Investigating the managerial “nuts and bolts” for the construction industry

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Abstract

Purpose – Managerial shortfalls can considerably undermine the delivery performance of construction projects. This paper appraises the project management essentials (PMEs) for successful construction project delivery.

Design/methodology/approach – Following a detailed literature review, a questionnaire survey was developed encompassing 20 PMEs that were identified. An opinion questionnaire survey was used to facilitate data collection from key construction stakeholders in the Malaysian construction industry. The survey data were subjected to descriptive statistics and exploratory factor analysis.

Findings – Findings indicated that the leading PMEs are competency of the project team, competency of project manager, good leadership, effective planning and control and realistic cost and time estimate. Spearman’s rank correlation tests affirmed a good agreement on the ranking of PMEs across stakeholder groups. The present study found that PMEs for construction have a total of four dimensions, namely: scope, communication and competence management; stakeholder commitment and collaborative engagement; construction time–cost planning and control; and environment, health, safety and quality management.

Practical implications – The findings could potentially contribute to the development of appropriate project management best practices to address managerial shortfalls in Malaysia and other developing countries.

Originality/value – This paper bridges the identified knowledge gap about critical managerial dimensions for successful project management in construction. The present study adds to the existing body of knowledge around this under-explored area in the construction management literature.

Keywords Construction industry, Factor analysis, Overruns, Performance management, Project management, Ranking

Paper type Research paper

Introduction

The plethora of project management problems continue to undermine project outcomes and tarnish the reputation of the construction industry, particularly in the developing world (Nguyen and Chileshe, 2015; Yap *et al.*, 2019a). In a Vietnamese study, Le-Hoai *et al.* (2008) interviewed 87 construction professionals to conclude that comparable reasons contributing to delays and cost overruns are observed in most developing Asian and African economies. They also claim that the academic curriculum to train engineers focusses on scientific and mathematical principles to solve technical problems but leave a gap in planning, managing and organising knowledge. On that front, Yap *et al.* (2019a) assert that most problems in the Malaysian construction industry are related to human and managerial predicaments – ratifying ineffective construction project management practices. In Thailand, Toor and Ogunlana (2008) also revealed an analogous trend whereby inexperienced members, inept contractors, poor contractual knowledge, impractical designs and ineffective project

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management practices are typical delay factors. This is unsurprising as comparable findings highly associated with mismanagement and lack of skills were also reported by Sambasivan and Soon's (2007) Malaysian and Akogbe *et al.*'s (2013) Benin studies. Interestingly, competencies assessment framework for construction project managers (PMs) in the developing world is still non-existence (Au *et al.*, 2018). Against this background, project personnel's level of competency is often not equal to the challenges they encounter in their profession (Edum-Fotwe and McCaffer, 2000) – resulting in projects continuing to fail at an astonishing rate.

To provide an overview of the shortcomings of existing research efforts, Alsehaimi *et al.* (2013) reviewed 16 delay studies conducted in the developing world to infer that ignorance and ineptitude prevalently prompt schedule delays in construction projects. Most research has focussed on identifying what causes project failures (e.g. Bagaya and Song, 2016; Damoah and Kumi, 2018; Nguyen and Chileshe, 2015), critical success factors (e.g. Alias *et al.*, 2014; Sinesilassie *et al.*, 2018; Yong and Mustaffa, 2013) and personality traits of PMs (e.g. Creasy and Anantatmula, 2013; Gruden and Stare, 2018; Zuo *et al.*, 2018). Few studies have attempted to recommend the managerial best practices and dimensions for construction projects, particularly in the context of a developing country (Alsehaimi *et al.*, 2013). Summarising the aforementioned review, there is an insufficient understanding of how a construction project should be sensibly managed and what ensures the successful competitive performance of performing organisations.

Given the current managerial shortfalls, the industry needs to evolve towards attaining enhanced schedule, cost and quality outcomes by leveraging project management best practices. As a corollary, this study aims to make a contribution towards filling these gaps by assessing the effectiveness of project management factors in tackling ubiquitous construction problems. The research questions are:

(1) What are the effective managerial measures to improve construction project management?

(2) What are the underlying dimensions for successful construction project management?

