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Construction project manager skills: a systematic literature review

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Abstract: The construction industry is one of the most important economic activities in the world, and research in this field has identified a positive relationship between project management skills and the success of construction projects. This research project systematically reviewed more than 380 documents in 14 academic journals from the construction and project management fields, searching for construction managers' skills and competencies, and identifying key skills in educative terms for graduates. The final selection of articles was reviewed in detail and categorised into three themes: education, project manager competencies, and employment. Additionally, a database with 306 competencies, gathered from the reviewed studies, was quantitatively analysed, grouping them into overarching categories. One of the main findings from this systematic literature review is the importance (in quantitative terms) of a project manager's personal attributes and leadership skills. This systematic literature review explores the current dichotomy the exists within the literature between research about key managerial competencies, and the lack of them within the industry and formal education institutions. Future research will explore how to bridge the gap between academic programs and industry needs.

Keywords: Construction, Competencies, Management, Project, Education, Skills.

1. INTRODUCTION

The construction industry is one of the most significant economic sectors in the world, accounting for 6% of global GDP. According to the World Economic Forum (2016), all economic value creation occurs within or by means of buildings or other "constructed assets". A well trained and experienced project manager can create a significant difference in the outcome of a project, and research in this field has identified a positive relationship between applied management skills and the success of construction projects (Cooke-Davies, 2002; Rezvani et al., 2016).

It should be noted that the roles of 'project manager' and 'construction project manager' need to be understood as two different professions. The role of project manager is focused on the whole project and does not require specific construction skills, 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. The construction project manager needs 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 introduced the unique knowledge areas for the worldwide construction industries: Project Health, Safety, Security, and Environmental (HSSE) Management, and Project Financial Management. Due to the dynamic nature of the construction industry, innovations, trends, and changes within the industry should be monitored and studied constantly to provide a well-defined scope of 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 and how these relate to curricular content and pedagogical frameworks to support industry needs. This paper outlines a systematic review and meta-analysis of the existing literature regarding 'construction managers' skills and competencies', and provides a 'big picture' exploration of the literature and emerging trends. Conducted as part of a larger research project, this literature review and meta-analysis aims to bridge the gap between the academic process of educating and training project managers, and in so doing address what the graduate attributes are required to best meet industry needs.

2. RESEARCH METHOD

For the systematic literature review, the SCOPUS database was selected as the target search database, as it is one of the largest research databases of peer-reviewed research articles with access to leading journals in the construction management and project management disciplines such as Construction, Management and Economics (CME), and the International Journal of Project Management (IJPM). (Elsevier, 2018).

As a point of departure for gathering construction managers' competencies and skills, we tested different key word search-string macros in order to find those which proffered appropriate results, without excluding the targeted knowledge. The search was narrowed to construction and project management journals, including 'construction education' journals. The keywords searched for in the title and/or abstract were 'competencies' and 'skills'. SCOPUS considers all the variation of the terms to provide more extensive search results (e.g. 'competency' and 'competencies'). The search was narrowed to journal articles published in the last 15 years (2002-2017). Given the dynamic nature of the industry and the strong impact that external factors such as 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. Additionally, conference articles and book chapters were excluded to avoid repetition of frameworks and ideas (journals present a common selection filter through similar peer-review processes). The search-string macros generated 362 documents. A one-by-one review of all the documents' titles and abstracts was conducted to generate a final document selection. The inclusion criteria involved, (1) evident connection to the construction industry (excluding IT and other fields), (2) competencies and skills of the construction project manager (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. The qualitative review describes the objective of the studies, their main conclusions and methodologies, grouping the literature into three categories or themes, namely: education, project manager competencies, and employment. The quantitative analysis describes a database that was generated with all the reviewed frameworks that contained project manager competencies and skills, so as to highlight general trends within the literature.

Table 1 and Figure 1 present the details of the search enquiry and the final document selection.

