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Barriers to the implementation of value management in small construction projects

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ABSTRACT

As a well-established approach for attaining cost-effectiveness and value for money, Value Management (VM) is often overlooked in small construction projects, particularly in developing countries. This paper takes Malaysia as a case study to investigate the barriers to implementing VM in small construction projects with a view to exploring possible measures in mitigating the barriers and improving VM usage in small projects. Construction practitioners directly involved in small projects were surveyed using a structured questionnaire. Results of the survey revealed that the frequency with which the practitioners implement VM for small projects remains relatively low. Barriers contributing to this can be categorized under the knowledge and guidance barriers, environmental barriers, resource barriers, methodological barriers, and cultural barriers. Significant barriers were found mainly associated with the knowledge, guidance, and environment of disseminating the approach in small construction projects. Furthermore, measures that are perceived viable in overcoming the barriers were discussed. The findings of this paper provide a favorable reference for participants of small construction projects in VM decision and implementation in Malaysia as well as other countries with similar situations. As little empirical study focused on VM in small construction projects, this paper also contributes to enriching the body of knowledge related to the management of small projects.

1. Introduction

Today, Value Management (VM) has evolved into a well-established approach for attaining cost-effectiveness and value for money that is being expanded globally [1]. Value is the balance of what to gain (e.g. benefits) for what to give (e.g. costs) in a broad sense [2]. For a project, VM intends to improve its value by providing solutions/alternatives to optimize project functions and costs without compromising quality and performance through multidisciplinary team exercises [3]. The approach was initiated by Lawrence Miles of General Electric in 1947 for seeking alternatives to sort the shortage of raw materials for products caused by World War II [4]. The superiority of the approach was later discovered to produce products with lower cost and comparable/even better quality and performance. VM was therefore retained after the War as a means of eliminating unnecessary costs and attaining value for money, subsequently presented to the construction sector in 1963 [5]. It originated in the US and has invaded many countries in the last century, including the UK, Australia, Japan, China, Malaysia, and Saudi Arabia [6].

VM has grown popular and widely practiced in the construction sector in most developed nations [7]. The fact that the US government has mandated the use of VM in its projects in spite of a low contract value indicates a considerable success of VM achieved in

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the country [8]. This also happened in Japan and Australia, where VM mandatory enforcement has been expanded to smaller and lower-cost construction projects [9]. A higher VM usage was revealed by Hwang et al. [10] in Singaporean small building projects, refuting the common perception of large projects receiving more VM. Such circumstance, however, is by no means the same in developing countries. Compulsory VM is only subject to large and costly public projects in Malaysia [11]. The majority of countries in Africa and the Middle East do not even exist legislative regulations providing for VM enforcement in projects of various sizes/costs [8]. Awareness of VM and its broad applicability still remains lacking in many underdeveloped areas [12]. VM can and should be applied to any type of project for attaining cost-effectiveness and value for money, irrespective of project size/cost [9]. Nevertheless, mass embracement of VM in developing economies is yet to achieve and remains confined by project size/cost, despite the fact of the approach's lengthy history in the industry and great track records in project planning, cost control, conflict management, and dispute resolution [13].

Small projects tend to confront greater challenges than large ones as they are constrained in cost and duration while alongside severe competition and low profitability [14]. Their management, therefore, requires more diligence to avoid cost overruns and unacceptable deliverables. VM is highly advocated as one of the best solutions to such an issue as it stresses achieving value for money by reducing cost while optimizing functions and removing unnecessary materials, processes, and worker time [15]. Meanwhile, it aids construction corporations, notably Small and Medium Enterprises (SMEs) mainly contracting small projects, in alleviating the dilemma of poor profitability of small projects and enhancing self-competitiveness in order to stay ahead of the competition [16].

The integration of VM method in small project management is undeniably advantageous. In comparison to the splendidness in developed areas, VM in small construction projects appears to be often overlooked in developing countries. This begs the question of what factors are to blame for this lack of VM adoption in small construction projects. To seek answers, this study takes Malaysia as a case study to investigate the barriers to VM in small construction projects with a view to exploring possible measures in reducing barriers and expanding VM acceptance in small projects. The findings can provide construction practitioners, particularly those directly involved in small projects, with a favorable reference on VM decisions and implementation. As few studies focused on VM in small construction projects, this study also contributes to enriching the body of knowledge in relation to the management of small projects. It is hoped that increasing attention from both academia and industry would be raised towards VM in small projects.

