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Identifying the gaps in project success research: a mixed bibliographic and bibliometric analysis

Abstract:

Purpose: This paper aims to review the existing literature on project success in academic journals, specifically within the context of construction engineering and management (CEM). It also aims to provide a holistic picture of existing research and to identify research implications in this specific area.

Design/methodology/approach: The paper is an extensive literature review of a total of 164 peer-reviewed journal papers between 2007 to 2017, using a mixed bibliographic and bibliometric method that considers annual circulation, institutional and regional contributions, author contributions, citations, categories of research methods, and keywords networking.

Findings: There has been an increasing research interest in CEM project success. The largest number of published studies target the developed regions, especially in Hong Kong, whereas the papers related to the developing economies remain weak. Questionnaire, interview, and case study have comprised the main data collection methods, and descriptive data analysis was performed in most of the case/field studies. The subtopic related to the Critical Success Factors (CSFs) is considered as the most popular in the keywords network in the targeted research area. Four implications, namely megaproject success, project success in developing countries, relationships between CSFs and success outcomes, and the influence of human factors are highlighted in future research.

Originality/value: This paper departs from earlier research by using a mixed bibliographic and bibliometric method, especially facilitating to analyze and illustrate the interlinkages between keywords effectively. Additionally, it provides a clear picture of the existing literature on CEM project success, which contributes to insights for successful construction project management. Finally, the holistic analysis identifies gaps in the body of knowledge, revealing avenues for future research.

Key words: Bibliometric analysis; Construction projects; Project success; UCINET

1 Introduction

In recent years, project management has been a hotspot in both academia and industry. This increasing interest has become more apparent in relation to construction activities, which has led to the establishment of project management theories and professional organizations such as the Project Management Institute (PMI).

Despite relatively mature project management theory and the completion of myriad construction projects, project outcomes continue to yield disappointing results. That is, many construction projects are not completed successfully, so it is vital to understand the reasons for the success or failure of construction projects (Ika, 2009). In addition, construction projects have become more complex, unpredictable, and risky, such as complex projects and megaprojects, which

leads to increasing difficulties in project management and delivery, and eventually bad performance or even failure. Megaprojects are characterized by a "performance paradox," in that most megaprojects face cost overruns, quality defects, and schedule delays (Flyvbjerg, 2007, Kardes *et al.*, 2013). It is apparent that megaproject management presents a major challenge worldwide (Hu *et al.*, 2015b), and the nature and characteristics of megaprojects distinguish them from normal construction projects and require a new approach to ensure success (Flyvbjerg, 2014).

Project success research has attracted the attention of many scholars and large number of papers related to project success in CEM has been published. The research topics under this specific area are diversified, such as the following: evaluation of project success (Akal *et al.*, 2016), identification of CSFs (Al-Saadi and Abdou, 2016), theories and principles of project success (Chou *et al.*, 2013), and the relationship between success factors and project success (Gilbert and Ron, 2016). And meanwhile, a few review articles on project success have been conducted during the past decades. Ika (2009) analyzed the characteristics of articles on project success published in Project Management Journal and International Journal of Project Management from 1984 to 2004, and the author suggested a shift to the project, portfolio, and program success. Machado and Martens (2015) reviewed project success related publications between 2000 and 2014 from the perspectives of most cited keywords, citations, co-citations, journals' impact factors and abstract analysis. Davis (2014) conducted a literature review on project success mainly to summarize the evolution of project success and identify perceptions of senior management, project core team and project recipient stakeholder groups. Jugdev and Muller (2005) developed a review mainly to assess evolving understanding of project success over the past 40 years and discuss conditions for CSFs and success frameworks.

Although review articles mentioned above can help researchers capture a picture of the field of project success and contribute to a better understanding of this specific topic. However, two main limitations cannot be ignored. On the one hand, previous studies only reviewed articles from selected journals or only focused on a specific topic within project success. That is, a plenty of articles of high quality published in peer-reviewed journals have not been analyzed. As suggested by Tsai and Lydia Wen (2005), a comprehensive review would assist the researcher to understand the current status and future trends of the chosen topics, which could help future researchers not to repeat what has already been done, and instead to build on the work of others. On the other hand, the above review articles almost used bibliographic analysis, which cannot reveal the interrelationships between keywords effectively. However, keywords are important indicators of studies that convey their main topics. As Kamalski and Kirby (2012) advocated, bibliometrics can be a useful tool to explore and visualize how keywords are connected in one specific research area.

Therefore, in this paper, the project success literature published between 2007 and 2017 in the construction projects field to identify its current status quo and latest research directions with the assistance of a mixed bibliographic and bibliometric method is comprehensively reviewed. To meet this study objective, the following questions are addressed:

- What was the coverage of project success in the field of construction projects by journal papers published from 2007 to 2017?
- Who were the main contributors to these studies from 2007 to 2017 and where are they from (countries or regions)?
- What were the main research methodologies, keyword characteristics, and trends in this area during this study period?

2 Basic concepts

2.1 Project success

Although research regarding project success began in the 1980s, as yet, no clear or uniform understanding of project success has been established (Ika, 2009). Researchers have proposed various perspectives for defining project success, which makes it difficult to assess and/or define the degrees of project success. For example, Tuman (1986) stated that the full use of resources and achievement of the desired goal define a successful project. Wit (1988) believed that if a project meets the required technical performance, then the main members of the project team and the main users consider the project results to have been satisfactory. By contrast, others assessed project success based on the "Golden Triangle" of cost, quality, and schedule (Ika, 2009). Ashley *et al.,* (1987) considered that if the results of a project in terms of its cost, schedule, quality, safety, and satisfaction of the project participants are better than required, then the project can be deemed a success. Pinto and Slevin *et al.*, (1987) deemed that successful projects must meet at least four requirements, namely completion on time, within budget, completion of all planned goals, and the acceptance of the results by customers. In addition to the three aspects of cost, quality, and schedule, project success also relies on human factors like project management. Some researchers have argued that the evaluation of project management success ought to be based on the "Golden Triangle," which requires multidimensional thinking (Machado and Martens, 2015, Shenhar *et al.*, 2001). The PMI defined project management success as good control of the time, cost, quality, resources, and risk accepted by the project management team, and focuses more on customers' expectations than other internal or external expectations (Khan *et al.*, 2011). On this basis, project management success is determined by evaluations conducted at the end of the project implementation phase, with respect to the project implementation stage, which is only one phase of the whole project life cycle.

2.2 Project success criteria and CSFs

Project success studies generally consist of two components—project success criteria and success factors (Müller *et al.*, 2012). Project success criteria refer to the use of a group of principles or standards to determine or judge project success. CSFs, first proposed in 1979 (Fortune and White, 2006), specify the project conditions, events, and circumstances that facilitate final success (Ika, 2009).

The "Golden Triangle" components of cost, time and quality are the most commonly used criteria for assessing project success. However, quality is an ambiguous and subjective index that can lead to different understandings by different project stakeholders (Wateridge 1995). For example, Chan *et al.,* (2002) suggested that the criteria for project success be further distinguished between those that are objective and subjective, whereby objective indicators would include time and cost, budget/economic performance/profit, and safety and health; and the subjective indicators would include quality, technical performance, production efficiency, owner satisfaction/project member satisfaction, legal claims, functionality, and environmental sustainability.