Table 1: Initial search and selected documents by source

Source	Documents Total	Selected Documents
International Journal of Project Management	96	22
Construction Management and Economics	74	8
Journal of Construction Engineering and Management	58	8
Engineering Construction and Architectural Management	45	2
International Journal of Construction Education and Research	27	4
Project Management Journal	22	6
International Journal of Construction Management	16	0
International Journal of Project Organisation and Management	12	1
Built Environment Project and Asset Management	8	0
Journal of Construction Education	6	1
Journal of Financial Management of Property and Construction	6	0
Journal of Modern Project Management	6	0
International Journal of Information Systems and Project Management	4	0
International Journal of Construction Supply Chain Management	3	1

Figure 1: initial search in a time-frame.

3. LITERATURE QUALITATIVE ANALYSIS

3.1 Education

Within the literature relating to education, many authors address formal PM tertiary education structures, modifications, and improvement. Bredillet, Conboy, Davidson, and Walker (2013) describe the context of project management education in Australia, presenting two models that incorporate the different topics that should be pursued at Bachelor, Masters and PhD levels. On more philosophical grounds, Crawford, Morris, Thomas, and Winter (2006) discuss the challenge of moving from a trained practitioner into a reflexive practitioner by creating education programs that focus on a reflexive process and presentations, complemented with the traditional research dissertation and standard PM knowledge acquisition. The reflexive component responds to the perceived lack of project management understanding beyond the core structural knowledge. They argue that the decision-making process, which considers past events and intuition, is not part of the current formal PM training. Pant and Baroudi (2008) also advocate for the incorporation of soft-skills in project management education within Australia. They claim that the PMBOK (base of PM education) promotes hard-skills over soft-skills. Ojiako, Ashleigh, Chipulu, and Maguire (2011) examine the key components of students' learning experiences. The first component, transferable skills, addresses parameters such as interpersonal skills, time management, curriculum coherence, critical thinking and communicating. The second component is virtual learning, which includes the quality of e-resources and how relevant and accessible information is managed online. Table 2 summarises the literature review related to project management education.

Table 2: Summary of the reviewed literature in PM education theme

Author	Sub-category	Description
Bredillet et al. (2013)	PM education structure	Organization of PM degrees in Australia
Crawford et al. (2006)	PM education structure	Move from trained to reflexive PM practitioner by changing educational programmes
Pant and Baroudi (2008)	PM education structure	Incorporation of soft skills in PM education
Ojiako et al. (2011)	PM education structure	Students perspective on PM education
Bigelow et al. (2013)	Impact on PM education	Use of competitions as a learning tool.
Córdoba and Piki (2012)	Impact on PM education	Use of group-based system inside the Project Management class
Glick et al. (2012)	Technology	Use of 3D models
Chipulu et al. (2011)	Technology	Use of virtual learning environments
Ellis et al. (2004)	Technology	Comparison of virtual learning and traditional learning for PM training
Pikas et al. (2013)	Technology	Framework for teaching BIM in construction management
Stoyan (2008)	Alternative PM education	'PM for all' teaching method
D. J. Fisher et al. (2005)	Alternative PM education	PM training programme inside a company

Good practices, and alternative ways to develop project management, expand the spectrum of possibilities beyond that of traditional education. The impact of the different factors, activities, and attributes of formal education on PM graduates' performance was also found to be a focus of PM research within the literature examined. Bigelow, Glick, and Aragon (2013)

explore the use of competition in construction education. Córdoba and Piki (2012) describe how project management education can be enhanced using student groups as systems, receiving tasks and generating deliverables through the development of project management courses.

In relation to the use of technology and the adoption of technology enabled learning within PM education, four studies are noted. Glick, Porter, and Smith (2012) state that the use of 3D models within the course materials and methods for construction students increases the perception of learning, especially in relation to masonry and metals. Additionally, Chipulu, Ojiako, Ashleigh, and Maguire (2011) relate the student learning process with the use of virtual learning environments, finding that the adoption of virtual learning modalities supports the development of interpersonal skills. These findings contrast with those of Ellis, Wood, and Thorpe (2004) who in their comparison of traditional education and distance software-based part-time learning in project management, found no significant difference in the performance of the two student groups.