Construction project management

Project management is about attaining on-time, on-budget and goal-focussed delivery of the project within the given constraints. Project Management Body of Knowledge (PMBOK) Guide outlines project management as "the application of knowledge, skills, tools, and techniques to project activities to meet the project requirements... enables organisations to execute projects effectively and efficiently" (Project Management Institute, 2017, p. 10). As such, management of construction project refers to the application of such skills, techniques and knowledge to the construction context. Oberlender (2000, p. 8) expresses construction project management as "the art and science of coordinating people, equipment, materials, money, and schedules to complete a specified project on time and within approved cost". All build-to-order (BTO) construction projects come with a differing set of requirements and limitations such as budget, development schedule and other resource constraints for completion. The ultimate goal of project management for construction is to deliver a facility that fulfils the client's requirements and attains predetermined objectives.

The identification of pertinent managerial factors is pivotal to ensure the success of this study. By conducting a systematic background review, the most commonly cited construction-specific managerial influencing factors for successful project realisation derived from some selected studies around the world are summarised in Table 1. Although there is no "one-size-fits-all" approach to managing projects, the identified project

Ref	Project management essentials (PMEs)	Fortune and White (2006)	Haron *et al.* (2017)	Chan *et al.* (2004)	Nguyen *et al.* (2004)	Yong and Mustaffa (2013)	Toor and Ogunlana (2008)	Micheal *et al.* (2014)	Alias *et al.* (2014)	Gudienė *et al.* (2014)	Frequency
1	Support from top management	x	x	x	x	x		x	x	x	8
2	Clear and realistic objectives and scope	x			x	x	x	x		x	6
3	Effective communication and feedback	x		x	x	x	x		x	x	7
4	Competency of project team	x	x	x	x	x	x	x	x	x	9
5	Competency of project manager	x		x	x	x	x		x	x	7
6	Adequacy of resources	x	x	x	x	x	x	x		x	8
7	Good leadership	x				x				x	3
8	Realistic cost and time estimate	x	x				x		x	x	5
9	Effective planning and control	x	x	x	x	x	x		x	x	8
10	Good performance of subcontractors/suppliers	x	x	x		x				x	5
11	Past projects' experience (learning from) and performance records	x	x	x	x		x			x	6
12	Total quality management		x	x		x	x			x	5
13	Environmental, health and safety attributes		x	x		x				x	4
14	Customer satisfaction		x								1
15	Up-to-date technology utilisation		x	x	x	x				x	5

(continued)

Table 1.
Summary of PMEs by different authors

Table 1.

Ref	Project management essentials (PMEs)	Fortune and White (2006)	Haron *et al.* (2017)	Chan *et al.* (2004)	Nguyen *et al.* (2004)	Yong and Mustaffa (2013)	Toor and Ogunlana (2008)	Micheal *et al.* (2014)	Alias *et al.* (2014)	Gudienė *et al.* (2014)	Frequency
16	Continuing involvement of stakeholders in project			x						x	2
17	Absence of bureaucracy				x		x				2
18	Commitment of stakeholders to project				x	x		x	x		4
19	Awarding bids to right designers/contractors				x	x	x				3
20	Mutual learning and knowledge sharing		x								1

management essentials (PMEs) are envisaged to significantly influence project performances and improve the industry holistically.

Research method

Questionnaire survey

This study employed a structured self-administered questionnaire survey to solicit the opinions of primary stakeholders in construction which comprise representatives from clients, consultants and contractors on the effectiveness of the 20 identified PMEs, using Malaysia as a case study for the developing world. The questionnaire contained two parts. The first part is intended to gather basic demographic information about respondents, whereas the second part involves rating the 20 PMEs using a five-point Likert scale (ranging from 1 = *ineffective* to 5 = *extremely effective*).

A total of 350 questionnaire forms were distributed through convenience and snowball sampling to increase the number of responses (Ling and Khoo, 2016) as these non-probability sampling techniques are preferred when it is difficult to obtain responses through random sampling approach (Bagaya and Song, 2016). The population comprised practitioners based in the Greater Kuala Lumpur (also known as Klang Valley) region, which is centred in Kuala Lumpur and includes major cities in the state of Selangor. This is the most economically vibrant and commercially important region as nearly 60% of Malaysia's construction value in 2017 is within this central region (Department of Statistics Malaysia, 2018). Over a period of one month, 117 valid questionnaires were collected. The response rate of 33.4% is considered acceptable for survey seeking feedback from construction practitioners (Le-Hoai *et al.*, 2008; Yap *et al.*, 2019a). In addition, the sample size is sufficient for reliable statistical interpretations (Hair *et al.*, 2010).

The detailed profiling information of the respondents is summarised in Table 2. The responses from clients, consultants and contractors are 35.0, 27.4 and 37.6%, respectively. Nearly half (48.7%) of the respondents are currently involved in traditional (design–bid–build) project delivery system. Regarding working experience in construction, almost 45% of them have 10 years or more, and 92.3% hold bachelor's degrees or above. Thus, the respondents are qualified professionals to provide sound judgement concerning local construction practices.

