Stakeholder management in prefabricated prefinished volumetric construction projects: Benchmarking the key result areas

Ibrahim Yahaya Wuni [a*], Geoffrey Qiping Shen[a]

[a] Department of Building and Real Estate, The Hong Kong Polytechnic University, 11 Yuk Rd, Hong Hum, Kowloon, Hong Kong

Abstract

Purpose – Prefabricated prefinished volumetric construction (PPVC) projects are industrialized building systems that are co-created. Thus, effective management of the involved stakeholders is required to ensure project success. However, knowledge of how best to manage the diverse stakeholders in PPVC projects is limited. This research identified and prioritized the success factors or key result areas (KRAs) for the effective stakeholder management (SM) in PPVC projects.

Design/methodology/approach – A quantitative research design was implemented involving a literature review, and structured questionnaire survey with international PPVC experts. The research identified and statistically analysed 12 KRAs for SM in PPVC projects.

Findings – Analysis showed that the top three KRAs for SM in PPVC projects include: effective working collaboration, communication and information sharing among participants; effective coordination of the PPVC supply chain segments; and early involvement of relevant stakeholders in the PPVC project. A factor analysis clustered the 12 KRAs into stakeholder analysis and early involvement, effective communication and information sharing, and stakeholder interest integration and conflict management.

Practical implications – The paper identified and prioritized the KRAs required for the effective SM in PPVC projects. To practitioners, the results may serve as decision support on the key areas to focus to ensure effective stakeholder management in PPVC projects and may guide the efficient allocation of limited resources.

Originality/value – This research constitutes the first exclusive attempt at identifying and benchmarking the generic KRAs required for effective SM in PPVC projects and contributes to the stakeholder management body of knowledge in industrialized construction.

Keywords: benchmarking; key result areas; off-site manufacturing; prefabricated prefinished volumetric construction; project team; stakeholder management

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Introduction

One major disruption in the construction industry is the transition towards off-site manufacturing (OSM); a construction business model whereby building components are manufactured in a specialized off-site factory and subsequently transported to a job site for final assembly and installation (Blismas, 2007; Goodier et al., 2019). Arguably, wider adoption and implementation of OSM could transform the ‘construction industry’ into a ‘production industry’ (Linner and Bock, 2012). Prefabricated prefinished volumetric construction (PPVC) constitutes a typical OSM technique whereby value-added volumetric building components, usually completed with finishes, fixtures and fittings are manufactured in an off-site factory based on an accredited fabrication method and then transported to a construction site and systematically installed to generate industrialized building systems (Building and Construction Authority, 2017; Wuni and Shen, 2019a). The basic delivery chain of PPVC involves module design, engineering, production, transportation, and on-site assembly (Wuni et al., 2019). These stages are associated with multidisciplinary stakeholders with their unique needs, requirements, value systems, and goals (Luo et al., 2019; Wuni and Shen, 2019b).

A successful PPVC project is a function of co-creation, requiring the expertise and contribution of many players. According to Sanvido et al. (1992), a successful construction project is one that realizes planned objectives and meets the expectations of stakeholders. Freeman (2007) indicated that the overall goal of project management is to create value for stakeholders. Thus, meeting the needs, expectations and satisfaction of stakeholders represent a significant component of construction project management (Mbachu and Nkado, 2006). Failure to effectively identify and manage the needs, concerns, power, and interests of stakeholder in the a construction project constitutes a major source of controversy, conflicts, delays, and sometimes abandonment of a project (Olander and Landin, 2005). For this reason, effective stakeholder management is a key result area (KRA) for construction project success (Newcombe, 2003). The most important role of stakeholder management (SM) in PPVC projects is the creation of a good working environment, condition and arrangement which encourages stakeholders to maintain their level of predictability, power, interest, urgency, legitimacy, proximity and network to ensure success implementation of the project (Newcombe, 2003; Wuni and Shen, 2019b).