3.2 Project Managers' Competencies

Different frameworks have been developed for describing PM competencies. The AIPM and PMI have competency standards based mainly on the knowledge units of the project management body of knowledge. In a 2005 study, Dainty, Cheng, and Moore (2005) utilised a regression model to examined survey results and identify key competencies of project managers. Their research identified self-control and team leadership as the most predictive behaviours of effective project managers. Arditi and Balci (2009) describe a competencies-based measurement utilised to assess project managers in the construction industry. The competencies outlined by Arditi and Balci are grouped into five key areas - (1) Managing Change, (2) Planning and organising, (3) Interpersonal skills, (4) Result orientation, and (5) Leadership. Hanna, Ibrahim, Lotfallah, Iskandar, and Russell (2016) created a mathematical model to describe PM competencies. The model developed by Hanna et. al. posits the importance of the development of a PM's cognitive problem solving side, rather than specific knowledge, technical and managerial capabilities.

The importance of leadership as a key attribute of PM competencies is a major recurring theme among the research examined. A study by Müller and Turner (2010) examined leadership competency profiles for different types of projects and sectors. Müller and Turner found a high expressions of one IQ sub-dimension (i.e. critical thinking) and three EQ sub-dimensions (i.e. influence, motivation and conscientiousness) in successful managers in all types of projects. Zhang, Zuo, and Zillante (2013) identify four dimensions of social competencies for construction project managers, i.e. working with others, stakeholder management, leading others, and social awareness. Related to the team leadership skills, team success was also part of the review. A recent study by Liu and Cross (2016) describe the factor that contribute to project team success. The study by Liu and Cross found that factors such as efficiency, knowledge, innovation, and harmony are crucial to project success. In a 2016 study examining the relationship between emotional intelligence, shared mental model (SMM) and team performance for IS developments, Xiang, Yang, and Zhang (2016) found that EI could enhance SMM. Pryke, Lunic, and Badi (2015) relate the project manager's emotional sensitivity and expressiveness (particularly head gestures) with variance in the quality of leader-follower chemistry. Miao, Humphrey, and Qian (2016) present the connection between leaders' emotional intelligence and subordinates' job satisfaction.

Specific construction and site competencies are also reviewed. Cottrell (2006) presents a regression model that relates job site productivity to process improvement initiatives (PIIs). The model demonstrates the strong relationship of project performance to a variety of PIIs including design completeness, the definition of a project vision statement, testing oversight, and project management experience and dedication. However, Cotrell finds that the difference in the competencies with the general project manager is not a significant factor for decision-making purposes. Arditi, Gluch, and Holmdahl (2013) described the differences in the managerial competencies between males and females. They concluded that the perception was similar across most of the competencies (17 out of 20), arguing that there is no evident difference in the managerial competency between men and women in the Swedish construction industry.

Table 3: Summary of the reviewed literature in PM Competencies

Author	Sub-category	Description
PMI and AIPM	Frameworks	Standards-based on knowledge units
Dainty et al. (2005)	Frameworks	PM Competencies through survey and linear regression
Arditi and Balci (2009)	Frameworks	PM competencies to assess them in Construction
Hanna et al. (2016)	Frameworks	Mathematical model to differentiate exceptional form average PM
E. Fisher (2011)	Frameworks	Competencies based on qualitative research (in-depth interviews)
Müller and Turner (2010)	Leadership	Leadership competencies vary depending on the type of project
Zhang et al. (2013)	Leadership	Four dimensions of PM social competencies
Davis (2011)	Leadership	Connection between emotional intelligence and interpersonal competence
Toor and Ofori (2008)	Leadership	Leadership competencies
Liu and Cross (2016)	Team	Team success factors
Xiang et al. (2016)	Team	Relationship between emotional intelligence, shared mental model, and team performance
Pryke et al. (2015)	Team	Effect of leader's "head gestures" over the quality of leader-follower chemistry
Miao et al. (2016)	Team	Effect of leader emotional intelligence and subordinate's job satisfaction
Cottrell (2006)	Construction	Relationship between job site productivity and process improvement initiatives (PII)
Ling (2002)	Construction	Model to predict Architects and Engineers performance in design-build projects
Jha and Iyer (2006)	Complementary	Difference between project coordinator and project manager
Arditi, Gluch, and Holmdahl (2013)	Complementary	Comparison of male and female managerial competencies.