Analysis and results

Ranking of PMEs

Cronbach's alpha is a convenient test used to gauge internal consistency, where the computed value of 0.944 is exceeding the 0.70 threshold needed to satisfy scale reliability (Hair *et al.*, 2010). The collected data concerning the effectiveness of the PMEs were analysed using the relative importance index (RII) technique to facilitate the comparative ranking of the PMEs surveyed. It is worth noting that this approach is commonly used instead of mean ranking to enable cognisance of the critical factors in construction management research (Akogbe *et al.*, 2013; Yap and Lock, 2017). The RII value ranges from 0 (not inclusive) to 1 and is calculated using the following equation:

$$\mathrm{RII} = \frac{\sum W}{5N} \quad (1)$$

where W = weighting given to each factor by respondents (ranging from 1 = *ineffective* to 5 = *extremely effective)*; and N = total number of responses.

The higher the RII value, the more effective is the factor in addressing project management problems. The category of significance (CoS) of each factor is further evaluated in consonance with the scale adopted from Yap and Lock (2017) where: $0.143 \leq \mathrm{RII} \leq 0.286$ as

Table 2.
Profile of respondents

Profile	Parameter	Respondent group Client	Consultant	Contractor	Frequency	Percentage
Education background	Doctoral degree	1	–	1	2	1.7
	Master's degree	4	9	7	20	17.1
	Bachelor's degree	35	23	28	86	73.5
	Diploma	1	–	7	8	6.8
	High school	–	–	1	1	0.9
Working experience (years)	0–5	12	16	18	46	39.3
	6–10	7	6	6	19	16.2
	11–20	16	5	13	34	29.1
	>20	6	5	7	18	15.4
Procurement type	Traditional	25	20	12	57	48.7
	Design and built	6	9	23	38	32.5
	Management contracting	10	3	9	22	18.8

not significant (NS); 0.286 < RII ≤ 0.428 as somewhat significant (SS); 0.428 < RII ≤ 0.571 as moderately significant (MS); 0.571 < RII ≤ 0.714 as significant (S); 0.714 < RII ≤ 0.857 as very significant (VS); and 0.857 < RII ≤ 1.0 as extremely significant (ES).

Table 3 provides the RII for the effectiveness ratings for each factor and arranged in descending order based on overall and the respondent groups correspondingly. As Table 3 indicates, the top 15 PMEs are perceived as very significant (VS) while the remaining five PMEs are regarded as significant (S). The five highly significant (effectiveness) factors based on overall are as follows:

(1) Competency of project team (RII = 0.827);

(2) Competency of PM (RII = 0.827);

(3) Good leadership (RII = 0.826);

(4) Effective planning and control (RII = 0.805); and

(5) Realistic cost and time estimate (RII = 0.795).

The five leading PMEs as perceived by *clients* to be:

(1) Competency of PM (RII = 0.854);

(2) Competency of project team (RII = 0.844);

(3) Good leadership (RII = 0.829);

(4) Awarding bids to right designers/contractors (RII = 0.820); and

(5) Effective communication and feedback (RII = 0.815).

The equivalent for *consultants* are:

(1) Good leadership (RII = 0.850);

(2) Competency of project team (RII = 0.838);

(3) Competency of PM (RII = 0.825);

(4) Realistic cost and time estimate (RII = 0.819); and

(5) Effective planning and control (RII = 0.800).

