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EXPLORING KNOWLEDGE AREAS OFFERED IN PROJECT MANAGEMENT PROGRAMS IN CONSTRUCTION

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Abstract: Construction project management requires various knowledge, skills, techniques, and applications. Therefore, project management (PM) degree programs have to equip future project engineers and managers accordingly. However, literature has provided limited understanding about how extensive these knowledge areas (KAs) have been offered in these degree programs. The goal of this paper is to explore to what extent different KAs are taught in PM Master's degree programs with emphasis in the construction industry. A survey was conducted with respondents who were academic staff responsible for these programs. Most of these programs under the current study were at institutions located in the U.K. and the U.S.A. Six KAs that had high percentage (50% or more) of construction programs offering more than ten teaching hours were time management and risk management (65%), procurement management, sustainability, and legal and ethical aspects (55%), and cost management (50%). In terms of relative teaching priority within a program, time management, risk management, sustainability, and cost management were frequently the top focus in these programs. Project scope, quality, and stakeholder management had the least teaching priorities among the PM KAs. While relative teaching priorities of many KAs were anticipated, the lowest teaching hours and priorities of project scope and quality management, and occupational safety and health were not expected as they were identified as major competencies for construction graduates.

1 INTRODUCTION

Project management in construction requires a variety of knowledge, skills, techniques, and applications. Project management (PM) degree programs have therefore to account for those when preparing the next generation of project engineers and managers. Because construction project management has taken place in an ever-changing environment, the required knowledge has also evolved over time. Accordingly, PM educators have to constantly update curricula and knowledge areas (KAs) offered in their PM degree programs to respond to such change. The dynamic nature of the construction industry requires constant curriculum updates to meet the workforce demands (Ahmed et al., 2014; Azhar et al., 2014). Russell et al. (2007) urged that educators and those involved must integrate key concepts to improve students' critical thinking, understanding globalization, social awareness, and the use of information technology for future construction professionals to meet the needs of society.

The need for investigating how various KAs have been delivered in PM degree programs in construction is essential. However, literature has provided limited understanding how extensive these KAs were offered in these degree programs. The goal of this study is to explore to what extent different KAs were

taught in PM Master's degree programs with emphasis in construction. Consequently, this paper aims at (i) identifying the distribution of teaching hours for KAs in PM Master's programs in construction and (ii) comparing the relative teaching priority of these KAs within a program. It should be noted that different degree names of these Master's programs have been used by different institutions around the world. Examples include Master of Construction Management (CM), Master of Science in Construction PM, Master of Science in CM, and Master of Science in Civil Engineering with a major in PM. This study called these programs as PM Master's degree programs with emphasis in construction or Construction PM Program.

2 BACKGROUND

As more than one-fifth of the global economic activities have taken place as projects (Bredillet et al., 2013), PM skills are generally needed in all industries, including construction. To respond to this demand, educators have launched new PM programs (Berggren and Soderlund, 2008) and increased enrollments. The number of accredited PM degree programs have also increased worldwide. For instance, as of 2014, more than 90 PM and related degree programs have been accredited by the Project Management Institute (PMI)'s Global Accreditation Center for Project Management Education Programs (GAC) (GAC, 2014).

The evolution of PM education is a point of concern as the PM body of knowledge (PMBok) has been evolving from research and practice (Bredillet et al., 2013). In construction PM education Becker et al. (2011) urged that programs had a responsibility of anticipating the skills and competencies for effective future professionals and refining curriculums to best prepare students for the future work. Ahmed et al. (2014) identified desirable skills from today's CM graduates. The top five skills were knowledge of health and safety regulations, interpreting contract documents, listening ability / giving attention to details, knowledge of building codes and regulations, and time management. Therefore, construction PM programs have to deliver KAs that provide the necessary skills to their graduates.