The factors which predicate success of SM in traditional construction projects are not directly applicable to PPVC projects because of their significant differences. First, PPVC requires early and upfront commitment to realize full benefits (Murtaza et al., 1993). This is because, unlike traditional projects, not all designs are suitable for PPVC implementation. The early commitment further requires early collaboration of key players. Second, unlike traditional projects, the design of PPVC projects draws on manufacturing principles within the framework of design for manufacture and assembly (Hwang et al., 2018). This eases the efficiency of the factory production and onsite assembly of the modules. Third, the delivery chain of PPVC involves the fragmented stages of module design, engineering, production, transportation, buffer or storage and onsite assembly (Wuni et al., 2020). The carriage and haulage of large modules in PPVC projects require coordination between the logistic companies and highway authorities within the stakeholder management framework. In most countries, the supply chain is incomplete (Wuni and Shen, 2020), requiring the extensive cross-border coordination of stakeholders. Fourth, unlike traditional projects, PPVC demands effective coordination of both onsite and offsite work packages and the associated multidisciplinary stakeholders.

Moreover, the relative importance of the KRAs for SM differs between PPVC and traditional projects. However, knowledge of how best to manage stakeholders in PPVC projects is limited (Hu, Chong, Wang, et al., 2019). As PPVC is gaining increasing attention in the architecture, engineering and construction (AEC) industries, it is imperative to identify and prioritize the KRAs for managing the multidisciplinary stakeholders involved in the PPVC delivery chain. According to Rockart (1982), key result areas (also critical success factors) are the key few management areas that require sustained attention and resources commitment to ensure success in a project or organization. This research identified and prioritized the KRAs for SM in PPVC projects. Thus, the research outcomes provide valuable insight into how best to manage stakeholders to improve the success of PPVC projects.

Overview of PPVC and existing stakeholder management research

According to the Construction Industry Council (2018), PPVC is an innovative construction method whereby "free-standing integrated modules (usually completed with finishes, fixtures and fittings) are manufactured and assembled in a factory and then transported to a construction site for final installation". The common types of PPVC include reinforced concrete module, steel frame module and a hybrid module. PPVC and OSM are implemented to improve productivity (Hwang et al., 2018), reduce construction time, minimize construction costs, improves predictability of cost and schedule, improve construction quality, improve the health and safety of workers (Blismas et al., 2006), promote streamlined project delivery, reduce construction waste (Jaillon et al., 2009), minimize carbon emissions (Mao et al., 2013) and promote innovation (Wuni and Shen, 2019c). Although PPVC can be used for diverse projects, it is very suitable for projects with repetitive designs and layout such as student halls, hotels, hospitals, schools, mass housing, prisons, among others.

The PPVC delivery chain have significant similarities with those of modular construction, volumetric prefabricated construction, industrialized building systems, and prefabricated prefinished volumetric construction (Wuni and Shen, 2019a). Where circumstances merit, the proper implementation of PPVC in a project leverages higher degree of construction project quality control and improves project adaptability, productivity, safety, and sustainability (Construction Industry Council, 2018). The general processes of PPVC project delivery involves project design, permitting, factory production of modules, transportation of modules to site, and on-site installation of modules (Building and Construction Authority, 2017). At each of these stages, the PPVC project has critical relationships with various stakeholders.

According to Wuni et al. (2019), the distinct segments of the PPVC supply chain are fragmented, complex and interdependent with each stage composed of multiple stakeholders. Some studies have explored stakeholder dynamics and relationships in PPVC projects. Jeong et al. (2009) developed a US-based industry specific framework explaining the relationship between manufacturers and suppliers in manufactured housing construction. Similarly, Teng et al. (2017) used stakeholder and industrial symbiosis theories to examine the relationship between stakeholders in the industry chain of industrialized building construction in China. Luo et al. (2017) examined the future roles of architects in off-site construction and conceptualized that there is a potential transformation of their roles from “an architectural work mode to a building product mode”. London and Pablo (2017) conceptualized and developed an extended stakeholder collaboration framework in industrialized building housing construction using an actor-network theory approach. Liu et al. (2018) developed an assessment criteria system for evaluating the supplier management maturity in prefabricated construction projects in China. Gan et al. (2018)

conducted a two-mode social network analysis of how stakeholder engagement could facilitate success implementation of OSM techniques in China. Similarly, Xue et al. (2018) conducted a social network analysis of OSM stakeholders and found positive effect of stakeholder collaborative management on the cost performance of OSM techniques. Hu, Chong and Wang (2019) examined the sustainability perception of OSM stakeholders in Australia. Hu, Chong, Wang, et al. (2019) reviewed OSM stakeholder management studies and concluded that existing studies focused on perceptions and behaviours of stakeholders in OSM adoption and stakeholder management strategies.

