. (2012). An organizational approach to leadership development for engineering and construction management project practitioners. *International Journal of Business, Humanities, and Technology, 2*(2), 121–131.

Benhart, B. L., & Shaurette, M. (2014). Establishing new graduate competencies: Purdue University's construction management curriculum restructuring. *International Journal of Construction Education and Research, 10*(1), 19-38.

Bhattacharjee, S., Ghosh, S., Young-Corbett, D. E., & Fiori, C. M. (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.

Carr, R. I. (1997). Engineering and construction management: Leadership and opportunity. *Journal of Construction Engineering and Management, 123*(3), 292-296.

Chartered Institute of Building. (2019). The education framework for master's degree programs. https://www.ciob.org/learning-providers/education-framework

Edum-Fotwe, F. T., & McCaffer, R. (2000). Developing project management competency: Perspectives from the construction industry. *International Journal of Project Management, 18,* 111-124.

Farooqui, R. U., & Ahmed, S. M. (2009). Key skills for graduating construction management students - A comparative study of industry and academic perspectives. In *Construction Research Congress 2009: Building a Sustainable Future* (pp. 1439-1448).

Harty, C., & Leiringer, R. (2017). The futures of construction management research. *Construction Management and Economics, 35*(7), 392-403.

Hsu, W.-L., Chen, Y.-S., Shiau, Y.-C., Liu, H.-L., & Chern, T.-Y. (2019). Curriculum design in construction engineering departments for colleges in Taiwan. *Education Sciences, 9*(1), 65.

Magano, J., Silva, C., Figueiredo, C., Vitoria, A., Nogueira, T., & Dinis, M. A. P. (2020). Generation Z: Fitting project management soft skills competencies - A mixed-method approach. *Education Sciences, 10*(7), 187.

Mason, J. (2018). *Qualitative researching* (3rd ed.). SAGE Publications.

Odusami, K. T. (2002). Perceptions of construction professionals concerning important skills of effective project leaders. *Journal of Management in Engineering, 18*(2), 61-67.

Pathuri, R. T., Killingsworth, J., & Mehany, M. S. H. M. (2022). Knowledge, skills, and abilities for senior-level construction managers: A US Industry-based Delphi study. *International Journal of Construction Education and Research, 18*(3), 234-250.

Pellicer Armiñana, E., Yepes Piqueras, V., & Ortega Llarena, A. J. (2013). Method for planning graduate programs in construction management. *Journal of Professional Issues in Engineering Education and Practice, 139*(1), 33-41.

Pietroforte, R., & Stefani, T. P. (2004). ASCE Journal of Construction Engineering and Management: Review of the years 1983–2000. *Journal of Construction Engineering and Management, 130*(3), 440-448.

Posillico, J. J., Edwards, D. J., Roberts, C., & Shelbourn, M. (2022). Curriculum development in the higher education literature: A synthesis focusing on construction management programmes. *Industry and Higher Education*, *36*(4), 456-470.

Posillico, J. J., Edwards, D. J., Roberts, C., & Shelbourn, M. (2023). A conceptual construction management curriculum model grounded in scientometric analysis. *Engineering, Construction and Architectural Management, 30*(9), 4143-4170.

Project Management Institute PMI. (2016). *Construction extension to the PMBOK guide.* Project Management Institute, Inc.

Project Management Institute PMI. (2017). *A guide to the project management body of knowledge (PMBOK Guide)* (6th ed.). Project Management Institute, Inc.

QS Top Universities. (2022, June 21). QS World University Rankings methodology: Using rankings to start your university search. QS Top Universities. https://www.topuniversities.com/qs-world-university-rankings/methodology

Robinson, O. C. (2014). Sampling in interview-based qualitative research: A theoretical and practical guide. *Qualitative Research in Psychology, 11*(1), 25-41.

Russell, J. S., Hanna, A., Bank, L. C., & Shapira, A. (2007). Education in construction engineering and management built on tradition: Blueprint for tomorrow. *Journal of Construction Engineering and Management, 133*(9), 661-668.

Slattery, D. K., & Sumner, M. R. (2011). Leadership characteristics of rising stars in construction project management. *International Journal of Construction Education and Research, 7*(3), 159–174.

Tatum, C. B. (1987). Balancing engineering and management in construction education. *Journal of Construction Engineering and Management, 113*(2), 264-272.

Teddlie, C., & Yu, F. (2007). Mixed methods sampling: A typology with examples. *Journal of Mixed Methods Research, 1*(1), 77-100.

Times Higher Education. (2020, August 24). THE World University Rankings 2021: methodology. Times Higher Education. https://www.timeshighereducation.com/world-university-rankings/world-university-rankings-2021-methodology

Vaz-Serra, P., & Mitcheltree, H. (2021). Understanding the key master of construction project management graduate competencies required to meet industry needs in Australia. I*nternational Journal of Construction Education and Research, 17*(3), 222-241.

Wu, P., Feng, Y., Pienaar, J., & Zhong, Y. (2015). Educational attainment and job requirements: Exploring the gaps for construction graduates in Australia from an industry point of view. *Journal of Professional Issues in Engineering Education and Practice, 141*(4), 06015001.