Table 3. Ranking of PMEs based of RII

PMEs	CoS	Overall (*N* = 117) RII	Overall (*N* = 117) Rank	Client (*N* = 41) RII	Client (*N* = 41) Rank	Consultant (*N* = 32) RII	Consultant (*N* = 32) Rank	Contractors (*N* = 44) RII	Contractors (*N* = 44) Rank
Competency of project team	VS	0.827	1	0.844	2	0.838	2	0.805	2
Competency of project manager	VS	0.827	1	0.854	1	0.825	3	0.805	2
Good leadership	VS	0.826	3	0.829	3	0.850	1	0.805	2
Effective planning and control	VS	0.805	4	0.805	6	0.800	5	0.809	1
Realistic cost and time estimate	VS	0.795	5	0.790	8	0.819	4	0.782	6
Effective communication and feedback	VS	0.790	6	0.815	5	0.775	6	0.777	7
Awarding bids to right designers/contractors	VS	0.776	7	0.820	4	0.763	8	0.745	12
Clear and realistic objectives and scope	VS	0.771	8	0.800	7	0.756	11	0.755	10
Good performance of subcontractors/suppliers	VS	0.771	8	0.746	10	0.775	6	0.791	5
Adequacy of resources	VS	0.762	10	0.746	10	0.763	8	0.777	7
Support from top management	VS	0.759	11	0.776	9	0.744	14	0.755	10
Mutual learning and knowledge sharing	VS	0.754	12	0.741	12	0.750	13	0.768	9
Past project’s experience and performance records	VS	0.738	13	0.732	14	0.763	8	0.727	14
Total quality management	VS	0.733	14	0.717	15	0.744	14	0.741	13
Commitment of stakeholders to project	VS	0.721	15	0.741	12	0.744	14	0.686	18
Environmental, health and safety attributes	S	0.709	16	0.702	17	0.719	17	0.709	15
Customer satisfaction	S	0.703	17	0.712	16	0.706	18	0.691	16
Up-to-date technology utilisation	S	0.691	18	0.673	19	0.756	11	0.659	19
Absence of bureaucracy	S	0.682	19	0.663	20	0.694	19	0.691	16
Continuing involvement of stakeholders in project	S	0.675	20	0.698	18	0.669	20	0.659	19

And for contractors:

(1) Effective planning and control (RII = 0.809);

(2) Competency of project team (RII = 0.805);

(3) Competency of PM (RII = 0.805);

(4) Good leadership (RII = 0.805); and

(5) Good performance of subcontractors/suppliers (RII = 0.791).

The most effective PME is *competency of project team*. A construction project is a “system” that embodied a series of mutually supporting activities and roles (Aibinu and Odeyinka, 2006). The project team consists of personnel from various parties performing different and specialised skills. Their competence should be well considered to enable all levels of works to be performed effectively and efficiently. Staffing of team members is critical as their level of competence is likely to define the team effectiveness (Kwofie *et al.*, 2015). The ineptness of one party can generate knock-on effects on the activities of another participant and hence reinforcing the vicious cycle to further deteriorate the situations (Yap *et al.*, 2019b). According to Lee *et al.* (2011), the competencies for project team comprise judgement, professional expertise, apportionment of responsibilities, collaborative working with other organisations, practical application capability, construction work experience, quality, safety and health management, cost management, process management, record management, complaint management and negotiation skills.

The second most effective PME is *competency of PM*. This factor is also ranked highest in Vietnam (Nguyen *et al.*, 2004). The PM functions embrace leadership, organisation, planning, monitoring and coordinating which is proven to significantly improve cost efficiency (Jin *et al.*, 2018). Competency of the PM includes the "hard skills necessary" (tools and techniques) needed to perform and complete the works. These technical skills may be related to project finance and budget preparation, utilisation of work schedule software, production of technical reports, undertaking project progress evaluation as well as performing risk management. Ahmed and Anantatmula's (2017) structural equation modelling (SEM) using survey data gathered from 289 PMs employed for government-funded projects in Pakistan affirmed that the people-related competencies of PM (e.g. specific tasks, clear expectations, process consistency, effective communication and credibility) are significant in attaining project success with regard to scope, schedule, budget, quality, safety as well as stakeholder satisfaction.

The third most effective PME is *good leadership*. A great PM motivates people to create a productive working environment (Anantatmula, 2010). The project leader should be able to inspire the team as well as stimulate the team's commitments (Sanchez *et al.*, 2017). Besides, project leader shall ensure the project achievement by establishing realistic project goals, offering clear instruction and effective planning as highly regarded leadership contributed to 29% of team effectiveness (Kwofie *et al.*, 2015). To improve project performance through leadership roles, Anantatmula (2010) suggests a PM to better define team members' obligations and tasks in order to create clarity in project communications.

The other two influential PMEs are *effective planning and control*, and *realistic cost and time estimate*. These two factors are interrelated to each other. According to Gbahabo and Ajuwon's (2017) study concerning time–cost overruns in Sub-Saharan Africa, inefficient cost estimate, planning and forecasting are the reasons contributing to project overruns. Front planning at the beginning of the project life cycle is crucial as it will affect the quality and accuracy of cost and time estimate. A reliable estimate can help the design team to make an informed decision which serves as the baseline for project monitoring and controlling mechanism. However, change management is also vital for the PM to effectively manage variations (Zhang *et al.*, 2013) through timely detection of deviations and carrying necessary measures to alleviate the implications (Yap *et al.*, 2019b).