However, for a public–private partnership (PPP) or design-build (DB) project, Osei-Kyei *et al.,* (2017) provided a total of 15 indicators and seven were very critical that included effective risk management, meeting delivery requirements, time control, long-term relationship and partnership, profit and budget control, reliable and quality service operations, and satisfying the need for public

facility/service . From the perspectives of various stakeholders, indicators and dimensions of project success are set against the stakeholder theory or the requirements of multidimensional participants. For instance, Davis (2014) categorized stakeholders of different classes, including project managers, users, and senior managers (sponsors, owner, and executives). Within this assessment model, project managers often measure success based on cost/budget, quality, and schedule/time, whereas users consider satisfaction and communication to be the two most important aspects. Meanwhile, senior managers consider decision-making processes, such as setting targets, to be most important.

Regarding CSFs, Slevin and Pinto (1986) proposed ten key factors: project mission, top management support, project plan, client consultation, personnel, technical skills, client acceptance, control and feedback, communication, and problem-solving. There is a trend in recent CSF papers to shift the focus to specifying, rather than generalizing, factors relevant to different countries/regions. Wang *et al*., (2007) analyzed the CSFs of PPP infrastructure projects in mainland China, and identified seven types of CSFs: project characteristics (project scale, attractiveness of private capital, rationality of financial assessment), good investment environment (good international reputation, stable legal system, public support), project company competencies (leadership, project organization structure), regulations and policies (reasonable risk sharing mechanism, supervision, justifiable pricing mechanism), governmental support (government subsidies and government political support), product features (quality of products or services, meeting environmental standards), and project management (project planning, effective project control, reasonable risk sharing, communication and coordination). Chan *et al*., (2002) conducted a DB project study and considered there to be six project success factors, including the project team's commitment, the contractor's ability, risk, and liability assessment, client ability, end user's needs, and the constraints imposed by the end user.

Obviously, there is no universally recognized list of project success criteria and CSFs that meet the needs of all construction projects. However, project success studies that have focused on project success criteria and CSFs have provided quantitative information and guidance for construction practices in the real world.

3 Research Methodology

This work mainly adopted a structured method advocated by Machado and Martens (2015) to identify and assess the major outputs of project success research in CEM published in peer-reviewed journals from 2007 to 2017. To acquire a more elaborated understanding of this study, the research framework is illustrated in Fig.1. The entire research process and methodology involved in this study will be discussed in Section 3.1, 3.2 and 3.3 in detailed; meanwhile, four contents consist of number of published papers, quantification of contributions, categories of research methods and keywords network will be analyzed and discussed in Section 4 and future interests will be put forward finally in Section 5.

(insert **Figure 1**. here)

3.1 Selection of target academic papers

For this study, comprehensive explorations within the context of CEM via the Web of Science and Scopus databases were conducted. Based on the abovementioned definitions of project success and research work by Machado and Martens (2015), for selection in the two target databases, the

keywords s*uccess AND project OR projects, successful AND project OR projects, success AND project management, successful AND project management* in the Title/Abstract/Keyword of selected databases were used. Since the Web of Science and Scopus databases do not contain a full record of CEM articles between 2007 and 2017, such as Project Management Journal, which is one of the most popular journals in the construction project field, the EBSCO database was also adopted to facilitate our article exploration. In this stage, a total of 263 journal papers were identified and then these papers to identify CEM-related content were briefly reviewed. Eventually, the total number of papers was narrowed to 164. Articles identified in this study between 2007 to 2017 are shown in Appendix 1.

3.2 Quantification of contributions of authors and institutes

Quantifying the contributions of major authors has been a traditional research approach. Generally, a widely adopted formula, as proposed by Howard *et al.* (1987), involves scoring the contributions of authors from different countries (or regions) and institutes (or universities) in a multi-authored paper, as shown in Formula (1) below. Studies that have employed this formula to identify research trends in construction and demolition waste management (Yuan and Shen, 2011) and partnering research trends in construction journals (Hong *et al.*, 2012) have confirmed its suitability and reliability in quantifying the contributions of authors and institutes. Therefore, employing this formula, the author scores based on their author-list orders to quantify the contributions of both the authors and their institutes were calculated. Specifically, the 164 articles to determine the contributions by author and institution (university) were quantitatively analyzed.

$$score = \frac{1.5^{n-i}}{\sum_{i=1}^{n} 1.5^{n-i}} \quad (1)$$

In this formula, n is the number of authors in the article and i is the order of the specific author. Table 1 shows details regarding the scoring matrix.

(insert **Table 1**. here)

3.3 Establishment of keywords network

The BICOMB 2.0 software (Bibliographic Items Co-occurrence Matrix Builder) was mainly employed to conduct the research in this part. To be specific, the frequency (also known as occurrence) of a selected keyword was calculated and then the keywords according to their frequency were ranked. The specific steps are as follows:

1. The authors used BICOMB software to build a co-word matrix that quantifies the frequency of two keywords appearing in one paper. Initially, 447 keywords were extracted. The authors then merged some similar keywords in the co-word matrix before performing the next step. Table 2 shows the resulting frequency of keywords.

2. The authors used UCINET v6.415 software with the co-word matrix to establish and visualize a keywords network.

3. To provide visualizations of the intensity of use and attention given to keywords by existing academic papers, a bi-dimensional multi-dimensional scale (MDS) table via SPSS was employed to indicate the most frequently discussed keywords.

(insert **Table 2.** here)

4 Discussion and analysis of results

4.1 Number of published papers

(insert **Figure 2.** here)

Figure 2 shows the annual number of published papers related to project success in the CEM, for a total of 164 journal papers. As shown in the figure, the number generally increased from 2007 to 2017, with the largest number in 2016 (29), which is approximately double those in 2011 (14) and 2012 (14).

Table 3 shows the number of project success papers related to CEM studies from 2007 through 2017 in the top 10 journals, including the *International Journal of Project Management* (IJPM), *Journal of Management in Engineering* (JME), *Journal of Civil Engineering and Management* (JCEM-1), *Journal of Construction Engineering and Management* (JCEM-2), *Project Management Journal* (PMJ), *Construction Management and Economics* (CME), *Construction Economics and Building* (CEB), *Built Environment Project and Asset Management* (BEPAM), *International Journal of Construction Management* (IJCM), and *International Journal of Managing Projects in Business* (IJMPB). As shown in Table 3, project success papers (total 88) accounted for only 1.4% of the total number of papers in the top 10 journals. The top five journals (IJPM, JME, JCEM-1, JCEM-2, PMJ) published the most articles in the past decade (27, 13, 9, 8, and 8, respectively), and published 74% of the 88 CEM project success papers by the top 10 journals. Of these journals, the IJPM published 27 articles, which represents nearly 31% of all the selected papers, thereby representing the most project success study cases. In addition, whereas the average ratio of this research with respect to all other research is 1.4% (Table 3), the relative values of IJPM (2.3%), JME (2.2%), PMJ (2.1%), CEB (2.1%) are higher than 2%, which indicates that these four journals published more targeted papers than the average. Notably, although the publication number of CEB was only 5, its average ratio ranked as third among the top 10 journals. This might suggest that the CEB can also be regarded as an important source for acquiring the most highly valued papers.

(insert **Table 3.** here)

4.2 Contributions of countries/regions and authors

The number of academic publications in a country or region is an indication of the extent to which industrial practices in academic areas are progressing in that location. Thus, it is meaningful to analyze the contributions of countries or regions to obtain a sense of the current industrial practices in particular areas (Hong *et al.*, 2012). In this study, the authors analyzed contributions based on the scores of each author's contributions. To do so, the formula (1) found in Section of Research Methodology was used to calculate the scores and used the sum of the values of all researchers within identified origins as the final score for this location. In addition, the contribution score of authors with two origins was divided into two equal parts, which is a recognized method for the calculation of contribution scores.