Previous studies investigated what construction graduate programs offered to their students. Arditi (1984) found that in 1982, the most three popular subjects in 24 graduate programs in construction in the U.S.A. were (1) laws, contracts, and specifications, (2) planning and scheduling, and (3) operations research methods. Later, Arditi and Polat (2010) observed that the trends in course offerings in 1982, 1996, and 2008 seemed to have minimal change except for the number of courses in PM going up significantly while the number of courses in cost estimating going down. A study in 23 PM Master's degree programs with a construction emphasis worldwide showed that the average percentages of courses related PM, business management, leadership and human resources (HRs), and stakeholders' relationships and a developed environmental framework were 45%, 32%, 13%, and 11%, respectively (Yepes et al., 2012). In addition, the top three common subjects in these 23 programs were PM (14.4%), followed by contract management (10.8%), and project scheduling (10.5%) (Pellicer et al., 2013).

Table 1: PM and related knowledge areas investigated

PM knowledge areas	Related knowledge areas
Project integration management	Program / portfolio management
Project scope management	Legal and ethical aspects
Project cost management	Leadership
Project time management	Entrepreneurship
Project quality management	Intellectual property
Project human resource management	Occupational safety and health
Project communications management	Sustainability
Project procurement management	Computational tools / techniques
Project risk management	Decision sciences
Project stakeholder management	Others (specified by the respondent)

Although these studies identified courses and/or subjects taught in PM degree programs there is still a need to investigate to what extent different KAs have been delivered in these programs. The reason is

that there are potential overlaps if course or subject level is investigated. Arditi and Polat (2010) reported PM and cost estimating as two courses. However, cost estimating is an aspect within project cost management of the PMBoK. Similarly, PM and project scheduling were considered two separate subjects in Pellicer et al. (2013) while project scheduling is a subset of PM. This current study explored the PM degree programs at the KA level. Nineteen specific KAs and one “others” were investigated in this study (Table 1). The 19 KAs consisted of 10 from the PMBoK (PMI, 2013) and nine related KAs.

3 METHODOLOGY

This study used a questionnaire survey as a primary tool of data collection. Potential population were academic institutions worldwide that offered PM degree programs. The population was first stratified into regions, e.g., Africa and Middle East, America, Asia, Europe, and Oceania. Internet search engines and available publications (e.g., World University Rankings, PMI GAC) helped identify institutions and their websites. The authors accessed the websites and identified if a PM degree program(s) was offered in these institutions. If there was a PM degree program, one academic staff (typically program leader unless not specified in the websites) and his/her contact were identified and added to the list of potential respondents. Finally, the authors compiled 256 respondents in 256 PM degree programs from 233 institutions. These 256 programs consisted of Africa and Middle East (8), America (91), Asia (20), Europe (109), and Oceania (28). A questionnaire were developed and pilot-tested with a group of five respondents. Their comments and feedback helped refine KAs, redesign the questions and improve the questionnaire. The final version was significantly shorter than the questionnaire used for pilot testing. An online survey was then created based on the final questionnaire (in an electronic form). The online survey was emailed to these 256 potential respondents. The data collection took place in October 2014.

The survey had a question: “*In which industry (or sector) has the PM degree program you have selected mostly focused? (select all that apply).*” The possible responses consisted of: (1) none in particular; (2) business; (3) production; (4) engineering; (5) IS/IT, software, and communications; (6) construction; (7) government; and (8) other, please specify. For the theme of this conference, this paper presents our analysis from programs which focused on construction. That is, this paper focuses on responses that selected either “construction” (6) or both “engineering” (4) and “construction” (6) for the above question. Due to the nature of the data and a limited number of responses, this study mainly used descriptive statistics for data analysis.