The inherently complex and dynamic interfaces make the aspects of construction planning and control challenging. As such, cost estimate reliability and accuracy continue to attract much attention from both academic and industrial research groups (Ahiaga-Dagbui and Smith, 2014). In this context, they explicate the two insistently conglomerated concerns, namely underestimation and overrun. The benefits of applying constructability principles include up-front participation of contractors, use of construction-sensitive schedules as well as modularisation and preassembly (Jergeas and Van der Put, 2001). They further claim that this approach can contribute to cost savings of around 30–40% along with improved safety and time performances.

Homogeneity of responses by respondent groups

Spearman's rank correlation tests are employed to appraise the homogeneity of responses among each pair of parties (Bagaya and Song, 2016). The range of values for the correlation coefficient is ±1, whereby a positive correlation indicates an agreement while an inverse correlation shows a disagreement between the parties. The Spearman rank correlation tests show very good agreements (exceeding 80%) between the three parties in ranking the PMEs with a significance level of 0.01. The highest degree of agreement belongs to the consultants–contractors group with 84.3%. Clients–contractors and clients–consultants groups achieved 84.0 and 83.6%, respectively.

Exploratory factor analysis of PMEs

To uncover the underlying factor structure of the PMEs, exploratory factor analysis technique was employed. The Kaiser–Meyer–Olkin (KMO) and Bartlett's tests for the 20 variables are 0.915 and 1609.962 ($p = 0.000$), respectively. Factor reliability of the item correlation matrix is established with KMO index exceeding 0.50 and Bartlett's significance at 0.05 level (Hair *et al.*, 2010; Ye *et al.*, 2014). Orthogonal (varimax) rotation technique is applied to the principal component analysis. Using latent root criterion with eigenvalues greater than 1.0, four factors can be extracted which account for 69.54% of total variance explained – greater than 60% of the variance needed for good confirmation of the factor analysis (Hair *et al.*, 2010; Yap *et al.*, 2019a). Table 4 indicates the final factors and retained items with loadings greater than 0.50 to increase correlation and necessary for practical significance. Cronbach's α ranges from 0.784 to 0.923, affirming the reliability of the four-factor solution (Papadopoulos *et al.*, 2012). To interpret the factors, variables with higher loadings are considered more important and have a greater influence on the label selected to represent a factor (Hair *et al.*, 2010). The extracted factors and associated variables are discussed in the subsequent section.

The average RII of each factor's variables is also calculated. Factors 1, 3 and 4 attained RII values of 0.782, 0.790 and 0.721, respectively, which are considered as very significant (VS). Factor 2, however, is significant (S) with average RII value of 0.704. In this light, these factors are critical managerial identifiers for effective project management in construction, underpinning the foundational paradigm, People + Process = Success.

Discussion of the factor analysis results

Factor 1: Scope, communication and competence management

Factor 1 has the largest total variance of 21.75% which explains the eight most important attributes associated with project management practices with the three most influential PMEs contained in this group. *Clear and realistic objectives and scope* attained the highest factor loading, followed by *effective communication and feedback* and *support from top management*. Cost performance of public infrastructure projects is significantly undermined by change orders on average of about 24% (Love *et al.*, 2017). Likewise, scope creep due to changes of design during construction is the leading problem plaguing the industry, contributing to massive time–cost overruns (Yap *et al.*, 2019a). As highlighted by Amoatey and Anson (2017), scope creep in the Ghanaian construction projects is often associated with frequent changes, uncertainties and vague definition of scope. Inefficiency and ambiguity tend to arise from the poorly documented scope, inadequate requirements definition and poor communication between stakeholders (Doloi *et al.*, 2012). Thus, it is imperative for the scope to be comprehensive, agreed upon, understood by all parties involved and formalised. However, project change management implementation is still lacking within the construction industry, resulting in ineffective scope change control (Hwang and Low, 2012). Proper project communication planning is needed to ensure timely information distribution in the right format and with the right impact to allow effective coordination (Project Management Institute, 2017) and avoid haphazard decision-making and reworking (Yap *et al.*, 2019b).