3.3 Employment

The employment of graduate PMs is explored through student background impact, recruitment, and expectations. Boahin and Hofman (2013) explore the effect of academic disciplines, students' background characteristics and industry training on the acquisition of employability skills through competency-based training. Boahin and Hofman found that whilst gender appears to have no impact, pre-education has an effect on the acquisition of employability skills. Kalfa and Taksa (2015) question the existing development of "skills" in tertiary education to improve employability, arguing that the human capital model has many critics and that a new framework is needed. Bhattacharjee, Ghosh, Young-Corbett, and Fiori (2013) compare the expectations of students close to graduation with industry expectations in terms of the expected knowledge and skill of construction managers. Overall, the expectations of the industry and the perceptions of the students showed a high correlation in relation to required construction knowledge, but weak concordance in relation to the necessary interpersonal skills. Ahsan, Ho, and Khan (2013) in an analysis of advertising for the recruitment of project managers found that soft skills are more commonly listed than technical skills when recruiting for a PM job.

Table 4: Summary of the reviewed literature in PM Employment

Author	Sub-category	Description
Boahin and Hofman (2013)	Tertiary Education	Effect of student's pre-education on employability skills
Kalfa and Taksa (2015)	Tertiary Education	Theoretical/philosophical discussion of skills' development on tertiary education
Bhattacharjee et al. (2013)	Industry	Comparison between students' expectation with industry expectations
Ahsan et al. (2013)	Industry	Analysis of PM job advertising

4. LITERATURE QUANTITATIVE ANALYSIS

A compilation of all the competencies found in the literature was analysed in quantitative terms to show key trends through: (i) a description of the authors by the number of competencies, (ii) the competencies by category, and (iii) the competencies in a timeframe. Table 5 describes the number of competencies that were recognised by different authors. The magnitude is important because it shows the relative relevance of each competence within its framework and the spectrum of variability between the small and the large frameworks.

Table 5: Studies with competency frameworks

Author	Year	Skills
Gunderson D.E., Ra J.W., Schroeder H., Holland H.R.	2002	15
Dainty A.R.J., Cheng M.-I., Moore D.R.	2004	21
Jha K.N., Iyer C.K.	2006	29
Toor S.-u.-R., Ofori G.	2008	8
Arditi D., Balci G.	2009	20
Müller R., Turner R.	2010	15
Davis S.A.	2011	4
Fisher E.	2011	8
Arditi D., Gluch P., Holmdahl M.	2013	20
Bhattacharjee S., Ghosh S., Young-Corbett D.E., Fiori C.M.	2013	36
Pikas E., Sacks R., Hazzan O.	2013	39
Zhang F., Zuo J., Zillante G.	2013	9
Hanna A.S., Ibrahim M.W., Lotfallah W., Iskandar K.A., Russell J.S.	2016	47
Naveed M.H., Thaheem M.J., Khurshid M.B., Farooqui R.U.H.	2017	26
Total		306

A database of all the competency frameworks was generated to analyse the literature based on 'competency units'. The competencies were divided into overarching categories: (i) construction knowledge; (ii) management and communication; (iii) financial and legal; (iv) environment, culture and digital; (v) personal attributes; and (vi) leadership. Figure 2 shows the presence of the five competency categories over the last 15 years. The graph rejects a possible scenario of having one or two articles that focus on a specific knowledge (for example BIM), as the relative representation across all categories has been relatively stable through the years. It also shows the relevance of personal attributes and leadership categories, which together represent more than 40% of the competencies.