The literature synthesis suggests that some studies have explored general OSM stakeholder management issues, usually in the context of wider adoption from an industry scale, but no study examined the success factors for SM in OSM techniques. Effectively, the success factors for SM in PPVC projects can hardly be identified directly from the literature. Nevertheless, some existing treatises have implicitly addressed the success factors for SM in OSM projects and several studies have also addressed the success factors for SM in traditional construction projects. Thus, these studies provided useful references to identify the success factors which may be relevant to SM in PPVC projects. For instance, Yang et al. (2009) conducted a questionnaire survey with project managers in Hong Kong and identified the top 5 KRAs for SM in construction projects as managing stakeholders with social responsibilities, exploring needs and constraints of stakeholders to a project, proper and frequent communication and engagement of stakeholders, understanding the interest areas and needs of stakeholders, and analysing conflicts and coalition among stakeholders.

Yang et al. (2010) identified the two most important success factors for SM in construction projects to include managing stakeholders with social responsibilities and effective communication among stakeholders. Yang et al. (2011) conducted a questionnaire survey with stakeholders and corroborated the findings of Yang et al. (2009). Molwus et al. (2017) conducted a questionnaire survey with practitioners in the UK and identified the top 5 KRAs for SM in construction projects to include involvement of relevant project stakeholders at the inception stage, understanding the project interest areas of the stakeholders, proper and frequent communication with stakeholders, managing how project decisions affect stakeholders, and resolving conflicts among stakeholders. A comprehensive review of the literature provided a sound basis for identifying the potential KRAs for SM in PPVC projects.

Research methodology

Identification of key result areas

The KRAs for SM in PPVC projects were identified through a comprehensive literature review and pretesting with PPVC experts. The literature review was used to identify the tentative list of KRAs for SM in PPVC projects because it is a useful approach which allows an empirical study to build on existing studies and provides a theoretical underpinning for the new study. This allows the findings to be discussed in the context of the existing literature. Based on the review, a preliminary list of the KRAs for SM in PPVC projects was developed. The tentative list was piloted with three PPVC experts from Australia, Hong Kong, and Canada. These three experts were purposively sampled because of their combined academic research track records and hands-on experience in PPVC/OSM projects. The three countries or economies were also selected because of their advancement in the PPVC or related OSM techniques. These three experts were not included in the final questionnaire survey. The experts were requested to ascertain the relevance and suitability of the KRAs for SM in PPVC projects. Based on the outcome of the expert review, some KRAs were reworded, merged, modified or deleted. Table I shows the final list of KRAs which formed the basis of the questionnaire survey in the study. According to Freund (1988), KRAs are few and usually ranges between 5 and 8. Thus, an evaluation of these KRAs through the questionnaire survey will highlight the most important KRAs for effective SM in PPVC projects.

[**Table I**. Final list of KRAs for SM in PPVC projects]

Questionnaire design and measurement instrument

A structured questionnaire formed the survey instrument for evaluating the identified KRAs for SM in PPVC projects. Although shrouded with subjectivity, questionnaires are widely used in construction management research to solicit quantitative data from practitioners and experts (Wuni and Shen, 2019a). Previous studies on KRAs for SM in construction projects mainly used questionnaires (Molwus et al., 2017; Yang et al., 2009, 2010). The administered questionnaire used contained two sections: section 1 solicited background information of the respondents

(Table II) and section 2 was designed to measure the significance and criticality of the KRAs. The measurement instrument used to evaluate the KRAs was a 5-point grading, where 1=least significant, 2=fairly significant, 3=significant, 4=very significant, and 5=extremely significant.

Sampling technique and data collection approach

The research aimed to identify and establish a generic framework of the KRAs for effective SM in PPVC projects. Thus, an international survey of experts was considered appropriate (Osei-Kyei et al., 2017). The expert approach draws on the lessons and hands-on experiences of different experts from different countries to evaluate the relevance, applicability and relative significance of the KRAs for SM in PPVC projects. It is immediately recognized that the relative importance of the KRAs is sensitive to different project characteristics and territories. Nonetheless, an expert has been used in previous studies evaluate success criteria for public-private partnership projects (Osei-Kyei et al., 2017) and drivers for implementing green building technologies (Darko et al., 2017). Following the precedents of Osei-Kyei et al. (2017) and Darko et al. (2017), a purposive sampling technique was adopted to identify the relevant PPVC experts because the non-existence of a central global database for PPVC experts rendered the use of random sampling impractical. The sampling framework included PPVC experts in academia and industry. The academic experts were identified based on PPVC and OSM research publications in high impact construction management journals whereas the industry experts were identified from the databases of offsite construction councils and bodies such as modular building institute, construction industry institute, among others. Overall, a total of 400 PPVC experts were identified and their contact details were recorded in an MS excel file.

