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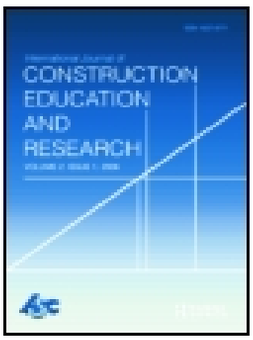

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Understanding the Key Master of Construction Project Management Graduate Competencies Required to Meet Industry Needs in Australia

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ABSTRACT

Within Australia, the construction industry is one of the largest contributors to the Australian national economy. Yet despite the economic significance of the sector, and the need for graduates of Master's level programmes entering the construction industry to have the skill sets and competencies required to meet industry requirements, there has been little research to date that examines the graduate competencies required to meet construction industry needs. This article examines the preliminary results from a structured survey aimed at identifying important Master of Construction Project Management graduate competencies from the perspective of key personnel in recruitment and senior managerial roles within the construction industry. From the data, it was found that within the construction industry, greater significance is placed on interpersonal skills, and competencies defined as traditionally fitting within core technical knowledge, than on business and research skills, knowledge of environmental waste management systems, and sustainability and life cycle analysis. The results highlight a need for further research examining why the industry values certain skill sets over others, and whether the skills and competencies valued when hiring graduates of Master of Construction Project Management programmes varies depending on the scale of the company and the organization's construction sector focus.

KEYWORDS

Construction management; competencies; industry needs; skills; education

Introduction

Within Australia the construction industry is one of the largest contributors to the Australian national economy, employing approximately 9.4% of the total national workforce, and accounting for over 8% of Australian gross value added (GVA) between 2016–2017 (Australian Bureau of Statistics, 2017). These figures are in-line with the long-term trend observed within the Australian economic data by industry, and over the last couple of decades, the construction industry, in conjunction with the mining and financial and insurance services sectors, have accounted for the largest share of the overall Australian economy. This parallels what is observed globally, with the construction industry accounting for 6% of global GDP (Australian Bureau of Statistics, 2017). Furthermore, the employment and economic impact figures for the Australian construction industry are predicted to increase, with projected growth within the industry listed by

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the Labor Market Information Portal of the Department of Jobs and Small Business projected as 118,800 (a 10.0 percent increase) new jobs between 2018 and 2023 (Labour Market Information Portal, 2018).

Research in this field has identified a positive relationship between the success of construction projects, company economic success, strategic management practices and applied management skills (Rezvani et al., 2016). Whilst there is an extensive body of knowledge that relates to desirable skill sets and attributes of successful project managers, it should be noted that such attributes do not directly translate to the role of construction project manager. The roles of 'project manager' and 'construction project manager' need to be understood as two distinct professions. The role of project manager is focused on the whole project and does not require specific technical construction knowledge. However, the role of the construction project manager requires, (i) interpersonal skills such as leading, communicating, negotiating and problem-solving within the construction industry, and (ii) specific technical expertise in construction across the entire project – from design development to project close (Gao, Vaz-Serra, & Gardiner, 2017). Construction project managers need to be able to manage risk, maintain sensitivity and responsiveness to environmental and community concerns, as well as manage cultural differences, and national and international rules and codes (PMI, 2016). The construction extension to the Project Management Institute's PMBOK Guide also introduces several unique knowledge areas for construction industries worldwide – namely, Project Health, Safety, Security, and Environmental (HSSE) Management; and Project Financial Management (planning and performance) (Project Management Institute, 2013).

Due to the dynamic nature of the construction industry, innovations, trends, and changes within the industry need to be monitored and studied constantly to provide a well-defined scope for education in tertiary educational institutions, and to ensure that graduates are equipped to meet changing industry processes and needs. Whilst the research in relation to construction project management skills is diverse in terms of contexts, taxonomy, and timeframe, there is little overarching research that examines the broader complexity of project management skills and competencies within the context of the Australian construction industry, and how they support the employability and workplace readiness of Master of Construction Project Management graduates entering the construction industry.

This article examines the preliminary results from a structured survey aimed at identifying important Master of Construction Management graduate competencies from the perspective of key personnel in recruitment and senior managerial roles within the construction industry in Australia. The survey identifies the key skills and competencies currently valued by the industry when recruiting construction management graduates of Master's level programmes, and highlights current industry expectations within Australia in relation to the skill sets needed for successful construction project management.

Literature review

As part of this research project, a systematic literature review of academic journals was conducted to develop a comprehensive understanding of key graduate skills and competencies currently identified within peer reviewed literature. The articles examined were categorized into three core themes; education, project managerial competencies, and employment. Additionally, a database of construction project managerial competencies,

gathered from the reviewed studies, was analyzed, grouping the results into overarching thematic categories.

To facilitate the systematic literature review of relevant literature pertaining to project management skills and competencies, different keyword search-string macros were tested to find those which proffered appropriate search results, without excluding relevant targeted knowledge. So as to limit the results to the most relevant and up-to-date research items, the search was further narrowed to peer reviewed articles published in the last 15 years (2002–2017) within construction and project management journals (including 'construction education' journals). Research by Artto, Gemuenden, Walker, and Peippo-Lavikka (2017) highlights the need for sector specific analysis of the different streams of project management so as to develop a more nuanced, industry specific knowledge base. In-line with Artto et al. (2017), the search results were further refined to focus primarily on construction project management. Given the highly dynamic nature of the industry, and the impact that economic changes and technological advances can have on management practices and processes, a period of fifteen years was considered a sufficient timeframe so as to avoid outdated approaches and research articles.