Table 4 lists the countries/regions of origin of publications along with the number of research institutions, affiliated researchers, a total number of articles involved, as well as the final scores. It shows that Hong Kong is the biggest contributor to papers on project success in CEM, with a total score of 14.38 for 23 researchers and 22 articles published between 2007 and 2017. Table 4 also shows that the top four contributions by researchers are from Hong Kong (23), Malaysia (15),

Taiwan (10), and Australia (10), which represents approximately 63% of all the researchers in the table. In addition, Hong Kong (22), Australia (8), Malaysia (6), and Taiwan (5) are the top four countries/regions that contributed publications to project success within CEM, accounting for almost 67% of the identified papers. In addition, although there are five developing countries/regions on this list (Malaysia, Iran, India, Thailand, and South Africa), they represent only 30% of the identified articles. To a great extent, this indicates that project success in these areas is a topic of greater interest compared to other developing countries or regions, such as China and India. Since developing countries are regarded as increasing markets for huge investments in infrastructure, these countries should strengthen their research efforts with respect to project success.

(insert **Table 4.** here)

A further examination of the research contributors of the identified papers is presented in Table 5. It shows that 10 researchers contributed more than two project-success-related papers from 2007 to 2017. By applying the formula (1) noted above in Section of Research Methodology, the total contribution score of each of these 10 researchers was calculated respectively. Albert P.C Chan published the largest number of related papers during the study period and received the highest score of 3.9, followed by Ralf Müller and Robert Osei-Kyei, who also received scores greater than 2, with 3.34 and 2.27, respectively. In addition, of these 10 researchers, only is one from a developing economy, which indicates the imbalanced development between developing and developed areas.

(insert **Table 5.** here)

Citation analysis is another effective way to analyze contributions. Table 6 lists the top 10 articles ranked by citations in the selected period. It shows that most of these articles were published in PMJ, IJPM, and JCEM-1, which indicates that these three journals published not only the most related papers, but also the most influential papers in the selected period. Although these analyses may not fully reflect the citation status of recent journal papers, project success research is identified as a consistently important area in CEM.

(insert **Table 6.** here)

4.3 Categories of research methods

Understanding the data collection and analysis methods used can help researchers gain insights into the development of project success. In this study, the target-publication methodologies were categorized as either questionnaire, case study, or interview, which were the top three methods used for data collection, totaling 66, 40, and 39, respectively. Other research methods, such as field research and literature review are also used. The primary data analysis method (approximately 83% of the total) was quantitative, which is typically implemented using one of many optimization tools. In this study, we categorized the main quantitative methods into the following groups:

1. Descriptive statistics/analysis, such as the chi-square test and analysis of variance (Muller and Turner, 2010, Zare *et al.*, 2016)
2. Factor analysis (Muller *et al.*, 2012)
3. Regression analysis (Wang and Gibson, 2010)
4. Structural equation modeling (SEM) (Ng *et al.*, 2010, Doloi *et al.*, 2011)
5. Analytic hierarchy process (AHP) (Akal *et al.*, 2016, Gupta *et al.*, 2012)

6. Principal component analysis (Almohsen and Ruwanpura, 2016)
7. Fuzzy analysis (Mostafaei *et al.*, 2016, Osei-Kyei *et al.*, 2016)
8. Delphi (Hu *et al.*, 2015a)
9. Modeling, such as system dynamic modeling (Ullah *et al.*, 2017)

It is worth noting that a method that had been adopted by more papers does not indicate that it is more popular than others since some approaches are more general in scope. It is also interesting that descriptive analyses were more likely to be used in the earlier studies, whereas more advanced statistical and modeling methods, such as genetic algorithms and fuzzy hybrid neural networks, are growing in popularity in project success CEM studies.

4.4 Analysis of keywords network

Keywords are indicators of studies that convey their main topics. As such, co-occurring keywords can be identified and analyzed to reflect the hottest research issues in a given field. In this review, a network of high-frequency keywords via the UCINET software (Fig 3) was constructed. A word's centrality is a primary indicator that reflects its interlinkages between target keywords and the size of each node. The thickness of the connection line reflects the number of co-occurrences of two keywords; that is, the thicker the line, the more co-occurrences.

As shown in Fig. 3, project success, CSFs, and project management are the most frequently targeted keywords, with project management being one of the core areas with a close connection to project success. Figure 3 shows an intense connection between CSFs and PPP, which may indicate that CSF-related analyses are highly valued in PPP construction projects due to their great advantages in improving efficiency and effectiveness. These factors have yet to be extensively studied in the academic and industrial realms. In addition, the target nodes on the edge of the network can be divided into two primary types (Fig. 3)—location (China, Hong Kong, Malaysia) and research approaches, such as AHP and factor analysis. Interestingly, projects conducted in different regions tend to adopt different approaches. For example, the keyword China is largely correlated with project complexity, stakeholders, and stakeholder management, whereas the keyword Malaysia is linked more to research methods like factor analysis.

(insert **Figure 3.** here)

Next, the authors used a bi-dimensional MDS table to statistically analyze the distances between target keywords. To standardize the data matrix, the cosine coefficient was used. The resulting stress value was 0.16 (<0.2) and the RQS was 0.866 (>0.8), which comply with the required standards. As shown in Fig 4, project success, project management, and project manager are keywords with intense links in the first quadrant. PPP, CSFs, and developing countries exhibited closer connections in the second quadrant, which reveals that developing countries rely heavily on PPPs and CSFs analysis. In the third quadrant, it shows that China, Malaysia, and construction project shared the strongest links, probably because these articles addressed regional CEM cases descriptively. In addition, the keywords megaproject, complexity, and project performance are strongly associated with each other in the fourth quadrant. This may indicate that these research papers focus mainly on the performances of large, complex construction projects.

(insert **Figure 4.** here)

5 Implications for future research

Based on the above review and analyses, project success in CEM is expected to be mainly centered on four areas: research on megaproject success, project success in developing countries/regions, identifying the relationships between CSFs and success outcomes, and human factors in project success. In the following section, four future research directions for each of these areas are discussed, as summarized in Fig. 5**.**

Megaproject success

Rapid global urbanization has triggered an investment boom in construction megaprojects for both renewal activities in developed countries and new construction activities in developing countries. For example, McKinsey estimates that the world will require about a US$57 trillion investment in infrastructure by 2030 to keep up with the expected GDP growth. Megaprojects differ from the normal projects in many aspects, such as huge investments, very long periods, high in complexities and uncertainties, and multiple stakeholders, which may lead to increasing uncertainties and difficulties in project success. However, most journal articles addressing project success in the field of CEM have only focused on normal construction projects, and studies on the success of megaprojects are rather limited. Hence, future research should emphasize project success within the field of megaprojects. This specific target area should cover criteria or dimensions that reflect and indicate megaproject success, key factors in the success of megaprojects of different types, and the different perspectives of megaproject participants at different construction phases/stages.

Project success in developing economies

During the past few decades, considerable effort has been invested in addressing the barriers to project success and strategies in construction practices in developed countries/regions, such as the UK and Hong Kong (as shown in Tables 4 and 5). However, these factors for improving the likelihood of construction project success have been insufficiently addressed in developing areas. The lack of existing research has adverse impacts on current construction practices. In addition, the variations in the social and cultural contexts of countries can result in errors in the application of project success theories or may require more region-specific strategies. Taking China as an example, organizations generally adopt a centralized leadership strategy, especially in large-scale and mega projects, by which construction projects can be guaranteed to be performed with high efficiency. This situation differs from that in western countries. Therefore, suggestions for future research directions include customized research topics that identify differences in the criteria and CSFs in developed and developing areas, identifying the barriers and strategies for project success in developing countries, and increasing the effectiveness of identified strategies.