4 ANALYSIS AND FINDINGS

4.1 Characteristics of Respondents and Surveyed Programs

The online questionnaire was emailed to 256 potential respondents working at institutions offering degree programs in PM or with emphasis in PM all over the world. These respondents were holding academic and/or administration positions in PM degree programs. The survey was opened on October 1 and closed on October 17, 2014. Sixty respondents from 60 institutions attempted to complete the survey. Fifty four (out of 60) fully responded to all questions in the survey and were valid for analysis. The valid response rate was 21%. Among these 54 programs, twenty were Master’s programs that focused on construction. This paper presents our analysis and findings of these twenty Master’s degree programs. Table 2 summarizes the characteristics of these twenty programs. Seven and six programs were from the U.S.A. and U.K., respectively. The other seven programs were from seven different countries or territories (Australia, China, Hong Kong, Spain, Switzerland, Trinidad, and Vietnam). Eleven programs (55%) were accredited by at least one third-party entity. Four programs (20%) were accredited by two or more agencies (e.g., RICS, CIOB, PMI GAC). Nine programs (45%) were not accredited or accredited internally (Table 2).

Seventy five percent (15 out of 20) of the respondents had at least ten years of experience in PM education. Thirty five percent (7 out of 20) of the respondents had more than 20 years of experience. Only one respondent (5%) had less than five years of experience in PM education. The respondents

holding program director, chair, leader, or coordinator were 55% (11 out of 20). The other 45% were holding a professorship or lectureship position.

Table 2: Characteristics of the PM Master's program with construction emphasis

Description	Frequency (Percent)
Program Delivery Method:	
On campus only	14 (70%)
Both on campus and online	6 (30%)
Accreditation*:	
American Council of Construction Education (ACCE)	2
Association for Project Management (APM)	1
Chartered Institute of Building (CIOB)	3
PMI Global Accreditation Center (GAC)	3
Royal Institution of Chartered Surveyors (RICS)	5
Internal or none	9
Number of Students Enrolled:	
Less than 50	11 (55%)
Between 50 - 100	5 (25%)
More than 100	4 (20%)

*A degree program could be accredited by more than one third-party entity.

4.2 Teaching Hours for PM and Other Knowledge Areas

A PM degree program in construction provided not only PM KAs but other KAs. Among the ten PM KAs, cost, time, and risk management tended to be taught the most. All of the surveyed programs taught these three KAs (Figure 1). Figure 1 shows that 65% of programs offered more than 10 teaching hours (11-20 hours to over 50 hours) for time management and risk management. Fifty percent of the programs delivered more than 10 hours for cost management. Time, cost, and risk management were taught more than 30 hours (31-40 hours to over 50 hours) in 45%, 30%, and 30% of programs, respectively.

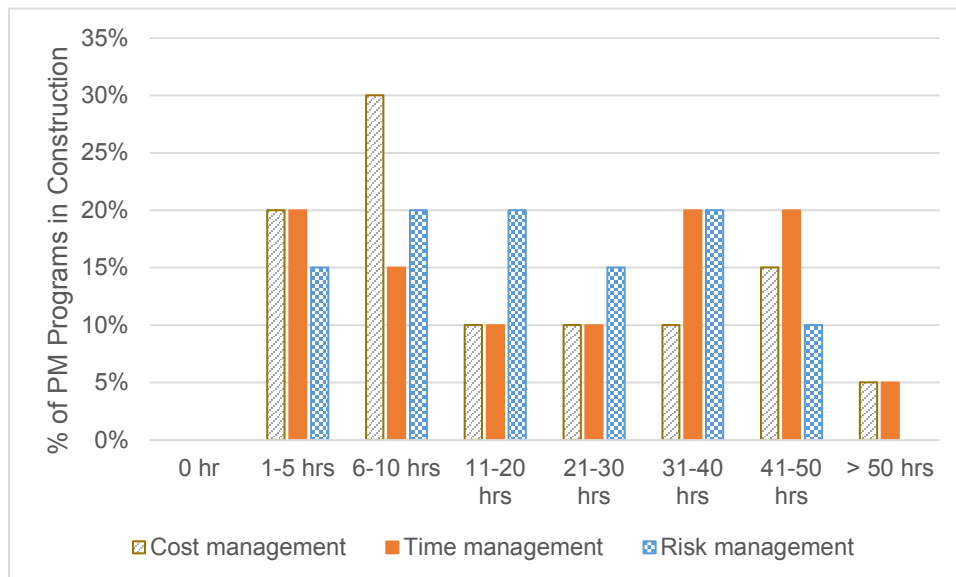


Figure 1: PM knowledge areas with high teaching hours

After risk, time, and cost management, four PM KAs, namely, integration, HR, communications, and procurement management, were taught in a considerable number of hours (Figure 2). Procurement management tended to be delivered between 6 hours and 30 hours (70% of programs). While 55% of