In total the search-string macros generated 383 documents. A one-by-one screening of all the documents' titles and abstracts was conducted to generate a final selection of eligible documents. The inclusion criteria involved: (1) evident connection to the construction industry (excluding IT and other fields), (2) content relating to the competencies and skills of construction project managers (excluding industry-related and organizational-business-based competencies), and (3) education and training reviews of construction/project management. Based on the selection criteria, 53 documents were deemed to be relevant and selected for review. After the analysis of those 53 documents 18 were considered as directly relevant due to their clear identification of construction project management skills and competencies. Several additional relevant articles were also identified through on-line searches and flow-on identification from the articles examined in the initial document searches. The skills and competencies identified through the literature searches were fundamental to and formed the basis of the subsequent development of the research questionnaire.

Some additional care was taken in relation to the search review terminology used in connection to construction project management. Within the construction industry and literature, the term project manager, is often used to refer to construction project managers. This variation in terminology in which the construction specific nature of the role is assumed and seen as implicit, ignores the fact that the term 'project management' is utilized across a range of other sectors that have nothing to do with construction activities and construction specific management needs. Utilizing a definition of competency as a characteristic or trait that is seen to be necessary for successful performance of a task (Dubois, Rothwell, Stern, & Kemp, 2004), the skills and competences relevant to the scope of this research were extracted from the literature assessed within this review (an assessment of the minimum requirements for each skill/competency is beyond the scope of this papers and will address in another paper).

While the need to structure academic courses in line with industry expectations is widely acknowledged, a practical concept or definition that acknowledges the multi-dimensional nature of employability, and the key factors in determining levels of graduate employability, remains elusive. A recent study conducted by Naveed, Thaheem, Khurshid,

and Farooqui (2017) identified that regular evaluation of industry needs and graduate programmes is one of the most important factors in reducing the gap between industrial needs and academic offerings. This is supported by work by Moore and Plugge (2008), which highlights the benefits of relationships between industry and academia to provide internship opportunities for students. In recent years, a range of studies have examined models for criteria selection of construction project managers (Afshari, 2015); academic performance benchmarks for construction management students (Elliott, Thevenin, & Bigelow, 2017) employability, industry expectations, and graduate competencies (Love, Haynes, & Irani, 2001); the perception of the value of skills gained through student participation in construction management student competitions (Bigelow, Glick, & Aragon, 2013); and the value of spatial visualization skills and the role that pedagogy and 3D visualization models, exercises, and software can play in acquiring these skills (Glick, Porter, & Smith, 2012; Russell, 2014). However, many of these studies focus on skills and graduate employability within non-allied industries, rather than those specific to the construction management industry, and fewer still focus on the needs of the Australian construction industry. Whilst research such as that by Arrowsmith, Bagoly-Simó, Finchum, Oda, and Pawson (2011), which defines a graduate's employment capability as the sum of their subject knowledge, technical competencies, and personal attributes, may be useful in defining generic graduate employment attributes, it does little to shed light on the employment needs and skill sets required for successful employment within the construction industry, nor requirements specific to the Australian construction industry context.

The importance of interpersonal skills to successful project outcomes appears as a common theme amongst much of the literature in relation to project management recruitment and skills (Ahsan, Ho, & Khan, 2013; Love et al., 2001). However, whilst such research points to the importance of a well-trained and experienced project manager to successful project outcomes, it does little to bridge current knowledge gaps in relation to what constitutes 'well trained'. And whilst research such as that by Ahadzie, Proverbs, and Olomolaiye (2008), makes inroads into developing competency-based measures for construction project managers based on contextual-task frameworks, there is very little research examining the key competencies required to prepare Master of Construction Project Management graduates for the workforce. Furthermore, there is little to no research, specifically outlining the Master of Construction Project Management graduate skills and competencies most sought after amongst prospective employers within the Australian construction industry. This research makes inroads into bridging that knowledge gap, and examines the key skills and competencies currently valued by large non-residential construction companies (that is, companies undertaking National Construction Code (NCC) Class 2–9 commercial construction, not Class 1 domestic construction) within Australia when recruiting construction project management graduates.

Several recent studies specific to construction project management are those of Olawale (2015), Omar and Fayek (2016), Ahmed, Yaris, Farooqui, and Saqib (2014), Torres-Machí, Carrión, Yepes, and Pellicer (2013), Teixeira et al. (2006), Bhattacharjee, Ghosh, Young-Corbett, and Fiori (2013), and Benhart and Shaurette (2014). Olawale's (2015) study identified 14 leading skills and competencies for construction project management graduates. Among all the skills identified, teamwork was the most sought-after skill amongst prospective employers, followed by verbal and written communication, leadership, and

flexibility. However, in the study by Ahmed et al. (2014), whilst some importance was placed on time management and interpersonal skills (listening ability/attention to detail), it was found that the most sought after skills valued when hiring graduate project managers were those relating to core technical knowledge competencies; namely, knowledge of the building codes and regulations, ability to interpret contract documents, and knowledge of occupational health and safety regulations.

The research by Benhart and Shaurette (2014), focused primarily on the process by which industry input was obtained for use in curriculum review and restructuring. Benhart and Shaurette (2014) list the need for improved 'soft skills' as a common theme during the focus groups conducted as part of their research. In line with similar research within this field, the top ranked competencies by industry participants related primarily to core industry knowledge and communication skills (Benhart & Shaurette, 2014). The study by Omar and Fayek (2016) ranked construction project competencies (both functional and behavioral) in relation to the order of the significance of their impact on project performance. Whilst not focused specifically on desirable graduate attributes, nor on construction project manager competencies, it does none-the-less provide an interesting insight into the relationship between organizational competencies and select project performance measures. A further study by Russell, Cho, and Cylwik (2014), whilst related specifically to construction engineering and management (CEM) education, has identified the importance of knowledge of BIM as having a significant impact on a student's employability and future career opportunities.