Relationships between CSFs and project success

In the analysis of keywords networking, CSFs has already been identified as the most popular subtopic in the targeted research area. Currently, existing studies on the relationship between a given factor or several factors and project success outcomes have been determined, facilitating a better

understanding and management of factors that contribute to a project's success. However, successful outcomes require the analysis of how CSFs affect project constraints, such as cost and time. Decision-makers and managers need this knowledge to manage efficiently. Although existing research has addressed some important factors regarding project success outcomes, research is needed that links the correlation of and possible causation by CSFs with project success.

In addition, methods like questionnaires and the Delphi approach primarily facilitate the identification of factors and the ranking of their importance to project success, whereas more complex data collection and analyses could be implemented with computer assistance. Therefore, future research considerations should ask: What are the relationships between CSFs and project success? How can we improve project management based on these identified relationships to help project managers improve their chances of achieving construction project success? Might there be a more robust method by which to conduct this research?

Human factors in project success

The identified papers addressing CSFs primarily focus on managerial and technical factors. Studies on human factors are rather limited. However, human-related factors, such as organizational citizenship behavior (OCB), have already demonstrated to contribute to project success, still lacking comprehensive studies in CEM project success area. Therefore, for human-factor-related project success studies, the following questions might be considered and addressed: What specific factors drive construction participants to contribute to project success? How can we design and implement effective incentives or reward schemes to inspire participants? How can we cultivate positive behaviors like OCB in construction practice to improve the likelihood of project success?

(insert **Figure 5.** here)

6 Conclusions

Our study provided a holistic assessment of project success in the field of the CEM, which reviewed a total number of 164 relevant papers published from 2007 to 2017, summarized the status of this field of research, and prospected for future research trends. The major findings of this paper are concluded as follows:

1. The PMJ, IJPM, and JCEM-1 appeared to be the dominant journals regarding the CEM project success, which majorly published studies conducted in the developed countries or regions such as Australia, Singapore, and Hong Kong. However, the developing economies that are currently flourishing in the construction activities contributed comparatively less in promoting CEM project success research.

2. Questionnaires, interviews, and case studies are the major data collection methods and descriptive analysis is the main data analysis method.

3. The CSFs research appears the predominant subtopic of project success at the current stage by keywords networking analysis.

4. The megaproject success, studies in developing countries, relationships between CSFs and project success, and human-related factor impacts on successful outcomes are four directions for future study.

The specific results of this paper can hopefully contribute to further research by providing new gaps and research opportunities for researchers. However, this paper only considered articles published in peer-reviewed journals in the last decade, and some relevant papers might be excluded. Moreover, although the classification of papers was based on well-designed procedures that aim to improve objectivity, the authors admit the possibility of some subjectivity, especially in the paper selection and categories of research methods. Given these limitations, significant contributions are still exerted in this work. This study reveals the status quo of project success in CEM and benefits studies that straddle the theoretical sciences and engineering projects. Meanwhile, a better understanding of research trends may enable scholars and practitioners to identify the key issues in project success research to facilitate faster

development in this area.

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Table1. Scoring matrix for multi-author articles

	Order of specific authors				
Number of authors	1	2	3	4	5
1	1.00	-	-	-	-
2	0.60	0.40	-	-	-
3	0.47	0.32	0.21	-	-
4	0.42	0.28	0.18	0.12	-
5	0.38	0.26	0.17	0.11	0.08

Table 2. High-frequency keywords identified in this study

Frequency	Keywords	Frequency	Keywords
51	project success	6	structural equation modeling
48	critical success factors	5	procurement
32	project management	5	project governance
25	PPP	5	factor analysis
17	project success factors	5	project performance
14	construction project	5	Hong Kong
8	success criteria	5	stakeholders
8	china	5	Malaysia
8	construction industry	4	principal component analysis
6	construction		

continue…

Table 3. Top 10 journals for published project success papers in CEM

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Total
Selected journals	435	455	473	516	525	576	643	662	691	755	672	6403
Project success	2	7	3	1	8	6	9	7	18	14	13	88
Ratio (%)	0.5	1.5	0.6	0.2	1.5	1.0	1.4	1.1	2.6	1.9	1.9	1.4
IJPM	84	84	80	79	96	82	100	126	150	147	126	1154
Project success	0	2	1	0	3	0	2	3	9	2	5	27
Ratio（%）	0	2.4	1.3	0.0	3.1	0.0	2.0	2.4	6.0	1.4	4.0	2.3
JME	24	28	24	24	27	46	52	73	117	92	87	594
Project success	0	1	0	0	2	0	1	0	3	3	3	13
Ratio（%）	0.0	3.6	0.0	0.0	7.4	0.0	1.9	0.0	2.6	3.3	3.4	2.2
JCEM-1	37	36	41	65	57	88	99	83	92	101	91	790
Project success	0	0	1	0	0	1	2	1	3	0	1	9
Ratio（%）	0.0	0.0	2.4	0.0	0.0	1.1	2.0	1.2	3.3	0.0	1.1	1.1
JCEM-2	109	103	132	131	127	151	170	153	109	175	181	1541
Project success	1	1	0	1	0	2	1	0	0	1	1	8
Ratio（%）	0.9	1.0	0.0	0.8	0.0	1.3	0.6	0.0	0.0	0.6	0.6	0.5
PMJ	12	39	30	35	36	36	36	36	42	55	27	384
Project success	0	2	1	0	1	1	1	0	0	1	1	8
Ratio（%）	0.0	5.1	3.3	0.0	2.8	2.8	2.8	0.0	0.0	1.8	3.7	2.1
CME	101	94	90	91	85	65	70	75	57	57	41	826
Project success	1	1	0	0	2	1	1	0	0	0	0	6
Ratio（%）	1.0	1.1	0.0	0.0	2.4	1.5	1.4	0.0	0.0	0.0	0.0	0.7
CEB	10	11	12	19	25	28	35	28	27	26	19	240
Project success	0	0	0	0	0	0	0	0	3	1	1	5
Ratio（%）	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	3.8	5.3	2.1
BEPAM	12	13	13	14	14	15	17	24	29	36	38	225
Project success	0	0	0	0	0	0	0	0	0	3	1	4
Ratio（%）	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.3	2.6	1.8
IJCM	14	12	17	22	20	21	23	23	28	25	23	228
Project success	0	0	0	0	0	1	1	0	0	2	0	4
Ratio（%）	0.0	0.0	0.0	0.0	0.0	4.8	4.3	0.0	0.0	8.0	0.0	1.8
IJMPB	32	35	34	36	38	44	41	41	40	41	39	421
Project success	0	0	0	0	0	0	0	3	0	1	0	4
Ratio（%）	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.3	0.0	2.4	0.0	1.0

Notation: JCEM-1refers to Journal of Civil Engineering and Management; JCEM-2 refers to Journal of Construction Engineering and Management.