The primary competencies of construction management professionals are aptitude of personnel, site problem-solving skills and continuing professional development through coaching and learning (Shi *et al.*, 2014). Ling and Ma (2014) deliberated that competencies in task performance encompass cognitive ability, job knowledge, task proficiency and job

Table 4.
Factor loadings and total variance explained

Description of factors and attributes	Factor loading	Variance explained (%)	Cronbach α
Factor 1: Scope, communication and competence management		21.75	0.923
Clear and realistic objectives and scope	0.800		
Effective communication and feedback	0.798		
Support from top management	0.764		
Competency of project team	0.690		
Adequacy of resources	0.631		
Competency of project manager	0.619		
Awarding bids to right designers/contractors	0.569		
Good leadership	0.508		
Factor 2: Stakeholder commitment and collaborative engagement		20.19	0.875
Commitment of stakeholders to project	0.829		
Continuing involvement of stakeholders in project	0.754		
Absence of bureaucracy	0.728		
Up-to-date technology utilisation	0.673		
Customer satisfaction	0.641		
Mutual learning and knowledge sharing	0.600		
Factor 3: Construction time–cost planning and control		15.95	0.818
Realistic cost and time estimate	0.774		
Effective planning and control	0.742		
Good performance of subcontractors / suppliers	0.654		
Factor 4: Environment, health, safety and quality management		11.65	0.784
Environmental, health and safety attributes	0.792		
Total quality management	0.747		
Cumulative variance explained (%)		69.54	0.942
Kaiser–Meyer–Olkin measure of sampling adequacy		0.915	
Bartlett's test of sphericity Approx. χ^2		1609.962	
Df		190	
Sig		0.000	

Note(s): Extraction method = Principal component analysis; rotation method = Varimax with Kaiser normalisation. Rotation converged in six iterations

experience. In this connection, Agyekum-Mensah and Knight (2017) interviewed London Olympic 2012's project team to observe that soft management which includes communication, experience, knowledge and competence is crucial to deal with planning and management problems. To engender individual and organisational learning, Love *et al.* (2018) encourage critical reflection in order not to repeat the same mistakes and utilise the knowledge gained to improve productivity and project performance while Carrillo *et al.* (2013) advise improving lessons learned practices in construction. Praxis of capability building and expert judgement development reinforces the popular proverb that "knowledge itself is power" to confront the challenges in construction project management. In this vein, Sullivan *et al.*'s (2010) best value system utilises expertise such as visionary team and specialist vendors to lower costs and increase performance. To reduce risk and increase probability of project success, Yap *et al.* (2019b) advocate leveraging on continuous project learning and knowledge reuse which include networking and communication, experience accumulation, collaborative learning and expert judgement to raise the capabilities of project personnel better. Effective knowledge management is envisaged to improve efficiency, enhance quality, reduce project duration and lead to better decision-making capacities in construction through reflective practice and learning (Forcada *et al.*, 2013; Yap and Lock, 2017).

Factor 2: Stakeholder commitment and collaborative engagement

This second largest factor accounts for 20.19% of the total variance explained. The top three variables with a factor loading higher than 0.70 are: *commitment of stakeholders to projects, continuing involvement of stakeholders in project* and *absence of bureaucracy*. Managerial ability to deliver is significantly influenced by early stakeholders' involvement in the planning of projects for gaining commitments to project endeavours – strong internal and external stakeholder orientation is needed for the project environment (Andersen *et al.*, 2006). In this vein, targeted communication routines facilitate stakeholder participation and collective commitment needed to build trust and prompt knowledge sharing (Butt *et al.*, 2016). Projects having motivated team members are more likely to deliver better outcomes, higher team engagement and lower attrition rates (Mir and Pinnington, 2014). In another study, Zhang and Cheng (2015) opine that knowledge sharing is not possible without a strong shared vision for the team. Considering the importance of collective intelligence and learning in construction project delivery, a collaborative and trustworthy working platform is needed to cultivate a high-performance team. Hence, effective teamwork and continuing involvement of stakeholders are pivotal in interweaving trust and communication in the pursuit of achieving the shortest project duration, least cost and highest-quality facilities (Cheung *et al.*, 2013). Bureaucracy and hierarchy, however, result in alienation and lack of effective information gathering, processing and sharing – a major factor to project failure (Damoah and Kumi, 2018).

Construction productivity levels are relatively low as compared to other sectors of the economy such as manufacturing and service (CIDB Malaysia, 2015). The intractable productivity problem is much attributable to the 3D work environment, industry fragmentation and underinvestment in skills development, research and development (R&D) and innovation (Yap *et al.*, 2019a). On the other hand, labour and equipment productivity considerably affect construction delivery performance. Other major inhibitors on construction productivity include rework, poor supervisor competency and incomplete drawings (Hughes and Thorpe, 2014). According to Jarkas and Bitar (2012), construction productivity factors can be categorised under management, technological, human and external. The most critical factors are: poorly defined technical specifications, excessive change orders during construction, poor coordination among various professionals, inadequate supervision of workers and unsatisfactory performance of subcontractors. To raise productivity levels, the industry needs to attract stakeholders to Industry 4.0 technologies, infuse digital innovation, rethink design and engineering processes, adopt modern technologies and practices, ameliorate construction supply chain management, transform on-site execution and reskill the workforce (Mckinsey Global Institute, 2017; Yap *et al.*, 2019a). In this respect, productive involvement of stakeholders in planning and facilitating progress can significantly improve production capacity and give rise to industry competitiveness.