The work of Bhattacharjee et al. (2013) aimed to identify and compare the differences between the perceptions of construction students and expectations of employers within the industry in terms of the skills and knowledge needed to be successful and work efficiently within the construction industry. Focusing on students at two US Universities (in the Mid-West and Mid-Atlantic region), and firms that either regularly recruited students from the Universities surveyed or were on the respective Universities' Industry Advisory Boards, questionnaires were completed by 58 firms and 85 students. Bhattacharjee et al. (2013) found that the top five knowledge areas valued by industry were the ability to interpret construction documentation, quantity take-off, knowledge of OSHA regulations related to construction, identification of project activities and their relationships, and quality control. And the top five skills/personal traits valued by industry were trust and honesty, problem solving, teamwork, critical thinking, and adaptability to change. Whilst there was some degree of overlap in the top five skills and knowledge areas identified by students and prospective employers, industry respondents placed a higher value on knowledge of OSHA regulations (health and safety), and quantity take-off, and on skills relating to trust and honesty, and critical thinking than the students surveyed.

The work of Torres-Machí et al. (2013) examined graduate students' in Construction Management perceptions of knowledge gaps in their training that may impact on their employability. This survey found that students identified communication skills (including knowledge of foreign languages), a preference for job security, and an unwillingness to move countries in search for work as potential barriers to employability. Whilst this study does not link the students' self-assessments to industry needs when hiring graduates, it is interesting to note that in line with other research in this field, communication skills are highlighted as a factor potentially impacting on employability.

Conducted with 293 organizations across four European countries (Portugal, Spain, Poland and Lithuania), the survey by Teixeira et al. (2006) focused on the continuing professional development and the training needs of professionals within the construction industry. From the survey results, it was found that amongst the organizations surveyed project cost estimation and management, planning and scheduling, quality management, project feasibility, and procurement and tendering procedures were the top five most relevant areas of CPD for project managers. In viewing these results, it should be noted that the research was specific to CPD course areas rather than skill sets and competencies selected for when recruiting graduates.

Of interesting note is also work by Gunderson and Gloeckner (2011) which focused on superintendent competencies and attributes required for construction project success. Conducted in the USA, Gunderson and Gloeckner's work identified 42 superintendent competencies, and compared the perceptions of skills required for success among different stake holders within the construction industry. Similar to the work of (Olawale, 2015), results highlight the perceived importance of communication and people skills as key requirements for success for superintendents working within the construction industry.

Whilst these studies have started to make inroads into bridging the current knowledge gap, the small sample size in the case of Olawale's research (n = 11), and the very specific target sample populations for each of these studies, make it difficult to draw broader inferences about the key construction project management graduate attributes required to meet industry needs. Whilst there may be parallels in the requirements and desirable attributes and skills for employment across different industries, it is important to establish a greater understanding of those skills and employment requirements specific to construction project management. Furthermore, it is important to develop an understanding of the requirements across a range of geographical regions. Whilst there may be similarities in the key construction project management competencies desired by industry across different geographic locations, there may also be differences in the requirements by region due to local variations in construction practices, regulatory compliance, and project mix.

Methodology

This study focuses on the key competencies most valued by large contracting companies when hiring Master of Construction Project Management graduates. Whilst it is intended that future iterations of this research will be expanded to examine a broader cross section of the range of construction companies in operation in Australia, given the scale and complexity of construction projects undertaken by the larger contractors, it was decided by the research team that the needs of this sector of the construction industry would best represent the full complexity of graduate competencies required to meet the broader spectrum of industry needs across more complex project structuring. Furthermore, the top 100 largest construction companies in Australia are among the largest employers of construction project managers within the sector and have mature systems related to the recruitment and retention of graduates.

The aim of this research project is to obtain a more in-depth understand of the key Master of Construction Project Management graduate competencies and skills required to meet construction industry needs within large contracting companies in Australia working across a spectrum of complex projects from commercial to retail projects. Based on

preliminary survey results, this paper examines industry perceptions of the core Master's level graduate competencies and knowledge areas required within the construction project management industry.

In order to develop the questionnaire, a roadmap was prepared to identify the main Master of Construction Project Management graduate skills and competencies highlighted over the last 15 years within academic research. These skills and competencies were examined in conjunction with the subjects offered within graduate construction project management degree programs within Australian Universities.

After the analysis and identification within the literature of the main competencies for construction project managers, the competencies were grouped into five overarching thematic categories: (i) construction knowledge -this domain is inclusive of knowledge of areas such as materials, construction methods, scheduling, site management, and supply chain; (ii) environment, culture and digital – this domain is inclusive of knowledge of areas such as lean management, digital strategy, Building Information Modeling (BIM), sustainability, and waste management; (iii) management and communication -this domain is inclusive of knowledge of areas such as project management, quality management, team management, and negotiation; (iv) financial and legal -this domain is inclusive of knowledge of areas such as risk, cost planning, construction law, contract administration, and corporate business; (v) and personal attributes -this domain is inclusive of knowledge of areas such as professional development, emotional intelligence, resilience, persistence, initiative and similar attributes (see Table 1).

In addition to the literature review, a desktop study was conducted of a broad cross-section of the Universities within Australia that offer postgraduate construction management programmes, so as to determine the graduate competencies listed under each programme. The entry requirements or pathways are generally consistent across all of the courses, with two key pathways – a Bachelor degree in a related field, or a bachelor

Table 1. Cronbach's alpha analysis.