programs offered at least 11 hours for procurement management, only 10% offered 31 contact hours or more for this knowledge area. Communications management was prone to be offered in a range of one to 20 hours (70% of programs). Sixty percent taught HR and integration management in ten hours or less.

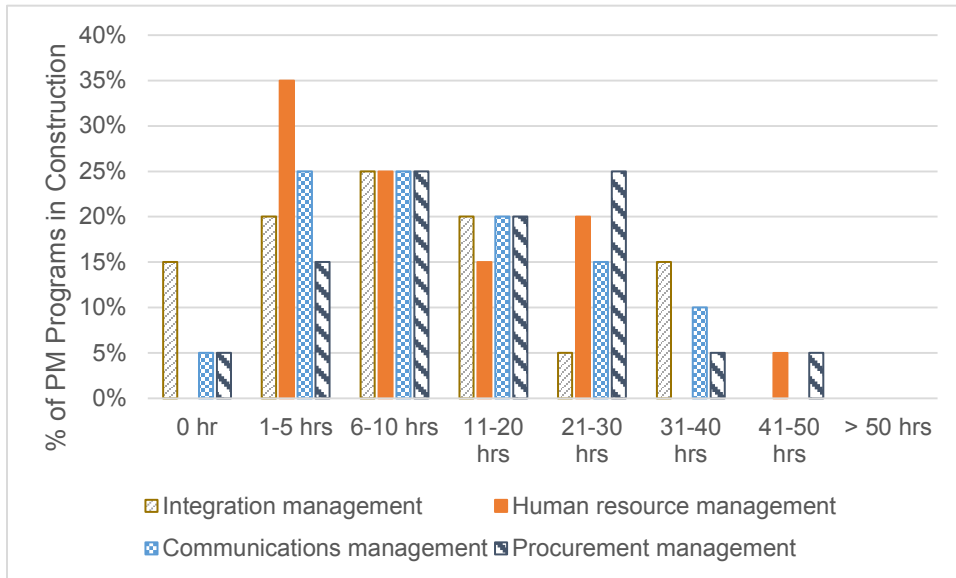


Figure 2: PM knowledge areas with medium teaching hours

PM degree programs in construction tended to offer least hours for scope, quality, and stakeholder management as the teaching-hour distributions skewed to the right (Figure 3). Project quality management and stakeholder management were taught less than 10 hours in 75% of the construction PM Master’s degree programs. Only 25% of programs taught quality and stakeholder management more than 10 hours. Scope management was taught less than 10 hours in 60% of these programs. No program taught scope and stakeholder management more than 40 hours.