Factor 3: Construction time–cost planning and control

Factor 3 comprised three attributes with a total variance of 15.95%. The planning and control of construction time and cost is the leading domain of construction management (Shi *et al.*, 2014). Accurate project costing and financing and shrewd cost control are essential measures to control construction cost. Accordingly, Marco and Narbaev (2013) propose using earned value management (EVM) for cost performance monitoring as this approach integrates cost, schedule and scope in a single methodology. Regarding design and documentation risk management, the contractor needs to work out a realistic tender price and project programme even in the circumstances when the design information is incomplete and time is scanty to complete contract documentation (Love and Edwards, 2004). Thus, a realistic initial estimation of construction duration and cost is paramount for efficient management during the implementation phase. This is consistent with Gudienė *et al.*'s (2014) assertion on planning project objectives that are clearly articulated, achievable and realistic along with timely completion. According to Love *et al.* (2017), for most public infrastructure projects, the construction costs are often underestimated, revenues overestimated, environmental impacts undervalued and development effects overvalued, resulting in inaccurate and low pre-construction estimates but inflated final accounts.

Nasseri and Aulin (2016) underscore that the vital enablers for planning and scheduling in construction comprise reliability of detailed schedules, the effectiveness of resource levelling in scheduling and efficiency of managerial support for motivational and training programmes. On the other hand, the major challenges include failure of project stakeholders to provide support in planning and the preparation of schedules, criticality of work activities are poorly determined and absence of resource-constrained scheduling for dealing with uncertainty problems.

Factor 4: Environment, health, safety and quality management

This factor comprises two variables relating to environmental, health, safety and quality aspects of construction projects. The construction industry is beleaguered with high incidences of accidents and fatalities, lack of safety culture, precarious work conditions (dirty and dusty) and poor work quality (Love *et al.*, 2015). Given the uncomfortable, hot and dirty working conditions at construction sites, the sector is often stigmatised as "dangerous, dirty and difficult" (3D), which also results in labour shortages as local youths are not attracted to join this field (Yap *et al.*, 2019a). Thereby, sustained efforts are required to upgrade the poor working conditions and manage job hazards. Accordingly, construction transformation strategies are needed to transition labour-intensive activities to mechanised and automated operations in order to reduce occupational risks. For example, the utilisation of factory-made industrialised building system (IBS) components reduces construction processes at site especially wet work which then leads to neater-site condition, increased safety, reduced material wastage, less labour at the site and better workmanship as compared to the conventional method (Bari *et al.*, 2012). To improve safety compliance and participation in the workplace, Wu *et al.* (2017) suggest supervisor safety leadership facets to include leading by example, participative decision-making, coaching, informing and showing concern. Thus, a more quality-, safety- and health-conscious construction industry will ensure higher levels of quality and professionalism in the built environment and reduce worksite accidents (Love *et al.*, 2015). More so, the responsible construction industry is needed to lower carbon emissions and have better compliance with environmentally sustainable practices whereby sustainability requirements can be embedded in the procurement process in the built environment (CIDB Malaysia, 2015).

Comparison with selected studies

In a recent study in Malaysia, Yap *et al.* (2019a) observed that the critical managerial problems in most developing countries can be categorised under six groups, namely adversarial working and 3D stigma, substandard site coordination and management, incompetence of construction stakeholders, slow technology adoption, haphazard decision-making and inefficient administrative processes. In India, the underlying dimensions for delay factors are lack of commitment, inefficient site management, poor site coordination, improper planning, lack of clarity in project scope, lack of communication and substandard contract. In the case of Saudi Arabia, the major causes of project failures are linked with the incompetence of project personnel (Al-Kharashi and Skitmore, 2009). The ten most frequently observed global delay factors include inappropriate planning and scheduling, poor judgement, high bureaucracy within project organisations, shortage of resources and ineffective communication and coordination between parties (Zidane and Andersen, 2018). Comparing the salient issues, there is a close similarity among these studies. Despite a number of studies, the recurring problems continue to undermine project outcomes. Because most of these problems are human- and management-related, the four managerial dimensions uncovered in this study can adequately address the current project management shortfalls in the developing world.