Table 4. Research origins of published papers

Ranking	Institutions	Countries/ regions	Researchers	Articles	Scores
1	Hong Kong Polytechnic Univ.	Hong Kong	23	22	14.38
2	National Taiwan Univ. of Science and Technology	Taiwan	10	5	5
3	University of Technology Malaysia	Malaysia	15	6	4.72
4	Queensland University of Technology	Australia	10	8	3.81
5	National University of Singapore	Singapore	6	4	3.72
6	Islamic Azad University	Iran	5	3	2.58
7	Indian Institute of Technology Delhi	India	4	2	2.53
8	University of Salford	UK	8	4	2.47
9	Asian Institute of Technology	Thailand	5	4	2.4
10	University of Pretoria	South Africa	6	3	2.4

Table 5. Top 10 researchers contributing to publications in project success

Researchers	Articles	Scores	Affiliation	Location
Chan, Albert P. C.	12	3.9	Hong Kong Polytechnic Univ.	Hong Kong
Müller, Ralf	7	3.34	Umea University	Sweden
Osei-Kyei, Robert	6	2.27	Hong Kong Polytechnic Univ.	Hong Kong
Turner, J. Rodney	4	1.61	Univ Lille Nord de France	France
Joslin, Robert	3	1.8	Skema Business School	France
Cheng, Min-Yuan	3	1.34	The National Taiwan University of Science and Technology	Taiwan
Khan, Adeel Sabir	3	1.19	Institute of Management Sciences	Pakistan
Davis, Kate	2	2	Kingston University London	UK
Toor, Shamas-ur-Rehman	2	1.2	National University of Singapore	Singapore
Chou, Jui-Sheng	2	1.07	The National Taiwan University of Science and Technology	Taiwan

Table 6. Top 10 journal papers ranked by citation

Authors	Year	Journal	Times
Ika, Lacagnon A.	2009	PMJ	465
Müller, Ralf and Turner, J. Rodney	2007	European Management Journal	396
Davis, Kate	2014	IJPM	211
Shen, L.Y., Tam, V.W.Y et al.	2010	Journal of Cleaner Production	169
Ahadzie, D.K., Proverbs, D.G., Olomolaiye, P.O.	2008	IJPM	162
Yang J., Shen Q.P et al.	2009	JCEM-1	155
Lam, W. M., Chan, Albert P. C. et al.	2008	JCEM-1	135
Al-Tmeemy SMHM., Abdul-Rahman, H., Harun, Z.	2011	IJPM	135
Turner, J. Rodney and Zolin, Roxanne	2012	PMJ	133
Bryde, David	2008	IJPM	131

Notation: Data obtained from Google Scholar (retrieved on 10 Oct, 2017)

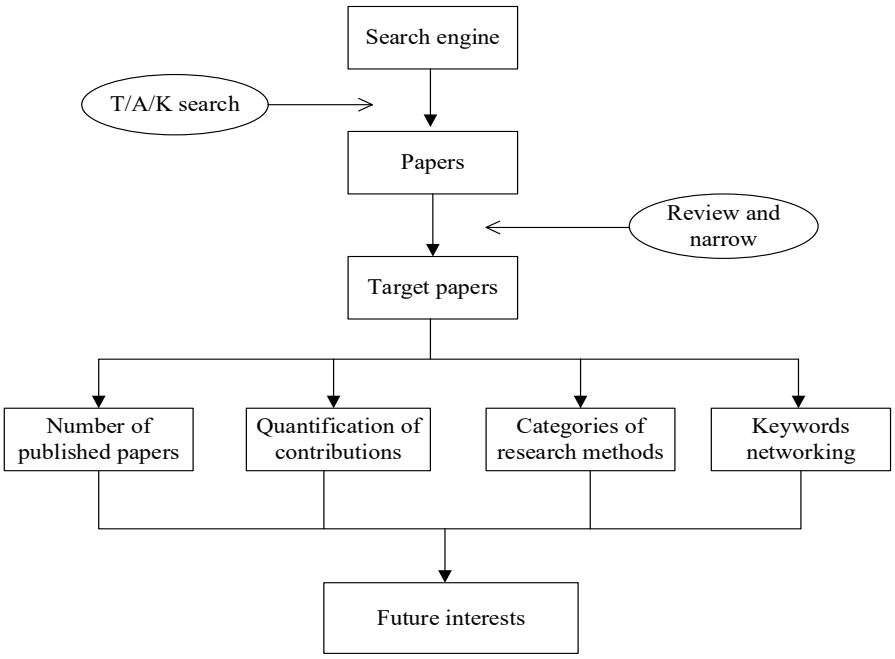

Figure 1. Research Framework of this paper

Notation: T/A/K- Title/Abstract/Keywords; MDS-Multi-dimensional scale

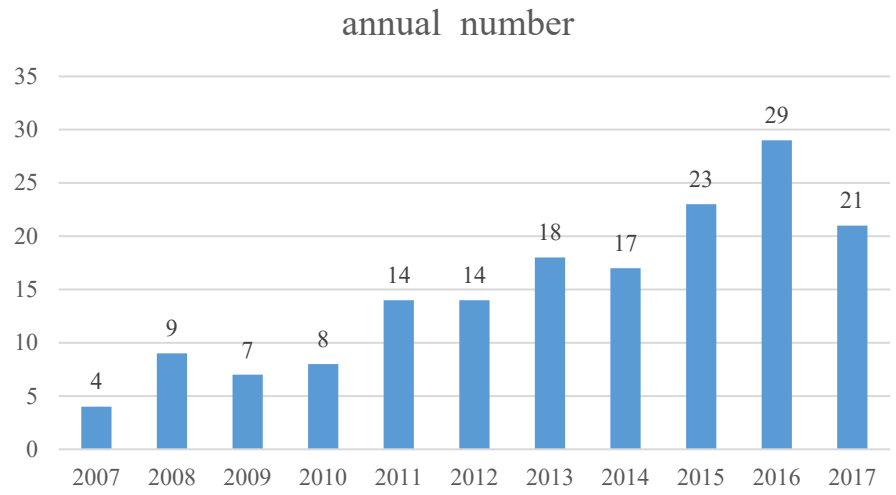

Figure 2. Annual publications in journal papers on project success in CEM from 2007 to 2017 (data for 2017 was up to October)

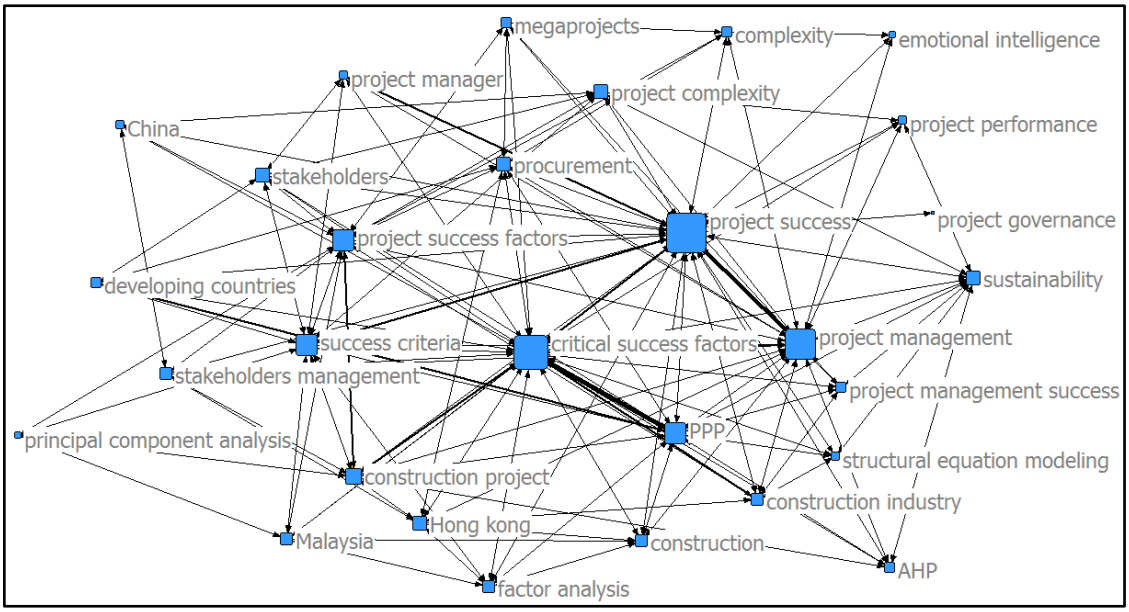

Figure 3. Network of high-frequency keywords.