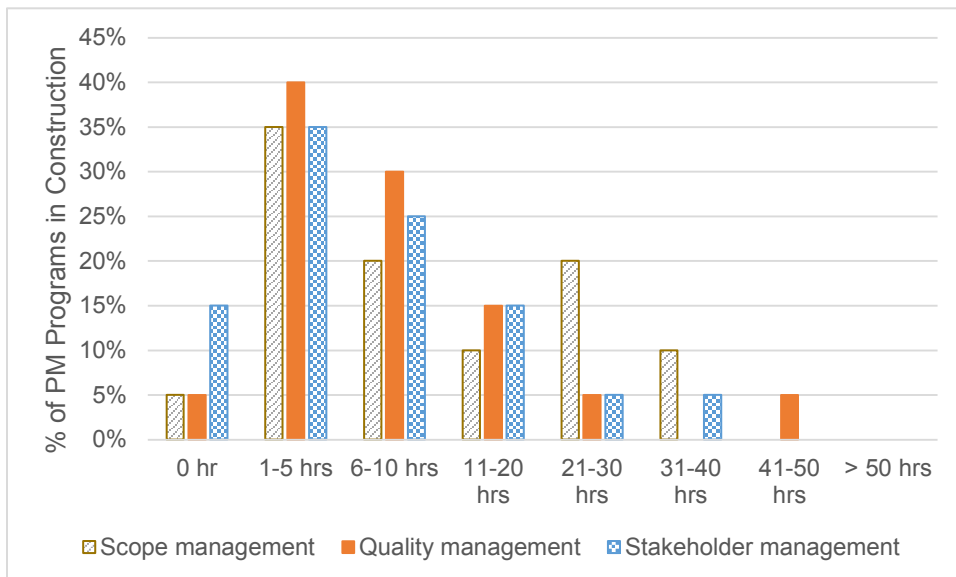


Figure 3: PM knowledge areas with low teaching hours

In addition to PM KAs, these programs also delivered other KAs. Figure 4 presents other KAs that had significant teaching hours. Sustainability and legal/ethical aspects each had more than 10 teaching hours

in 55% of programs. Computation tools/techniques had more than 10 teaching hours in 40% of programs. Sustainability were taught more than 30 hours in 30% of programs. The teaching hours of sustainability and legal/ethical aspects were comparable with such PM KAs with high teaching hours as project time, cost, and risk management.

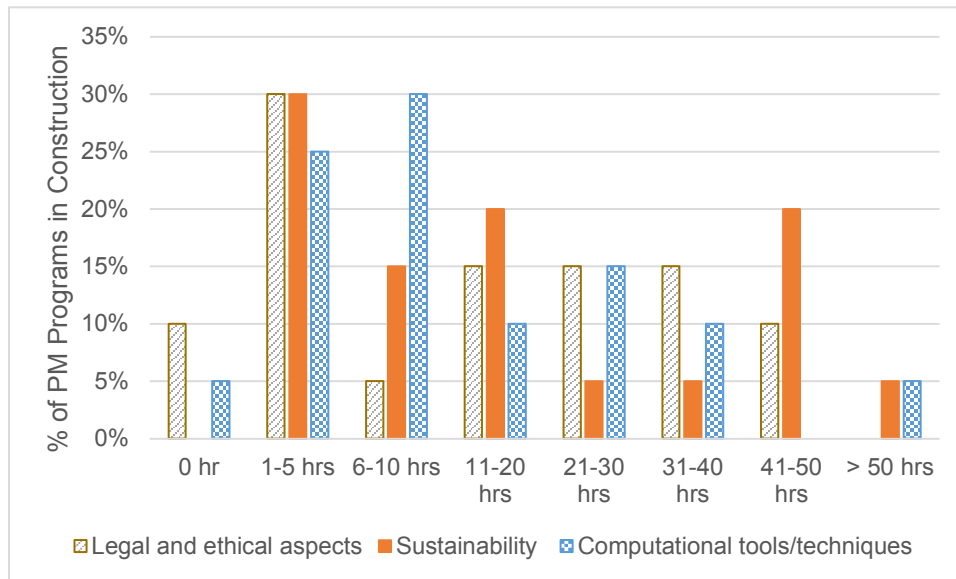


Figure 4: Other knowledge areas with significant teaching hours

4.3 Teaching Priority within a Construction PM Program

Teaching hours for each KA within a degree program depend on the length of this program. Therefore, the extent of the KAs taught should be analyzed not only between programs but also within programs. In other words, for a knowledge area, five teaching hours in this program and 10 teaching hours in another program should not only be compared each other but also be compared with the numbers of teaching hours for other KAs taught in that program. This study assigned a relative teaching priority for each knowledge area to compare its level of effort (in terms of teaching hours) to those of the other KAs within a degree program. Table 3 exemplifies the proposed teaching priority for analysis within a program. The highest priority (i.e., 1) was assigned to KAs that had the most teaching hours within that program. Because program A had 41-50 teaching hours for KA2 and KA6, both KA2 and KA6 had number one priority. Similarly, KA1 in program B also had number one relative priority. KA4 in program A had the next highest teaching hours and hence had priority 3 (after KA2 and KA6). If a program did not teach a certain KA, this KA had zero priority (e.g., KA3 in program A).