Inquiry	Cronbach's alpha all	Analysis of correlations Objective: all correlations >+0.2	Cronbach's alpha adjusted
20 Construction Knowledge	0.850	Industry experience is separate	0.870
21 Management and Communication	0.808	Communication (written/verbal/pres) and Quality Management systems are separate	0.863
22 Financial and Legal	0.880	All ok	0.880
23 Environment, Culture and Digital	0.816	Cultural awareness is separate	0.841
24 Personal Attributes	0.585	'Other' question is separate	0.848
29 Skills	0.504	All questions are separate, with technical skills being the most different to the others (but all are essentially different)	n/a
30 Construction and Building Environment	0.853	Methods is separate	0.854
31 Management and Communication	0.730	Project Management Theory is separate	0.732
32 Financial and Legal	0.800	All ok	0.800
33 Environment and Culture	0.890	All ok	0.890
34 Digital Technology	0.920	All ok	0.920
35 Research Projects and Industry	0.679	Industry Placement and Internship questions are separate to the other questions	0.812

degree and relevant industry experience. All courses allow some degree of choice and specialization within their subject offerings, while also specifying required or mandatory core subjects. Study in the following two key areas are understandably core requirements: Construction, and Project Management. Electives in the other key areas of construction management are offered across all courses, in particular with the following categories or topics: Procurement; Cost Management; Risk Management; Environment or Sustainability; and Construction Law. On average the curriculum of the course is divided by topics or categories following the percentages: 17% for Construction and Building Environment; 19% for Management and Communication; 36% for Financial and Legal; 15% for Environment, Culture and Digital (4% in Digital like Building Information Modeling); 13% for Research Projects and Industry. Paradoxically, none of the courses appeared to have subjects specifically geared toward developing personal competencies. Emerging subjects, such as the application of digital technology, informatics, and knowledge management, are available as electives in some courses, but not commonly across the group within Australia.

Professional recognition was also covered to some extent, and is done in Australia by the Australian Institute of Building (AIB), which requires as part of their course accreditation demonstration that the discipline provides advanced cognitive, technical and communication skills, and the ability to apply methods and technologies in construction and construction management (AIB, 2018). It should be noted that although the AIB accreditation is for construction and construction management, the focus of this research is exclusively on construction project management competencies and skills.

Utilizing the competencies extracted from the desktop study, in conjunction with data gathered from the systematic literature review, a comprehensive list of 34 competencies was developed as part of this research project. These competencies then formed the basis for the questionnaire. In addition, as part of the questionnaire development process, a preliminary pilot survey was distributed to a small sample of academics and construction project management industry professionals for completion and review. On the basis of the pilot survey feedback and review, minor changes to the questionnaire wording and structure were made prior to the distribution of the final questionnaire.

The final questionnaire was structured into six sections. The first three sections introduced the project and involved questions related to respondent demographics and company profile data. In compliance with the University ethics requirements, the first section outlined the project aims and tasks, and the individuals and organizations involved in the research. Sections two and three consisted of questions related to respondents' background demographic data, such as age, gender, years within the industry and education background; and company profile data such as annual revenue, number of employees, the number of years in operation, construction sector focus, and whether or not the organization provided in-house graduate training.

The second half of the questionnaire focused on industry perceptions across a range of knowledge domains, skills, and graduate attributes. Utilizing a series of multiple choice and 5-point Likert-type scale questions, the questions examined general expectations within the industry in relation to graduate competencies and skills, as well as the priority placed by the industry on a range of course subject areas in relation to enhancing the employability of graduates of Master of Construction Project Management programmes.

Section four examined the degree to which different areas of knowledge are important for each company when recruiting a construction project management graduate. In line with the data gathered from the desktop study and literature review, the knowledge areas examined within this section were structured into five overarching knowledge domains: construction knowledge; management and communication; financial and legal; environment, culture and digital; and, personal attributes (Oliveros & Vaz-Serra, 2018). Each of these knowledge domains was further broken down into subsidiary skills and attributes, with 34 different competencies examined in total, and utilizing a Likert-type scale, respondents were asked to rank the importance of each of the attributes from 5 (very important) to 1 (unimportant).

In order to identify industry perceptions of the key curriculum content for academic programmes for construction project management, section five asked respondents to rate select knowledge domains and course subject areas. This section consisted of a range of questions from multiple choice questions about course duration, content focus and delivery mechanisms, to Likert-type scale questions that examined the importance of a range of different topic areas (n = 36) for inclusion in a Master of Construction Management course, and the most important skills to include in academic curricula for a Master's, or similar level, in construction management. So as to be able to conduct comparative analysis across the different sections within the questionnaire, similar to the structuring in section 4, topics were grouped under 5 key overarching knowledge domains: construction and building environment; digital technology; management and communication; environment and culture; financial and legal; and research projects and industry placement.

The final section, section six, was a more general open-ended section so as to provide space for open-ended feedback about construction management programmes, additional comments, and feedback about the survey process.

The survey sample pool was derived from the HIA-CoreLogic Construction 100 2016/2017 list (HIA, 2017). The HIA-CoreLogic report contains a listing of the 100 largest nonresidential construction companies within Australia. In defining the target study sample, construction companies that focused exclusively on civil engineering works were excluded from the potential survey sample pool, as were those dealing exclusively in smaller scale construction (such as small scale domestic construction) that does not typically require a construction project manager. As the focus of the research was on industry perceptions of the most sought-after graduate competencies for construction project managers within the construction industry, it was felt that companies that focus exclusively on civil engineering works and engineering management did not offer the complexity and breadth of services and as such were outside of the scope of this research.