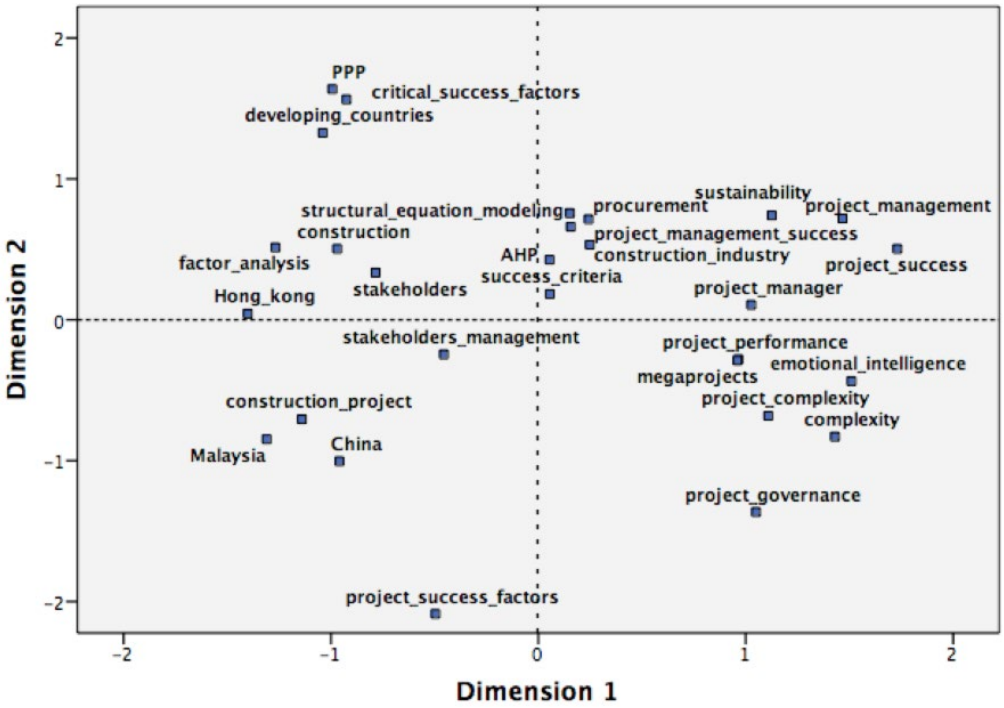

Figure 4. Bi-dimensional table of MDS

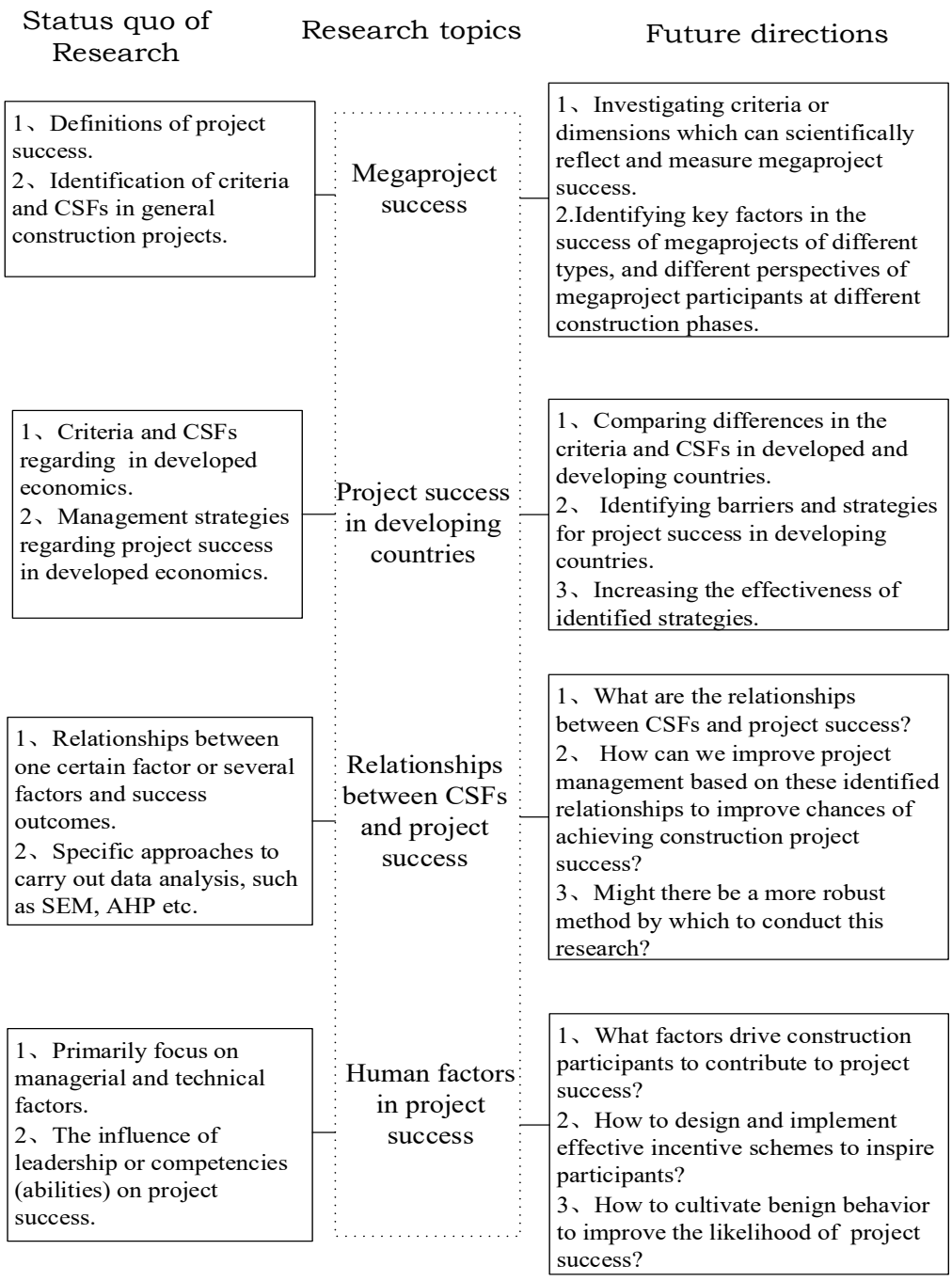

Figure 5. Future research directions in project success in the field of CEM

Appendix 1. A total of 164 articles identified in journals between 2007 and 2017

No.	Journal	Authors	Year
1	African Journal of Business Management	Li, Y., Lu,Y., and Peng,Y.	2011
2	Advanced Engineering Informatics	El-Saboni, M., Aouad, G., and Sabouni, A.	2009
3	African Journal of Business Management	Khan, A. S., Gul, S., and Shah, A.	2011
4	Arabian Journal for Science and Engineering	Nilashi, M., Zakaria, R., Ibrahim, O., Majid, M.Z.A. Zin, R.M., and Farahmand, M.	2014
5	Asia Pacific Business Review	Thi, C. H. and Swierczek, F. W.	2010
6	Asian Social Science	Rajablu, M., Marthandan, G., and Yusoff, W.F.W.	2014
7	Australian Journal of Civil Engineering	Crosby, P.	2017
8	Australian Journal of Management	Clements, K. W. and Si, J.	2011
9	Automation in Construction	Wang, Y. R. and Gibson, G. E.	2010
10	Automation in Construction	Cheng, M. Y., Tsai, H. C., and Sudjono, E.	2012
11	Baltic Journal of Management	Muller, R., and Turner, J. R.	2010
12	Benchmarking: An International Journal.	Osei-Kyei, R., Chan, A.P. C., and Ameyaw, E. E.	2016
13	BEPAM	Amoatey, C., and Hayibor, M. V. K.	2017
14	BEPAM	Rohman, M. A., Doloi, H., and Heywood, C. A.	2016
15	BEPAM	Babatunde, S. O., Perera, S., Zhou, L., and Udeaja, C.	2016
16	BEPAM	Thanh, N. H., and Hadikusumo, B. H. W.,	2016
17	Cities	Bae, Y., and Joo, Y. M.	2016
18	Civil Engineering Journal	Zare, M. B., Jalili, A. M., and Mirabi, M.	2016
19	Civil Engineering Journal	Akal, A.Y., Abu, E., and El-Hamrawy, S.	2016
20	CEB	Alashwal, A.M., Fareed, N.F., and Al-obaidi, K.M.	2017
21	CEB	Fahri, J., Biesenthal, C., Pollack, J., and Sankaran, S.	2015
22	CEB	Sanni, A. O.	2016
23	CEB	Rotimi, J. O. B., and Ramanayaka, C.	2015
24	CEB	Musa, M. M., Amirudin, R., Sofield, T., and Musa, M. A.	2015
25	Construction Innovation	Nitithamyong, P., and Skibniewsk, M. J.	2011
26	Construction Innovation	Toor, S. R., and Ogunlana, S. O.	2009
27	CME	Rowlinson, S., and Cheung, Y. K. F.	2008
28	CME	Lehtiranta, L., Kärnä, S., Junnonen, J. M.,and Julin, P.	2012
29	CME	Thomson, D.	2011
30	CME	Tabish, S. Z. S., and Jha, K. N.	2011
31	CME	Yong, Y. C., and Mustaffa, N. E.	2013
32	CME	Mbachu, J., and Nkado, R.	2007
33	Corporate Ownership & Control	Mavetera, N., Sekhabisa, K., Mavetera, C., and Choga, I.	2015
34	Ecological Indicators	Olanipekun, A. O., Chan, A. P. C., Xia, B., and Ameyaw, E.E.	2017

35	Engineering Management Journal	Ahmed, R., and Mohamad, N.A.B.	2016
36	Engineering Management Journal	Hughes, S. W., Tippett, D.D., and Thomas, W.K.	2015
37	Engineering, Construction and Architectural Management	Heravi, G., and Ilbeigi, M.	2012
38	Entrepreneurial Business and Economics Review	Węgrzyn, J.	2016
39	Environmental Modelling & Software	Merritt, W. S., Fu, B., Ticehurst, J. L., Sawah, S., and Vigiak, O.	2017
40	European Management Journal	Müller, R., and Turner, R.	2007
41	Evaluation & the Health Professions	Hogle, J. A., and Moberg, D. P.	2014
42	Facilities	Osei-Kyei, R., and Chan, A. P. C.	2017
43	Habitat International	Zhou, T., Zhou, Y., and Liu, G.	2017
44	IEEE Transactions on Engineering Management	Ng, S. T., Wong, Yoki. M.W., and Wong, James. M.W.	2010
45	IEEE Transactions on Engineering Management	Muller, R., Geraldi, J., and Turner, J. R.	2012