Table 3: Example of Assigning Relative Teaching Priority

	KA1	KA2	KA3	KA4	KA5	KA6
Program A	11-20 hrs	41-50 hrs	0 hr	21-30 hrs	1-5 hrs	41-50 hrs
<i>Assigned priority</i>	4	1	0	3	5	1
Program B	Over 50 hrs	1-5 hrs	31-40 hrs	21-30 hrs	6-10 hrs	41-50 hrs
<i>Assigned priority</i>	1	6	3	4	5	2

Within a program and among PM KAs, project time, risk, and cost management tended to be allocated more teaching hours while project quality, scope, and stakeholder management tended to be allocated less teaching hours (Figure 5). Fifty percent of programs had time management as the first teaching priority. Time and risk management was on the top five priority among nineteen KAs in 70% of programs while cost management and procurement management was on the top five priority in 55% and 50% of

programs, respectively. Project HR, integration, and communications management tended to have similar priority. They were in the top five priority between 35% (communications) and 40% (HR and integration) of programs. Surprisingly, quality management was never the first priority in these programs. Project scope, quality, and stakeholder management was in the top five priority in terms of teaching hours in only 25% of programs.

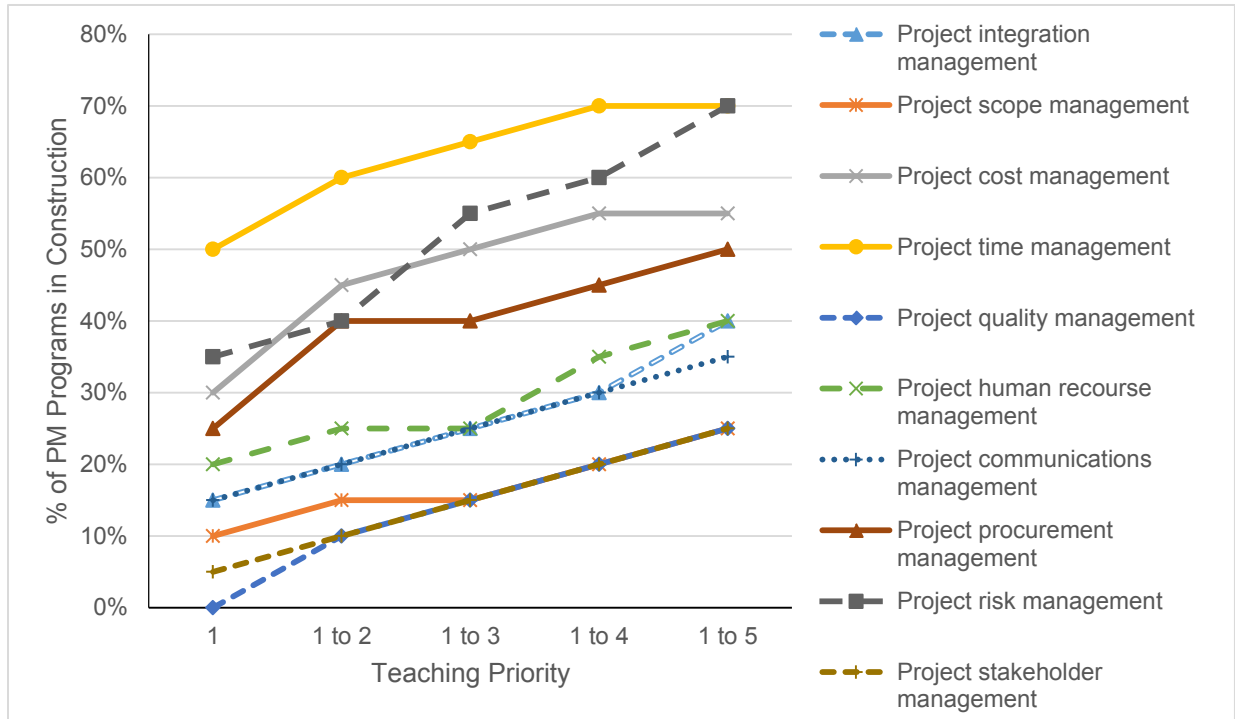


Figure 5: PM knowledge areas with teaching priority within a construction PM program

For other nine KAs, sustainability and legal/ethical aspects were on the top five priority among PM and non-PM KAs in 50% of programs (Figure 6). Similar to project risk management, sustainability had the first teaching priority in 30% of programs, only after project time management. Although computational tools/techniques was usually not the first priority (only 10% of programs), it was in the first five priorities in 45% of programs. Leadership and decision sciences was on the top five priorities in 35% and 30%, respectively, of programs. It was not surprising that entrepreneurship and intellectual property did not have high teaching priority in construction PM Master's programs. Program/portfolio management was still not focused in these programs. Occupational safety and health had also low priority when it was on the top five priority in 15% of programs.