[**Table II.** Background information of the engaged experts]

The most feasible and economical way to solicit the opinions of the experts was through online surveys (Darko et al., 2017; Osei-Kyei et al., 2017). The "Survey Monkey" platform was used to generate an online version of the questionnaire and the web link was copied. Personalized emails were written each of the 400 experts, inviting them to participate in the survey. In each email, the link to the online questionnaire survey was attached. The experts were encouraged to complete the survey within 4 weeks. After two rounds of reminders, samples of 56 valid responses were retrieved. Although small, such smaller sizes are characteristic of international surveys. This sample size was considered adequate because it satisfied the minimum requirement of 30 responses for the central limit theorem and exceeded the samples sizes in similar studies such as 27 (Sachs et al., 2007) and 46 (Osei-Kyei et al., 2017).

Methods of data analysis

A two-stage statistical analytical protocol was implemented on the dataset with the aid of the Statistical Package for the Social Sciences (SPSS v.20). The first stage involved pretesting of the dataset for reliability and distribution. The Cronbach's Alpha was computed to measure the reliability of the grading scale. An Alpha value ranges between 0 and 1 with a minimum acceptable value of 0.70 (Tavakol and Dennick, 2011). The analysis of the dataset generated a Cronbach's Alpha of 0.787, indicating acceptable reliability and validity of the grading scale. Based on Zafar et al. (2019), the Shapiro – Wilk test was conducted to ascertain the normality of the dataset and the results are shown in Table III. The outcome revealed that the dataset was not normally distributed. As a result, a ranked-based nonparametric statistical techniques, called the Kruskal – Wallis test was used to determine whether there are statistically significant variations between the responses of the experts from academia and those from industry (Zafar et al., 2019). The outcome revealed that all the KRAs (except SF6) were not significant (P>.0.05) at 95% confidence interval, as shown in Table III. The results indicated that there are no significant variations, implying that the responses can be treated as a unified whole.

The second stage involved quantitative evaluation of the KRAs. The mean scores of the KRAs for SM in PPVC projects were computed to determine the average quantitative ranking of the KRAs. The mean score (μ_i) of each KRA was computed as follows:

$$\mu_i = \frac{\sum_{i=1}^{n}(X_i \times E_i)}{\sum_{i=1}^{n}(E_i)}, \qquad (1 \leq \mu_i \leq 5) \tag{1}$$

Where, X_i represents a score given to each KRA by the experts, ranging from 1 to 5 (1= least significant and 5=extremely significant); and E_i represents the frequency of each rating (1 – 5) for each KRA. The mean scores formed the basis for ranking and prioritizing the KRAs.

The dataset was further tested to ascertain its suitability for factor analysis. First, the 12 factors to 56 sample size in the current study satisfied the 1:5 factor to sample size requirement for factor analysis (Lingard and Rowlinson, 2006). Second, an acceptable Cronbach's Alpha value of 0.787 indicated a good internal consistency of the grading scale and supported factor analysis (Zafar et al., 2019). Third, the Kaiser-Meyer-Olkin (KMO) Test for Sampling Adequacy generated a test statistic of 0.664, which is within acceptable range (Norusis, 2008). Fourth, the Bartlett's test for Sphericity was conducted to ascertain suitability of the dataset for structure detection. The test generated an approximate Chi-Square value of 253.90 and a p-value less than 0.000, indicating the correlation matrix of the KRAs does not constitute an identity matrix. Considering these outcomes, an exploratory factor analysis was conducted to explore the structure of the KRAs. Drawing of Zafar et al. (2019), the research used Principal Component Analysis as the factor extraction method and Varimax with Kaiser Normalization as the factor rotation method. The rotation converged in 12 iterations and a generated a 3-factor solution. The factor groupings are referred to as principal result areas (PRAs) and are shown in Table V.