46	IEEE Transactions on Engineering Management	Lechler, T. G., and Dvir, D.	2010
47	Industrial Engineering and Management Systems	Khalilzadeh, M., Akbari, H., and Foroughi, A.	2016
48	International Journal of Applied Engineering Research	Sandbhor, S., Choudhary, S., Arora, A., and Katoch, P.	2014
49	International Journal of Applied Engineering Research	Sandbhor, S,K., Shirsagar, M., Choudhary, S., Arora, A., and Katoch, P.	2015
50	International Journal of Business and Society	Markom, R., and Ali, E. R. A. E.	2012
51	International Journal of Civil Engineering and Technology	Wahaj, M., Deep, S., Dixit, R.B., and Khan, A. S.	2017
52	IJCM	Wai, S. H., Aminah, M.Y., and Syuhaida, I.	2013
53	IJCM	Osei-Kyei, R. and Chan, A. P. C.	2016
54	IJCM	Saadi, R., and Abdou, A.	2016
55	IJCM	Jin, X.H., Tan, H.C., Zuo, J., and Feng, Y.	2012
56	International Journal of Disaster Resilience in the Built Environment	Ophiyandri, T., Amaratunga, D., Pathirage, C., and Keraminiyage, K.	2013
57	International Journal of Engineering Business Management	Wai, S. H., Yusof, A.M., Ismail, S., and Ng, C. A.	2013
58	International Journal of Information Systems and Project Management	Gilbert, S. A. J. and Ron, S.	2016
59	IJMPB	Sato, C. E. Y. and Milton, F. C.	2014
60	IJMPB	Rolstadas, A., Tommelein, I., Schiefloe, P. M., and Ballard, G.	2014
61	IJMPB	Joslin, R. and R. Müller	2016
62	IJMPB	Motaleb, O.H., and Kishk, M.	2014
63	IJPM	Ahadzie, D.K., Proverbs, D.G., and Olomolaiye,	2008

		P. O.	
64	IJPM	Ika, L. A., and Donnelly, J.	2017
65	IJPM	Osei-Kyei, R., and Chan, A. P. C.	2015
66	IJPM	Joslin, R., and Müller, R.	2015
67	IJPM	Joslin, R. and Müller, R.	2016
68	IJPM	Chang, A., Chih, Y.Y., Chew, E., and Pisarski, A.,	2013
69	IJPM	Mazur, A., Pisarski, A., Chang, A., and Ashkanasy, N. M.	2014
70	IJPM	Carvalho, M. M., Patah, L.A., and Diógenes, S.B.	2015
71	IJPM	Bryde, D.	2008
72	IJPM	Rezvani, A., Chang, A., Wiewiora, A., Ashkanasy, N.M., Jordan, P.J., and Zolin, R.	2016
73	IJPM	Petro, Y., and Gardiner, P.	2015
74	IJPM	Alzahrani, J. I. and Emsley, M. W.	2013
75	IJPM	Zou, W., Kumaraswamy, M., Chung, J., and Wong, J.	2014
76	IJPM	Khan, A. S., and Rasheed, F.	2015
77	IJPM	Müller, R., Zhai, L., and Wang, A.	2017
78	IJPM	Carvalho, M. M., and Rabechini, R.	2017
79	IJPM	Banihashemi, S., Hosseini, M.R,. Golizadeh, H., and Sankaran, S.	2017
80	IJPM	Yu, J. H., and Kwon, H. R.	2011
81	IJPM	Davis, K.	2014
82	IJPM	Davis, K.	2017
83	IJPM	Ruuska, I., and Teigland, R.	2009
84	IJPM	Doloi, H., Iyer, K. C., and Sawhney, A.	2011
85	IJPM	Todorović, M. L., Petrović, D. C., Mihić, M. M., Obradović, V. L., and Bushuyev, S. D.	2015
86	IJPM	Costantino, F., Gravio, G., and Nonino, F.	2015
87	IJPM	Tmeemy, S. M. H. M., Abdul-Rahman, H., and Harun, Z.	2011
88	IJPM	Toor, S.R., and Ogunlana, S. O.	2008
89	IJPM	Chou, J.S., and Pramudawardhani, D.	2015
90	International Journal of Strategic Property Management	Osei-Kyei, R., Chan, Albert P. C., Javed, A.A., and Ameyaw, E.E.	2017
91	International Journal of Strategic Property Management	Gudienė, N., Banaitis, A., and Banaitienė, N.	2013
92	International Journal of Sustainable Built Environment	Ihuah, P. W., Kakulu, I. I., and Eaton, D.	2014
93	International Journal of Urban Sciences	Ghanaee, M., and Pourezzat, A. A.	2013
94	Jordan Journal of Civil Engineering	Kahwajian, A., Baba, S., Amudi, O., and Wanos, M.	2014
95	Journal of Business Economics and Management	Kao, C. H., Huang, C.H., Hsu, M. S. C., and Tsai, I. H.	2016