4.4 Discussion

The analyses showed that project time, risk, and cost management, sustainability, and legal and ethical aspects were the five KAs usually having highest teaching hours in PM Master's degree program with construction emphasis. They also tended to have the highest teaching priority within a program. Time, cost, and risk management were undoubtedly the essential PM KAs. Legal / ethical aspects having high teaching hours and priority within a program was not a surprise. Many previous studies emphasized the need of legal aspects in construction programs (Householder, 1987; Shahbodaghlou and Rebolz, 1990; Mead and Gehrig, 1995). In fact, contract administration/legal issues was consistently ranked first in terms of percent of programs offered this course category over the past 30 years in the U.S.A. (Arditi, 1984; Arditi and Polat, 2010). In the U.K construction law was also considered as an important subject in construction programs. (Mihara et al., 2014).

The PM degree programs in construction increasingly focused on offering sustainability to their potential students. The sustainability knowledge area seemed not to appear in the 1982, 1996, and 2008 surveys of graduate programs in construction management (Arditi and Polat, 2010). A decade ago, only a few number of programs (members of the Associated School of Construction) offered sustainability-related courses (Tinker and Burt, 2004). However, the integration of the sustainability body of knowledge in construction curricula has been observed in recent years (Wang, 2009; Sullivan and Walters, 2013). Iyer-Raniga et al. (2010) stated that future construction graduates would be in a working environment where sustainability would be incorporated at the core level of their practice. Therefore, programs in CM progressively concentrated on environmental responsibility because of increased regulations and increasing opportunities for practicing sustainability knowledge upon graduation (Celik et al., 2014).