Results of data analysis

Frequency distribution of the KRAs for SM in PPVC projects

The number of times the experts assessed the KRAs based on the 5-point grading scale are shown in Table III. Results of the Shapiro – Wilk test (p-values) and the Kruskal – Wallis test (p-values) are also shown in Table III. Aside SF12, a maximum of one expert assessed each of the KRAs as ‘least significant’. Majority of the experts evaluated the KRAs as either significant or very significant (see Table III). This evaluation pattern suggests that the experts considered all the KRAs relevant to the effective SM in PPVC projects. The Shapiro – Wilk test were statistically significant ($P<0.000$) for all KRAs, suggesting the dataset is not normally distributed. The Kruskal – Wallis test was not statistically significant ($P>0.05$) for all other KRAs, except SF6. The p-value for SF6 in Table III is significant ($p = 0.015$) at 95% confidence level, indicating that there were significant variations in its evaluation by the experts in academia and industry. Thus, it was removed and excluded from the factor analysis. This provided a sound basis for treating the remaining dataset holistically.

[**Table III**. Frequency scores of the KRAs for SM in PPVC Projects]

Mean score analysis and ranking of the KRAs for SM in PPVC projects

The mean scores of the KRAs for SM in PPVC projects were computed and shown in Table IV. It also shows the standard deviations of the responses for each success factor and their overall ranking. Based on the mean scores and standard deviations, the 5 most important KRAs for effective SM in PPVC projects include: SF1– effective working collaboration, communication and information sharing among participants (3.86), SF2– effective coordination of the PPVC supply chain segments (3.79), SF3 – early involvement of relevant stakeholders in the PPVC project (3.77), SF13 – extensive planning and analysis of stakeholder salience, needs, constraints and interest areas (3.71), and SF4 – active involvement of key participants throughout the project (3.70).

[**Table IV**. Mean Scores of the KRAs for SM in PPVC Projects]

Based on the linguistic variables assigned to the 5-point grading scale, the minimum criticality threshold is 3.00 (Zafar et al., 2019), suggesting that all the KRAs were assessed as significant to the success of SM in PPVC projects. These KRAs are all discussed in the subsequent sections of the paper.

Factor analysis of the KRAs for SM in PPVC Projects

The factor analysis generated 3 PRAs, explaining about 66.63% of the total variance in the success of SM in PPVC projects. Table V shows the results of the factor analysis. The 3 PRAs include: PRA1 – stakeholder analysis and early involvement, PRA2 – effective communication and information sharing, and PRA3 – stakeholder interest integration and conflict management. The reduction of the 11 KRAs into 3 PRAs reduces the cognitive complexity associated with managing the fragmented list of KRAs and provides a comprehensive framework for implementing the KRAs (Ameyaw and Chan, 2015). These 3 PRAs are discussed in the next section.

[**Table V**. Principal result areas for SM in PPVC Projects]

Discussions of key findings

PRA1 – stakeholder analysis and early involvement

Stakeholder analysis and early involvement comprises 4 KRAs and explains about 39.64% of the total variance in the success of SM in PPVC projects. The 4 KRAs are: (a) effective coordination of involved stakeholders in the PPVC project, (b) extensive planning and analysis of stakeholder salience, needs, constraints and interest areas, (c) early involvement of relevant stakeholders in the PPVC project, and (d) effective management of stakeholder-associated risks in the PPVC. The use of PPVC in a project requires early commitment to the approach to realize its full benefits (Blismas et al., 2006; Wuni et al., 2019). Construction stakeholder theory postulates that several stakeholders abound in construction project. Successful SM in PPVC projects also involves early identification, planning, engagement, and control of the relevant stakeholder and the risks associated with realization of their expectation from the project (Project Management Institute, 2017). Generally, SM initiates with stakeholder mapping and analysis (Freeman, 1984). Extensive planning and analysis results in the identification and determination of the relevant stakeholders in the PPVC project (Hu, Chong, Wang, et al., 2019).