Within the Australian construction industry context, construction project managers are predominantly employed by registered Commercial builders. Due to the restrictions on the scale and class of project that different registration types enable a firm to take on, within Australia registered Commercial builders are responsible for the management and construction of buildings and structures classified under the National Construction Code (NCC) as class 2–9 buildings and structures, and class 10b buildings that are not associated with domestic structures (Victorian Building Authority, 2019). As such, whilst a registered commercial builder may work on mid-to-high rise multi-residential developments (classified in Australia as 'commercial construction'), they do not manage or carry out building works on structures classed within the NCC as domestic buildings, even

though these are residential buildings. As such, only non-domestic construction companies were approached to take part in the survey, and from the original 100 companies listed in the HIA-CoreLogic report listings, in total 80 companies were deemed to be eligible (due to the nature of their construction project focus, scope and scale of works) for inclusion within the survey sample.

During the first two months, contact was made by phone with each of the companies to identify key personnel (HR managers, and senior construction managers) actively involved in the graduate recruitment process within each organization. After identification of the name and e-mail address of the most suitable contact within each organization, an e-mail was sent with an accompanying letter explaining the research project, and an invitation to participate in the survey. Conducted at the beginning of 2018, the survey was open for a duration of three months.

Findings

Of the 80 companies contacted, 9 declined to participate, and questionnaires were distributed via e-mail to the remaining 71 companies. Of the 71 companies sent questionnaires, 24 fully completed questionnaires were returned within the timeframe allocated for the survey. Whilst most respondents (45.8%) had been at their current company for less than 5 years, the majority of respondents had significant experience within the construction industry, with 58.4% having worked within the industry for over 16 years. The difference between time at their current company relative to time within the industry is indicative of the dynamic nature of the construction industry and the highly mobile nature of employment patterns and work flux due to project specific employment.

In order to determine how best to analyze the survey instrument, Cronbach's Alpha was used to determine the coefficient of reliability (consistency) of the survey responses. The survey was broken into a number of separate inquiries and utilizing Minitab 17, Cronbach's alpha calculated to determine how consistent the question responses are within each of the separate inquiries. The table below (see Table 1) summarizes the results.

Cronbach's alpha is an indicator of consistency in the sentiment underpinning how respondents have answered what have been grouped as a priori similar questions. One of the benefits of the Cronbach's Alpha analysis is that it enabled the research team to determine which individual questions behave consistently and, by deduction, which questions should be considered separately due to their lack of correlation with other questions within the same domain (these questions being denoted by * in Tables 2–6) (Ercan, Yazici, Sigirli, Ediz, & Kan, 2007).

Cronbach's alpha is reasonably resilient to smaller sample sizes (e.g. Ercan et al., 2007), and whilst there is some disagreement in the literature around this, a meta-study by Bujang, Omar, and Baharum (2018) of papers which examine the behavior of Cronbach's alpha under small samples provides support that Cronbach's alpha may be used in the context of pilot studies but also other scenarios where sample sizes are small with a null hypothesis of no association ($H_0 = 0$). Where the critical value of Cronbach's alpha is 0.7 ($H_1 = 0.7$), Bujang et al. (2018) calculate that, for a power of 90%, then a sample size of N of 24 is ample for groups of five items (or more). For smaller groups, a higher threshold of Cronbach's alpha is required or a larger sample size is necessary. Based on the analysis

Table 2. Mean significance ranking of construction knowledge attributes.

Construction Knowledge		
Skill No.	Skill/Attribute	Mean significance ranking
2	Construction methods, systems, and technologies	4.21
6	Scheduling/planning	3.96
8	Workplace Health and Safety management (OHS/WHS)	3.96
9	Site management	3.75
4	Construction codes and regulations	3.71
1	Materials and structures	3.67
7	Industry experience*	3.54
5	Supply chain	3.50
3	Construction Labor	3.33

*Denotes questions that have been identified through the Cronbach's Alpha analysis as questions that should be considered separately due to their lack of correlation with other questions within the same domain.

of Bujang (2018), Cronbach's alpha will yield at least 90% power in all but one case (the measure is disregarded in that item group).

We also carefully examine correlation matrices for each question group to determine whether any particular question warrants separate consideration by virtue that the question might show different sentiment patterns to other questions in the group. Moreover, with a sample size of 24 for each question, we can have confidence that comparing Mean Significance Rankings (MSRs) across different Likert scales using standard parametric tests is likely to yield statistically valid answers (Boone & Boone, 2012; Sullivan & Artino, 2013).

$$\mathrm{MSR} = \sum a/n$$

Where:

- a is the relative weight given to each assigned attribute by each respondent.
- MSR – Mean Significance Ranking
- n is the total number of respondents

Within the survey, respondents were asked to rate the degree of importance of a series of graduate skills and knowledge areas using a five-point Likert scale, from 1 (not at all important) to 5 (very important). Whilst there is some research indicating that a 10 point Likert-type scale is more efficient as an operating measurement model than a 5-point Likert-type scale (Coelho & Esteves, 2007), a 5-point Likert scale was opted for within this survey as it still provides enough points to differentiate respondents answers, is suitable for uni-polar constructs, and enables response reliability and statistical validity whilst being easy to interpret and use (Vanette, 2018). In examining the findings, to examine the central tendency, the mean ranking for each of the skills and knowledge areas was calculated so as to be able to index the mean significance ranking (MSR) of each skill (Boone & Boone, 2012). The mean significance ranking was calculated both for individual characteristics, skills and knowledge areas, and for each overarching knowledge domains examined. The standard deviation between responses for individual traits and across umbrella knowledge domains was also examined, so as to be able to determine the degree of variation between respondents.