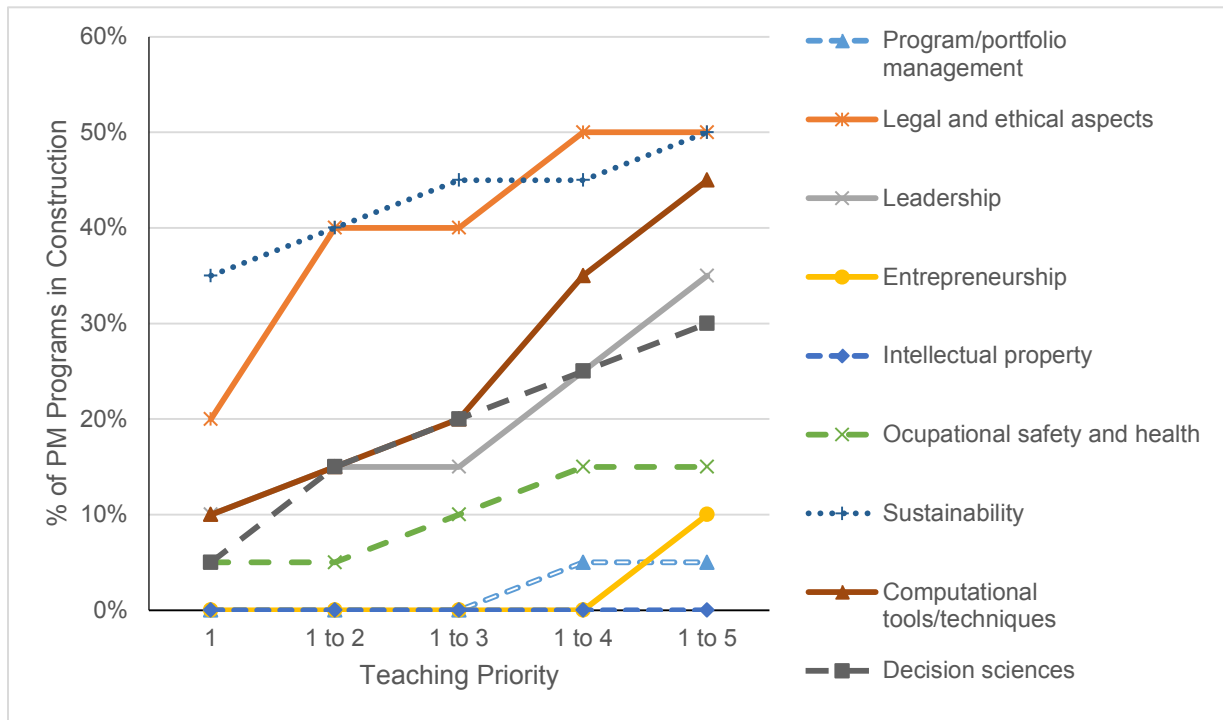


Figure 6: Other knowledge areas with teaching priority within a construction PM program

The fact that project scope and quality management, and occupational safety and health had the lowest teaching hours and lowest teaching priorities was a surprise. Scope management and quality management have been considered as critical KAs in construction project management. In fact, they are considered as primary project and project management objectives. Considering scope as important as budget and schedule, Oberlender (2000) observed that *“the source of many problems associated with a project is failure to properly define the project scope.”* Mincks (2008) argued that quality management was an essential knowledge for individuals involved in CM and had to be addressed in construction education. Finally, knowledge of health and safety regulations was the top skill desired by the industry from graduating CM students (Ahmed et al., 2014).

4.5 Limitations

This study has a few limitations. The findings were drawn from a small number of programs and responses. The small number of responses also limited the use of statistical analysis, i.e., inferential statistics. Although the authors endeavored to identify as many PM degree programs as possible, the research samples (256 PM degree programs) were programs that had information on the Internet (e.g., program websites), especially information provided in English.

5 CONCLUSIONS

This paper investigated KAs taught in 20 Master's PM degree programs around the world (U.S.A. [7], U.K. [6], Australia [1], China [1], Hong Kong [1], Spain [1], Switzerland [1], Trinidad [1], and Vietnam [1]) with emphasis in construction. Nineteen specific KAs, including 10 PM and nine related KAs, were explored in these programs. Six KAs that had high percentage (50% or more) of the programs offering more than ten teaching hours were time management, risk management, procurement management, sustainability, legal and ethical aspects, and cost management. The four PM KAs including project integration, human resource, communications, and procurement management followed these six KAs in teaching hours. In terms of relative teaching priority within a program, time management, risk management, sustainability, and cost management were frequently the top focus in these programs. Project scope, quality, and stakeholder management had the least teaching priorities among the PM KAs. While relative teaching priorities of many KAs were anticipated, the lowest teaching hours and priorities of project scope and quality management, and occupational safety and health were a surprise because they were identified as major competencies for construction graduates. Construction educators may use these findings when reviewing, refining, and updating their PM degree programs.

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