According to Yong and Mustaffa (2013), the critical factors for Malaysian construction projects encompass project personnel, commitment and communication and site management and supervision. In Vietnam, the groupings for success factors are comfort, competence, commitment and communication (Nguyen *et al.*, 2004). In this light, this study helps expand existing knowledge with new evidence from Malaysia with practical and academic ramifications for developing countries.

Limitations of research

Despite the achievement of the objectives, this study, unavoidably, has some limitations. First, the single data collection using a questionnaire does not provide methodological triangulation as compared with a mixed-methods approach. Second, the data was collected from only the Greater Kuala Lumpur region in Malaysia and may restrict the generalisability of the research findings. Future studies could consider employing a complementary qualitative approach using in-depth interviews or focus groups to yield rich data and a greater understanding of managerial success factors for construction project delivery and from more regions in Malaysia.

Conclusion

This research investigated the critical managerial measures to improving construction management and delivery of facilities. Based on the literature review, a questionnaire was developed as a tool for data collection in the field survey targeted at primary construction stakeholders in Malaysia. The data were then analysed using the appropriate statistical techniques.

The first objective and research question were to appraise the effective project management measures to improve performance. Using relative important index technique, this study has determined the significance of the PMEs. In the overall context, the five most effective measures are *competency of the project team, competency of PM, good leadership, effective planning and control and realistic cost and time estimate*. Spearman's rank correlation tests affirmed the homogeneity of opinions between key project stakeholders about the ranking of these effective PMEs, further corroborated the relevance of the PMEs to ensure project success among construction professionals with disparate project roles.

The second objective was aimed to uncover the underlying dimensions for successful construction project management. The exploratory factor analysis revealed that a factor structure consists of four principal factors: *scope, communication and competence management; stakeholder commitment and collaborative engagement; construction time–cost planning and control;* and *environment, health, safety and quality management*. The manifested principal factors are seen as having the ability to largely explain the critical managerial measures needed to successfully deliver construction projects.

This study adds to the existing knowledge by identifying the significant PMEs that could lead to improved project performance. The second contribution of this study is built upon the examination of the underlying dimensions of PMEs as perceived by construction professionals in Malaysia. Although there has been a significant amount of research on the determinants of project success, little work offers detailed insight into the key dimensions of managerial factors in construction project delivery. In this light, the findings have filled a significant knowledge gap by unfolding underlying dimensions to enable both academics and practitioners to gain an increased understanding of the classification of managerial factors influencing project success.

The implication for research is that empirical evidence for PMEs applicable for optimising the performance of construction projects in Malaysia and in the broader context of developing countries is brought to light. As highlighted by Edum-Fotwe and McCaffer (2000), the knowledge and skills necessary to maintain the competency relevant to the changing business circumstances of the industry are acquired largely from construction workplace experiences. To address current skills gaps within the industry, one pertinent recommendation is instilling construction practitioners at every level with project management abilities through continuous professional development and management training. By taking cognisance of the critical PMEs, construction practitioners can increase the likelihood of accomplishing superior project outcomes, in terms of time, cost, quality, safety and satisfaction. The construction industry would benefit from staffing the project with qualified personnel having the right knowledge, skills and attitudes through every stage of project delivery. As such, cultivating the expertise of managers, designers, engineers and supervisors working in a collective construction setting is requisite and emergent. The focus of human resources management is on the quality of training and continuous development rather than merely producing a large number of human resources just to meet the increasing industry demand in the developing world. The role of leadership competence in ensuring successful completion of projects is critical. A highly competent manager can detect emerging issues before they become major problems. An effective manager can best utilise the training and experience to advance the project successfully. To this end, top management should select a PM with a proven track record and a desirable perspective to the project. Another notable issue is that existing practices on project scheduling and cost management should be reevaluated. This finding may also be attributed to unrealistic contract duration and underestimation of construction costs that inhibit effective project control. Flyvbjerg *et al.* (2018) revealed that underestimated cost resulting in cost overruns is found in nine out of ten transportation infrastructure projects worldwide. The implication for practice is that reliable, de-biased schedule and cost estimates that fit the client's risk appetite are needed to produce better outcomes. Drawing on the aforementioned, these findings are useful to guide construction professionals to customise their project management approach to address the managerial challenges and ameliorate the inefficiencies in the construction industry in a bid to enhance the likelihood of project success.

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