In analyzing the results, if we look at each overarching knowledge domain individually, in relation to construction knowledge, it was found that respondents rated skills relating to 'Construction methods, systems and technologies' as being the most important knowledge area (MSR = 4.21) when hiring recent graduates (see Table 2). This was followed by knowledge of 'scheduling/planning', and 'workplace health and safety management (OHS/WHS)' – both of which had a mean significance ranking of 3.96. Knowledge of construction labor (as workmanship and labor related issues) was seen as the least important area of knowledge within this overarching knowledge domain, with a mean significance ranking of 3.33.

In relation to Management and Communication (see Table 3), respondents on average, rated communication skills as being the most important graduate attribute, 'Communication – verbal, written, presentation' the highest (MSR = 4.63), followed by managerial skills – 'Project management' (MSR = 4.17), and 'Team management' (MSR = 4.04). Knowledge of quality management systems had the lowest mean significance ranking within this section, with an MSR of 3.63.

When examining attributes under the umbrella 'Financial and Legal' knowledge domain (see Table 4), respondents on average ranked knowledge of 'cost planning, measurement and estimation' the highest (MSR = 3.79), very closely followed by knowledge of 'procurement methods' (MSR = 3.75), and 'risk analysis and risk management' (MSR = 3.71). Whilst 'business and corporate management' skills were seen as being the least important (MSR = 3.04). It should be noted that this questionnaire was conducted among the top 100 largest construction companies in Australia, and as such, certain attributes and skills categories may not be as significant within large organizations as they might be within small to medium scale organizations. Many of these larger companies have business managers and a range of admin staff to facilitate the business and corporate management side of the organization – this may account in part for the lower

Table 3. Mean significance ranking of management and communication attributes.

Management and Communication		
Skill No.	Skill/Attribute	Mean significance ranking
12	Communication – verbal, written, presentation*	4.63
10	Project management	4.17
13	Team management	4.04
15	Leadership, supervision, mentoring	4.00
14	Negotiation and conflict resolution	3.92
16	Performance management of staff/sub-contractors	3.79
11	Quality Management Systems*	3.63

*Denotes questions that have been identified through the Cronbach's Alpha analysis as questions that should be considered separately due to their lack of correlation with other questions within the same domain.

Table 4. Mean significance ranking of financial and legal attributes.

Financial and Legal		
Skill No.	Skill/Attribute	Mean significance ranking
18	Cost planning, measurement and estimation	3.79
21	Procurement methods	3.75
17	Risk analysis and risk management	3.71
22	Contract administration (Arbitration and mediation)	3.58
20	Construction law	3.54
19	Advanced cost management and value management	3.42
23	Business and corporate management	3.04

mean significance ranking of business management and administration skills by respondents.

Among the different knowledge domains examined, 'Environment, Culture and Digital', had the lowest overall mean significance rankings of the skills listed under this umbrella knowledge bracket (see Table 5). Survey respondents rated 'cultural awareness' as being the most significant skill within this bracket (MSR = 3.58), followed closely by 'knowledge management' (MSR = 3.54), and both 'lean construction' (MSR = 3.33) and 'digital strategy integration (e.g. BIM)' (MSR 3,33). Interestingly, despite an increase in national and global mandates to improve sustainability within the construction industry, knowledge of 'sustainability and life cycle analysis' was seen as being the least important skill within this knowledge cluster, and the second lowest overall across all attributes examined within the survey, with a mean significance ranking of 3.08. It should also be noted that despite findings by Russell et al. (2014) that knowledge of BIM significantly impacts on career pathways for construction and engineering management (CEM) graduates, that the same level of importance in relation to knowledge of BIM was not seen in our survey findings. This in part could be due to difference in focus and value placed on BIM within different global construction sectors.

On average, skills examined within the 'Personal attributes' knowledge domain ranked higher than all other knowledge domains examined within the survey (see Table 6). Respondents ranked 'resilience and persistence' as the highest skill within this sub-grouping (MSR = 4.58), followed by emotional intelligence (MSR = 4.50) and commitment to personal development (MSR = 4.33).

Table 5. Mean significance ranking of environmental, culture and digital attributes.

Environment, Culture and Digital		
Skill No.	Skill/Attribute	Mean significance ranking
27	Cultural awareness*	3.58
29	Knowledge management	3.54
25	Lean Construction	3.33
28	Digital strategy and integration (e.g. BIM)	3.33
24	Environmental and Waste management systems	3.29
26	Sustainability and life cycle analysis	3.08

*Denotes questions that have been identified through the Cronbach's Alpha analysis as questions that should be considered separately due to their lack of correlation with other questions within the same domain.

Table 6. Mean significance ranking of personal attributes.

Personal Attributes		
Skill No.	Skill/Attribute	Mean significance ranking
33	Resilience and Persistence	4.58
32	Emotional intelligence	4.50
31	Committed to personal development	4.33
30	Committed to professional development	4.29
34	Other*	3.33

*Denotes questions that have been identified through the Cronbach's Alpha analysis as questions that should be considered separately due to their lack of correlation with other questions within the same domain. Please note that "Other" was added to this umbrella domain to enable respondents to add via an open-ended category any personal attributes that were sought after but not accounted in the other skills/attributes listed in the survey.