The relevance of the involved stakeholders differs across the major stages of the PPVC project. Stakeholder analysis is required to identify the relevant stakeholders at the different stages of the PPVC project life cycle and their interest, motives, value systems, needs, and constraints to the project (Luo et al., 2019). The outcome of such analysis provides a sound basis for effective SM, starting from the earliest stages of the PPVC project life cycle. For instance, the most relevant stakeholders at planning, conception and design stages of PPVC projects include the architect, designer, engineers, contractor, owners/developers and fabricators (Wuni et al., 2019). These multidisciplinary stakeholders have their unique roles at the design stage but their effective coordination will improve the success of the early stages and subsequent stages (Xue et al., 2018).

PRA2 – effective communication and information sharing

PRA2 comprises 4 KRAs for successful SM in PPVC projects, including (i) effective coordination of the PPVC supply chain segments, (ii) effective working collaboration, communication and information sharing among participants, (iii) active involvement of key participants throughout the project, and (iv) effective use of information and communication technology. PRA2 explains about 14.62% of the total variance in the success of SM in PPVC projects. The different stakeholders perform mutually reinforcing and complimentary roles comprising decision support, production, and coordination of construction trades (Hu, Chong, Wang, et al., 2019). Good working collaboration, effective communication and information sharing is indispensable to the successful SM throughout the PPVC project life cycle. As expected, proper and frequent communication among stakeholders constitutes one of the most cited KRAs for SM in construction projects (Molwus et al., 2017; Yang et al., 2010; Yang and Shen, 2015). This collaboration constitutes a necessity in PPVC projects because the decisions and roles of upstream stakeholders significantly influences the roles and decisions of downstream stakeholders along the PPVC supply chain (Wuni et al., 2019). For instance, the dimensional and geometric tolerances specified by the design team (architect, designer, engineer) are engineered and reflected in the production of the modules by the factory production team. Thus, poor collaboration between these two teams could result in significant risk of cost increase and disputes among the project participants. Thus, the prevailing poor shared understanding of the best mechanisms for effective collaboration among the interdisciplinary stakeholders engenders a significant risk to successful SM and the overall success of PPVC projects (Nadim and Goulding, 2009). Effective collaboration of stakeholders along the PPVC supply chain can be leveraged using information and communication technology such as building information modelling (BIM). Li et al. (2017) combined BIM and radio frequency identification and developed a real-time collaborative platform for knowledge exchange, information sharing and active monitoring of the supply chain of prefabricated construction in Hong Kong. The use of BIM could facilitate advanced supply chain arrangement to improve collaboration and communication among project participants.

PRA3 – stakeholder interest integration and conflict management

This PRA comprises 3 KRAs and explains about 12.36% of the total variance in the success of SM in PPVC projects. The KRAs within PRA3 include: (i) effective stakeholder conflict resolutions and management, (ii) effective use of integrated project delivery method and contracting, and (iii) adequate knowledge and good contractor leadership. Successful PPVC projects should the expectations and requirements of the relevant stakeholders (Sanvido et al., 1992). However, the relevant stakeholders in PPVC projects are interdisciplinary and diverse, with their unique goals, value systems, and needs along the supply chain (Luo et al., 2019; Wuni et al., 2019). The varied expectations, interests and concerns of the stakeholders are often competing and conflicting (Freeman, 1984). Thus, adequate experience and effective leadership of the contractor, developer and project managers are required to balance the conflicting interests and reconcile the expectations with the overall objectives of the PPVC project (Choi et al., 2016; Wuni and Shen, 2019b). The integration of the stakeholders beyond their conflicting interests in the project allows for resources pooling, deployment of complimentary capabilities, and promotion of greater collaborative innovation. The integration of the varying requirements, expectations and interests require stakeholder conflict resolutions and management. It takes good leadership in the PPVC project to proactively identify these conflicting interest and to develop effective measures to minimize their significant impact on the success of SM in PPVC projects (Hu, Chong, Wang, et al., 2019).