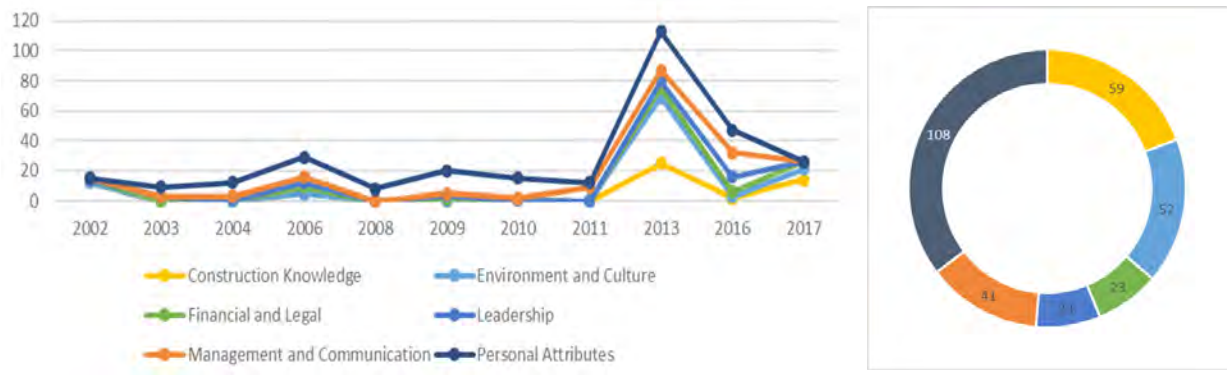

Figure 2: Competency database in a time-frame and in total

5. DISCUSSION AND CONCLUSION

The literature review highlighted that construction project managers' competencies and skills are one of the predominant areas of focus in the literature examined. The strong representation of managerial competencies and skills within the research, reflects the impact that such skills have on the overall project success and the positive correlation between a project manager's capacity and the overall project performance. It should be noted that the aim of the paper is to provide a descriptive and predominantly quantitative analysis of the existing literature - presenting the main journals, authors, topics, and research trends in relation to PM competencies and skills, and PM education. Whilst this analysis enables an overview of the literature in relation to 'what is being researched' and 'in what amounts', it runs the risk of potentially hiding, or obfuscating, the qualitative relevance and impact of each attribute, and the results presented here should be viewed in relation to the defined scope of the research.

From the quantitative analysis it was found that PM personal attributes was a prominent area of research focus within the literature, and the category with the most competencies represented. The review shows that research has been focusing on personal attributes over those related to technical knowledge and general managerial skills. Whilst it is not possible to assess the relative relevance (quality) of each competency, the quantitative analysis indicates that personal attributes is focus priority within the research; and therefore, by implication an area of high relevance. From the competency-database generated, there is a wide spectrum of relevant personal attributes, including many competencies that are difficult to measure - from authority and analytical skills to empathy, emotional resiliency, flexibility, courage, honesty and integrity. The use of BIM and other technology-based expertise is not a general theme and many competency frameworks do not include them, except for one article that specifically addresses this issue and proposes a general plan of BIM education.

A framework to understand the cause-effect relationships of the many issues that are present in the PM competency literature could bring greater value to the research. Research in construction (especially in technological advances) influences the industry through formal Transfer of Technology (TOT), but also indirectly through the knowledge that graduates obtain from the formal education in which the technology is developed. This interrelated system of value-creation should drive the current research so as to provide a better evidence-base through which to understand the relevance, impact and effectiveness of changes in practice and education.

This paper is part of a larger research project that bridges the gap between formal education programs and industry needs in construction management for the Australasian region. This review confirms the gap in knowledge, the relevance of the different categories (construction knowledge, management and communication, financial and legal, environment and culture, and personal attributes); and the need to link skills and competencies with the existing formal curricular and pedagogical frameworks. The paper contributes to the research agenda by presenting an overview of PM competencies, and highlighting existing gaps within the knowledge base, and avenues for further research such as: further analysis of competencies in specific contexts, industry sectors, and geographical areas; research on methods through which to acquire the different competencies within formal education and experience-based situations; a model to connect existing technology with the acquisition of competencies to support project success; and innovative models to connect formal education with industry in order create a continual improvement process loop.

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