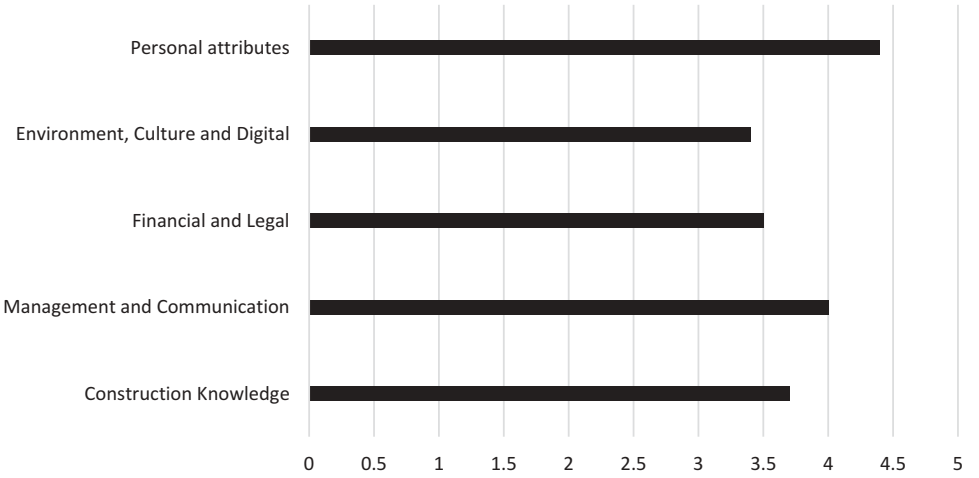

Figure 1. Umbrella knowledge domains: average response rate.

When looking at the mean significance ranking of all attributes listed within each umbrella knowledge domain, excluding those questions which have been determined as inconsistent within their group (see Figure 1), the top three umbrella knowledge domains valued by industry are 'personal attributes' (average response rate of 4.4), 'management and communication' (average response rate of 4), and 'construction knowledge' (average response rate of 3.7).

These findings support the meta-analysis of the literature review in which one of the main findings was the importance (in quantitative terms) of a project manager's personal attributes and leadership skills (Oliveros & Vaz-Serra, 2018).

In analyzing the mean significance ranking of the skills and attributes examined across all of the knowledge domains (see Figure 2), it can be seen that the top 5 traits valued (see Figure 3) by the construction industry when recruiting Master of Construction Project Management graduates are:

(1) Communication – verbal, written, presentation
(2) Resilience and persistence
(3) Emotional intelligence
(4) Commitment to personal development
(5) Commitment to professional development.

It is interesting to note, that whilst knowledge of project management and construction methods, systems and technologies both rate highly, that these skills are seen as being of lesser importance when recruiting a Master of construction project management graduate than interpersonal and communication skills.

Whilst these preliminary findings in part support those of Olawale (2015), Benhart and Shaurette (2014), and Ahmed et al. (2014), care needs to be taken in assessing the results from this survey, and our findings should be viewed in relation to the specific scope of the survey and the select population examined; namely large commercial construction firms within the Australian construction context. Whilst the specific skills sets and personal

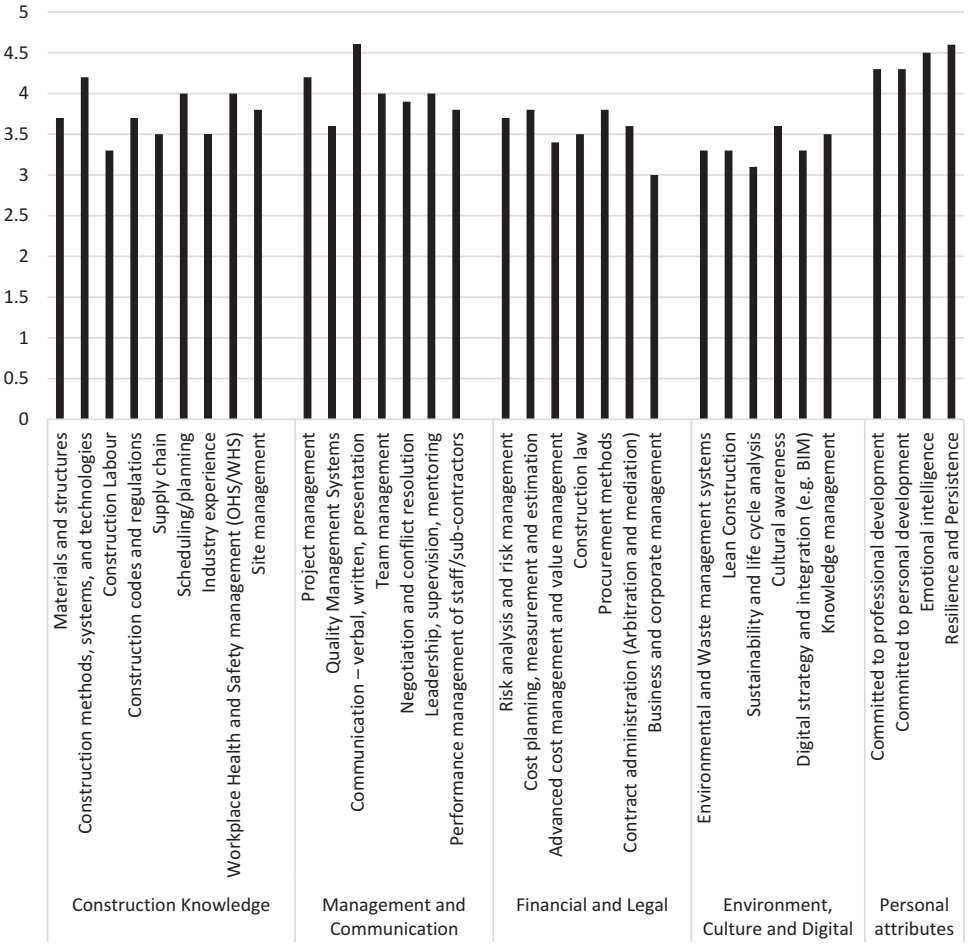

Figure 2. Mean significance ranking across individual skills and knowledge domains.

attributes examined in this study differ slightly from those examined by Ahmed et al. (2014), Benhart and Shaurette (2014), and Olawale (2015), there is some overlap in the areas examined and a strong value placed by respondents on personal attributes and communication skills. However, one key difference is the importance found in the research by Ahmed et al. (2014) in relation to core technical knowledge competencies; namely, knowledge of the building codes and regulations, ability to interpret contract documents, and knowledge of occupational health and safety regulations. Whilst respondents to our questionnaire rated technical knowledge highly, the most highly sought-after traits when recruiting Master of construction project management graduates related to interpersonal traits and communication skills. It should be noted that the difference in the value placed on different attributes and skills, could in part be a function of the project focus and scale of organizations surveyed, and differences in corporate culture and hiring focus between the different geographic regions examined.