Although stakeholder integration is complicated in practice, one effective mechanism to promote stakeholder interests integration and conflict management in PPVC projects is the effective use of integrated project delivery method and contracting (Tam et al., 2007; Wuni and Shen, 2019b). Tam et al. (2007) expounded on the potentials of using integrated project delivery methods and contracting such as the design-build procurement method to reduce conflict in construction projects. Although the design-build (design-manufacture-assemble) procurement method has its unique limitations, it offers the greatest advantage of unifying the design and construction functions of the project to a single entity (Tam et al., 2007). The use of integrated PPVC project delivery method has the advantages of: (i) early integration, coordination, and collaboration among the relevant PPVC stakeholders, (ii) clear definition of the roles and responsibilities of each PPVC project participant, (iii) effective coordination of off-site production of modules and on-site construction trades, (iv) encourages the proactive discharge of assigned roles and responsibilities, (v) promotes effective flow of information and efficient allocation of resources between the PPVC project participants throughout the project life cycle; and (vi) eventually encourages effective communication, trust, and commitment across interfaces (Hu, Chong, Wang, et al., 2019).

Practical implications for OSM and PPVC practitioners

The outcomes of the current research have useful implications for the practice and praxis of OSM and PPVC projects' implementation. This research draws on rich perspectives and hands-on experiences of international experts and provides a generic framework for successful SM in PPVC projects. First, the research constitutes the first exclusive attempt at benchmarking the KRAs for SM in PPVC projects. It highlighted some best practices associated with accomplishment of the KRAs and may be adopted to promote successful SM PPVC projects. Thus, it contributes to the practical management of PPVC projects and broadens the global understanding of how best to manage stakeholders in OSM projects. Second, the research prioritized the KRAs and thus delineates the key few areas that should receive sustained attention and efficient allocation of resources to guarantee the successful SM in PPVC projects. Finally, the factor analysis generated a framework of 3 broad management areas which are necessary for the successful SM in PPVC projects. Thus, the research has simplified and reduced the cognitive complexity associated with handling a set of fragmented KRAs.

Conclusions, limitations and future research

The effective implementation of PPVC, together with associated supply chain arrangements reduces construction time, improves project quality control, adaptability, sustainability, productivity and reduces project life cycle costs. However, the implementation of PPVC projects involves interdisciplinary stakeholders with conflicting interests, requirements, value systems, and needs. A successful PPVC project must realize planned objectives and meet the expectations of the diverse stakeholders. Yet, there is very limited research on how best to manage the stakeholders associated with PPVC projects. This research identified and prioritized the 12 KRAs for SM in PPVC projects, drawing on international survey of experts. Based on mean scores, the 5 most important KRAs for SM in PPVC projects include: effective working collaboration, communication and information sharing among participants; effective coordination of the PPVC supply chain segments; early involvement of relevant stakeholders in the PPVC project; extensive planning and analysis of stakeholder salience, needs, constraints and interest areas; and active involvement of key participants throughout the project. These highlight the profound importance of planning, early commitment, communication, collaboration, and supply chain coordination to the successful management of PPVC stakeholders. A structure detection analysis of the KRAs generated 3 PRAs explaining about 66.63% of the total variation in the success of SM in PPVC projects. The 3 PRAs include: stakeholder analysis and early involvement; effective communication and information sharing; and stakeholder interest integration and conflict management.

Although the study makes both useful theoretical and practical contributions to the OSM stakeholder management body of knowledge, the study suffered the following limitations. First, although adequate, the sample size was small and may compromise generalization of the results. Second, the generalized analysis of the KRAs overlooked their sensitivities to different project types, stages, and territories. However, such sweeping generalization is sometimes necessary to promote theoretical development of the CEM research domain and to establish generic framework of key management areas. Future research will increase the sample size and explore the interactions of the KRAs using a structural equation model.

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Table I. Final list of KRAs for SM in PPVC projects

S.N.	Key result areas for SM in PPVC projects
SF1	Effective working collaboration, communication and information sharing among participants
SF2	Effective coordination of the PPVC supply chain segments
SF3	Early involvement of relevant stakeholders in the PPVC project
SF4	Active involvement of key participants throughout the project
SF5	Effective coordination of involved stakeholders in the PPVC project
SF6	Understanding of early decisions and their implications on the roles of project participants
SF7	Effective use of integrated project delivery method and contracting
SF8	Effective management of stakeholder-associated risks in the PPVC supply chain
SF9	Adequate knowledge and good contractor leadership
SF10	Effective use of information and communication technology
SF11	Effective stakeholder conflict resolutions and management
SF12	Extensive planning and analysis of stakeholder salience, needs, constraints and interest areas