96	JCEM-1	Surlan, N., Cekic, Z., and Torbica, Z.	2015
97	JCEM-1	Ghosh, S., Amaya, L., and Skibniewski, M. J.	2012
98	JCEM-1	Liu, H., Skibniewski, M. J., and Wang, M.	2015
99	JCEM-1	Gudienė, N., Banaitis, A., Podvezko, V., and Banaitienė, N.	2014
100	JCEM-1	Yun, S., Jung, W., Han, S.H., and Park, H.	2015
101	JCEM-1	Pinter, U., and Pšunder, I.	2013
102	JCEM-1	Yang, J., Shen, G.Q., Ho, M., Drew, D.S., and Chan, Albert P. C.	2009
103	JCEM-1	Aznar, B., Pellicer, E., Davis, S., and Ballesteros, P.P.	2017
104	JCEM-1	Cheng, M.Y., Huang, C.C., and Roy, A. F. V.	2013
105	Journal of Cleaner Production	Shen, L.Y., Tam, V. W. Y., Tam, L., and Ji, Y.B.	2010
106	JCEM-2	Tabish, S. Z. S. and Jha, K. N.	2012
107	JCEM-2	Chou, J.S., Irawan, N., and Pham, A.D.	2013
108	JCEM-2	Love, P. E. D., Mistry, D., and Davis, P. R.	2010
109	JCEM-2	Ghanbaripour, A. N., Langston, C., and Yousefi, A.	2017
110	JCEM-2	O'Connor, J.T., Choi, J.O, and Winkler, M.	2016
111	JCEM-2	Hwang, B.G., and Lim, E.S.	2012
112	JCEM-2	Lam, E.W.M., Chan, A.P. C., Chan, D.W. M.	2008
113	JCEM-2	Ko, C.H. and Cheng, M.Y.	2007
114	Journal of Engineering, Design and Technology	Chau, N. D., and Long, L.H.	2016
115	Journal of Environmental Planning and Management	Bassan, M., Koné, D., Mbéguéré, M., Holliger, C., and Strande, L.	2014
116	Journal of Facilities Management	Ameyaw, E. E., Chan, A.P.C., and Owusu-Manu, D.G.	2016
117	Journal of Fundamental and Applied Sciences	Zare, M. B., Mirjalili, A., and Mirabi, M.	2016
118	Journal of Green Building	Rasekh, H., and McCarthy, T. J.	2016
119	Journal of Infrastructure Systems	Osei-Kyei, R. and Chan, A. P. C.	2017
120	JME	Hu, Y., Chan, A.P.C., and Le, Y.	2014
121	JME	Jiang, W., Lu, Y., and Le, Y.	2016
122	JME	Liu, J., Love, P.E.D., Smith, J., Regan, M., and Davis, P.R.	2015
123	JME	Luo, L., He, Q., Xie, J., Yang, D., and Wu, G.	2017
124	JME	Chan, Albert P. C., Chan, Daniel W. M., Fan, Linda C. N., Lam, Patrick T. I., and Yeung, John F. Y.	2008
125	JME	Erdem, D., and Ozorhon, B.	2015
126	JME	Molenaar, K.R., Javernick,W.A., Bastias, A.G., Wardwell, M.A., and Saller, K.	2013
127	JME	Lam,P.T. I., Chiang,Y. H., and Chan, S.H.	2011

128	JME	Meng, X., Zhao, Q., and Shen, G.Q. P.	2011
129	JME	Yu, A. T. W., and Shen, G. Q. P.	2015
130	JME	Krajangsri, T., and Pong, P.J.	2017
131	JME	Almohsen, A.S., and Ruwanpura, J. Y.	2016
132	JME	Liu, B., Huo, T., Meng, J., Gong, J., Shen, Q., and Sun, T.	2016
133	Journal of Performance of Constructed Facilities	Oyedele, L.O.	2013
134	Journal of Sustainability Science and Management	Ponniah, V., Ismail, R., and Shafiei, M.W.M.	2015
135	KSCE Journal of Civil Engineering	Ribeiro, P., Paiva, A., Varajão, J., and Dominguez, C.	2013
136	Life Science Journal	Ejaz, N., Hussain, J., Shabbir, F., Shamim, M., and Naeem, U.	2013
137	Management Research Review	Gupta, A., Gupta, M.C., and Agrawal, R.	2012
138	International Journal of Management Science and Engineering Management Journal	Ogwueleka, A.	2011
139	Pakistan Journal of Statistics	Wu, G.	2013
140	Planning Theory and Practice	Ward, E. J., Wright, P.G., and Dimitriou, H.T.	2014
141	PMJ	Alderman, N., and Ivory, C.	2011
142	PMJ	Martens, M. L., and Carvalho, M. M.	2017
143	PMJ	Khang, D. B., and Moe, T. L.	2008
144	PMJ	Ika, L. A.	2009
145	PMJ	Williams, T.	2016
146	PMJ	Creasy, T., and Anantatmula, V. S.	2013
147	PMJ	Turner, R. and Zolin, R.	2012
148	PMJ	Geoghegan, L. and Dulewicz, V.	2008
149	Quality & Quantity	Ahmed, R., Mohamad, N.A.B., and Ahmad, M.S.	2014
150	Renewable and Sustainable Energy Reviews	Zhao, Z.Y., Zuo, J., and Zillante, G.	2013
151	Renewable Energy	Zhao, Z.Y., Zuo, J., Zillante, G., and Wang, X.W.	2009
152	Research in Transportation Economics	Galilea, P., and Medda, F.	2010
153	Safety Science	Aksorn, T., and Hadikusumo, B. H. W.	2008
154	Scientific Research and Essay	Elattar, S. M. S.	2009
155	South African Journal of Industrial Engineering	Van Niekerk, S. I., and Steyn, H.	2012
156	South African Journal of Industrial Engineering	Chihuri, S., and Pretorius, L.	2012
157	South African Journal of Industrial Engineering	Pretorius, S., Steyn, H., and Jordaan, J. C.	2012
158	Structural Survey	Low, S.P., Gao, S., and Tay, W.L.	2014
159	Structural Survey	Ofori-Boadu, A., Owusu-Manu, D.G., Edwards, D., and Holt, G.	2012

160	Sustainability	Shi, S., Chong, H.Y., Liu, L., and Ye, X.	2016
161	The TQM Journal	Ullah, F., Thaheem, A.J., Siddiqui, S.Q., and Khurshid, M.B.	2017
162	Transportation Planning & Technology	Hugo, P., and Bert, V.W.	2007
163	Transport Reviews	Liyanage, C., and Villalbaromero, F.	2015
164	Water Science Technology	Mostafaei, A., Kalantari, N., and Zarkesh, M. K.	2016