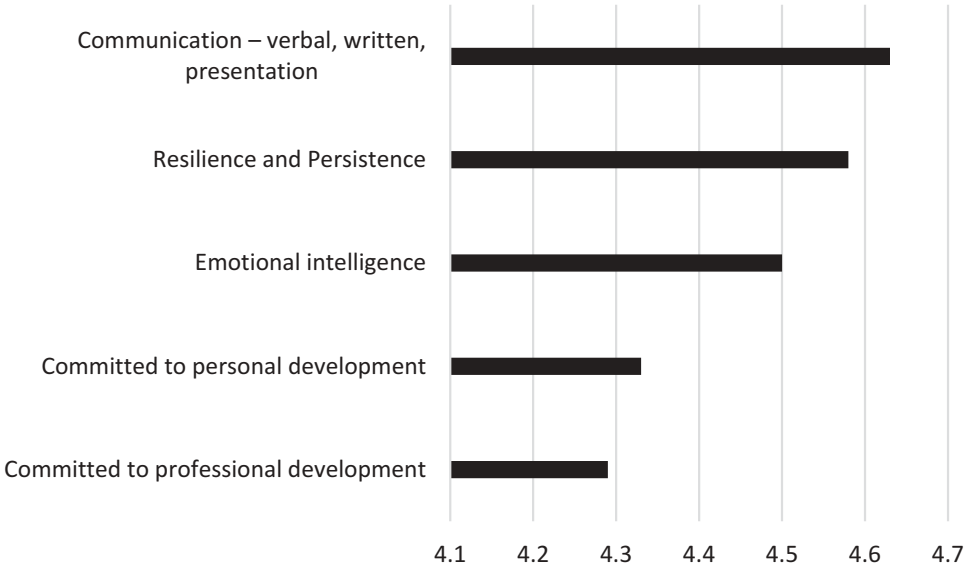

Figure 3. Top 5 traits/knowledge areas valued when recruiting a construction project management graduate.

Changes within the industry to project structuring, such as shifts in the contractual delivery system, the introduction of collaboration and information exchange platforms, and changes in procurement processes mean that students entering the construction industry need to have a range of skills beyond base core industry specific knowledge. With the increased uptake of PPP, Novated contracts, and project alliancing, the role of building practitioners is shifting, and construction project managers are being engaged on projects at an early stage. Whilst good interpersonal skills and communication assist in being able to engage with a range of consultants and contractors, effective communication also requires an adequate knowledge base across the range of knowledge domains needed at every stage of building procurement.

Whilst this research examines the importance placed by industry on specific skills and knowledge areas and the perceived value of these skills, it does not quantify in real terms the impact of the application of these skills to project success and the ability of Master of construction project management graduates to work collaboratively within the workforce. Skills such as interpersonal skills, emotional intelligence, adaptability to novel scenarios, and critical analysis and research skills all contribute to a graduate's ability to work effectively in collaborative partnerships, take on leadership roles, and adapt to technological innovations and changes to standard project structuring (Alhadidi & Mitcheltree, 2016; Davis, 2011). In viewing and interpreting these results, it should be noted that legacies from historical industry practice and processes and may mask the actual impact and value of some skills. This research at present only provides an insight into *what* skills and graduate attributes the industry most values when hiring graduates of Master of construction project management programmes, and not *why* such skills are sought after. Further examination is needed to examine why the construction industry values particular skill sets over others and the impact of this on construction project outcomes.

Conclusions

Due to rapid changes in technology, management and methods in construction, there is a need to evaluate construction project management degree programmes on a regular basis to ensure that graduates have the skills and knowledge base needed to meet changing industry needs. This research highlights the need to examine Master of Construction Project Management graduate competencies in a wholistic manner, so as to develop a more comprehensive understanding of the relationship between technical, cultural, managerial, legal and interpersonal skills.

From the data collected, it was found that among larger construction companies within Australia, greater significance is currently placed on interpersonal skills, and competencies defined as traditionally fitting within core technical knowledge, than on business and research skills. The results highlight current industry expectations, and core areas to examine in curricular review so as to equip Master of construction project management graduates with the skill sets needed to improve their employment prospects and better equip them for entry into the workforce.

The main findings highlighted that the top 5 traits valued by the construction industry when recruiting Master of construction project management graduates are: (1) Communication (verbal, written, presentation); (2) Resilience and persistence; (3) Emotional intelligence; (4) Commitment to personal development; (5) Committed to professional development.

One of the limitations of this research is that it was based on a survey conducted exclusively in Australia among companies listed in the HIA 100 biggest construction firms in 2017. To be able to assess desirable skills and attributes for Master of construction project management graduates across a broader range of end career pathways, further research will need to be conducted across a range of company profiles, from large construction firms to public organizations, developers, consultants, medium and small contractors, subcontractors, special contractors and suppliers.

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