Table II. Background information of the engaged experts

Attribute	Sub-attribute	Responses	% Responses
Years of PPVC work experience	Below 10 years	40	71.4
	11 - 20 years	7	12.5
	Above 20years	9	16.1
	Total	***56***	***100.0***
Regions	North America	18	32.2
	Asia and Pacific	19	33.9
	Australia	5	8.9
	Europe	11	19.6
	South America	1	1.8
	Africa	2	3.6
	Total	***56***	***100.0***

Table III. Frequency scores of the KRAs for SM in PPVC Projects

Code	KRAs	Number of Responses					Shapiro - Wilk test (p-value)	Kruskal-Wallis test (p-value)
		1	2	3	4	5		
SF1	Effective working collaboration, communication and information sharing among participants	0	2	16	26	12	0.000	0.534
SF2	Effective coordination of the PPVC supply chain segments	0	2	17	28	9	0.000	0.736
SF3	Early involvement of relevant stakeholders in the PPVC project	1	2	21	21	11	0.000	0.816
SF12	Extensive planning and analysis of stakeholder salience, needs, constraints and interest areas	0	6	15	24	11	0.000	0.958
SF4	Active involvement of key participants throughout the project	0	5	13	28	10	0.000	0.605
SF5	Effective coordination of involved stakeholders in the PPVC project	0	8	19	21	8	0.000	0.488
SF6	Understanding of early decisions and their implications on the roles of project participants	1	8	20	18	9	0.000	0.015
SF7	Effective use of integrated project delivery method and contracting	1	8	19	25	3	0.000	0.128
SF10	Effective use of information and communication technology	1	6	25	19	5	0.000	0.708
SF8	Effective management of stakeholder-associated risks in the PPVC	0	7	28	16	5	0.000	0.213
SF9	Adequate knowledge and good contractor leadership	0	11	25	15	5	0.000	0.420
SF11	Effective stakeholder conflict resolutions and management	5	6	22	17	6	0.000	0.148

Table IV. Mean Scores of the KRAs for SM in PPVC Projects

Code	KRAs	Mean	Standard Deviation	Rank
SF1	Effective working collaboration, communication and information sharing among participants	3.86	0.80	1
SF2	Effective coordination of the PPVC supply chain segments	3.79	0.76	2
SF3	Early involvement of relevant stakeholders in the PPVC project	3.77	0.85	3
SF12	Extensive planning and analysis of stakeholder salience, needs, constraints and interest areas	3.71	0.90	4
SF4	Active involvement of key participants throughout the project	3.70	0.89	5
SF5	Effective coordination of involved stakeholders in the PPVC project	3.52	0.91	6
SF6	Understanding of early decisions and their implications on the roles of project participants	3.46	0.99	7
SF7	Effective use of integrated project delivery method and contracting	3.38	0.86	8
SF10	Effective use of information and communication technology	3.38	0.86	8
SF8	Effective management of stakeholder-associated risks in the PPVC	3.34	0.81	10
SF9	Adequate knowledge and good contractor leadership	3.25	0.88	11
SF11	Effective stakeholder conflict resolutions and management	3.23	1.08	12

Table V. Principal result areas for SM in PPVC Projects

Code	KRAs/PRAs	Factor Loadings	Eigen value	% of Variance Explained	Cum. % of Variance Explained
PRA1	**Stakeholder Analysis and Early Involvement**		**5.153**	**39.642**	**39.642**
KRA5	Effective coordination of involved stakeholders in the PPVC project	0.819			
KRA12	Extensive planning and analysis of stakeholder salience, needs, constraints and interest areas	0.801			
KRA3	Early involvement of relevant stakeholders in the PPVC project	0.801			
KRA9	Effective management of stakeholder-associated risks in the PPVC	0.699			
PRA2	**Effective communication and information sharing**		**1.901**	**14.621**	**54.263**
KRA2	Effective coordination of the PPVC supply chain segments	0.831			
KRA1	Effective working collaboration, communication and information sharing among participants	0.818			
KRA4	Active involvement of key participants throughout the project	0.657			
KRA11	Effective use of information and communication technology	0.625			
PRA3	**Stakeholder interest integration and conflict management**		**1.607**	**12.362**	**66.625**
KRA12	Effective stakeholder conflict resolutions and management	0.774			
KRA8	Effective use of integrated project delivery method and contracting	0.668			
KRA10	Adequate knowledge and good contractor leadership	0.661			