2. Background

2.1. Small projects

Global consensus has yet been achieved on the specific definition of small projects [14]. Nevertheless, the characteristics of these projects still can be gleaned from former studies. It was recognized that projects are typically small when they do not involve a heavy investment [17]. The Construction Industry Institute (CII) revealed that judging whether a project is small primarily relies on the intuition that reflects the company's size and present work volume [18]. The CII also revealed that small projects tend to involve less staff, along with more contingencies and limited formal controls. Small projects, according to Griffith & Headley [19], are more inclined to possess shorter duration and lower complexity, with a major issue of disproportion between management inputs and project costs. Their common types of work contain repetition, routine, maintenance, renovation, remodeling, and upgrade, which can be costing around/below USD1 million [20]. Under a global context, Liang [21] summarized the cost of small projects to be commonly ranging from USD0.1 million to USD5 million. This was endorsed by Abdullah et al. [22], who demarcated small projects in Malaysia as those with a contract sum of less than Malaysian Ringgit (MYR) of 5 million (≈USD1.2 million). Such demarcation was further clarified by Memon & Rahman [23] and Mohamed et al. [24] as consistent with the characteristics of Small and Medium-sized Contractors (SMCs) in the country. That is the tendering limit of these contractors to undertake a project is up to MYR5 million, stipulated by the Construction Industry Development Board (CIDB) [25]. Accordingly, the subject of this VM study is focused on construction projects worth less than MYR5 million in Malaysia. Such scope is in line with the demarcation of small projects in previous studies based on project cost, while also reflecting the firm size as suggested by the CII.

2.2. VM in small projects

Small projects are prone to face more challenges than larger ones in terms of systematic management due to their inherent characteristics such as tight schedules, limited costs, less staffs involved, etc. [26]. Hence, a lack of attentive management in small projects can easily lead to cost overruns and poor deliverables. Memon & Rahman [23] revealed that cost overruns on small projects can typically approach 10–15% of the estimated cost, and advocated VM as a precaution. However, VM appears to be frequently overlooked in small projects as one of the viable options in curbing such menace. It was inherently considered as a costly and time-consuming process that requires experts and intensive information analysis, which is intuitively incompatible with the characteristics of small projects and deemed more suitable for larger ones [8]. Phyo & Cho [27] believed that the level of professionalization and duration for VM should be adjusted and determined according to the project's size. With proper use of it, the cost benefits generated are commonly tangible and greater than the inputs [10]. Despite VM having been expanded globally and becoming a well-praised technique, its embracement in small projects has still yet been satisfactory in the majority of underdeveloped areas and remains confined by project size [13].

The British Office of Government Commerce (OGC) indicated that VM is applicable to any type of project, irrespective of project size [28]. It has evolved into an established service with commonly understood tools, techniques, and styles amongst the British construction industry and has been widely accepted in managing projects of different types and sizes [29,30]. In Singapore, Hwang et al. [10] discovered that VM usage is about four times higher in small building projects under SGD5 million (≈USD3.7 million) than that in large ones over SGD100 million (≈USD74 million). Also, the US government has mandated VM for all its projects when project cost reaches USD2 million, while such figure for projects of the transport sector is more stringent, as low as USD100,000 [31]. Lee & Na [32] stated that Korean Tier 1 construction projects with a budget over KRW0.5 billion (≈USD0.4 million) must conduct VM to eliminate potential inefficiency and make certain cost-cutting factors, while the value has been revised and tightened to KRW0.1 billion (≈USD84,000) in accordance with the latest regulation. Such VM regulation however still remains only applicable to large projects costing over MYR50 million (≈USD12 million) in Malaysia since 2009 [11]. For most African countries, associated VM legislations are still absent, which significantly stymies the promotion of VM in projects of different sizes [33,34].

The application of VM in projects with lower costs helps the projects eliminate unnecessary costs, optimize functions, improve design and performance, and makes obtaining maximum value for the least amount of money more pronounced [8]. Abd-Karim et al. [35] asserted that VM implementation would encounter heavier dilemmas in SMCs than in large ones. Former studies cited that construction companies, particularly SMCs mainly contracting small projects, did not place adequate importance on VM due to a lack of internal knowledge and awareness about VM and its applicability [35–37]. Many SMCs were discouraged from investing in VM owing to the disparity between the resources necessary for VM and the low-profit margins of small projects [19]. Furthermore, intense competition leads SMCs to price their bids so low that they could be left with insufficient excess budgets for VM activities [26].

Al-Yami [38] identified a number of significant issues that could stymie VM adoption in developing countries, e.g. lack of information on VM requirements, standards, and historical data; lack of time for VM; lack of comprehension of VM; and so forth. According to Lai [39], the absences of VM knowledge and corresponding guideline as well as inadequate stakeholders' support could considerably restrict the widespread use of VM in various construction projects. This was agreed by Jaapar et al. [40], who further highlighted that inadequate awareness and training, resistance to change, and contradictory project goals amongst different parties were the significant difficulties confronting VM workshops in Malaysia. Shen & Liu [41] investigated the VM knowledge and implementation in the Chinese construction industry and discovered three major reasons why VM was not widely embraced in its work environment, namely lack of understanding of how VM should be implemented, lack of confidence in the introduction of VM to various parties, and lack of time to implement VM. Moreover, Kissi et al. [42] had examined more than 20 issues of VM application in Africa in order to gain insights into the VM team's implementation challenges, technical concerns, and obstructions in developing economies.

Notably, some factors obstructing VM deployment in developing countries were found similar and stood out according to the findings of prior studies. This supports the views of Aghimien et al. [15] that the similarities in the barriers to VM implementation in developing countries are attributable to the similarities in the characteristics and execution modalities of projects in these nations. With the aid of former studies, the factors that obstruct the implementation of VM were gathered to facilitate the present work. As a little number of studies focused on VM in small construction projects, this study expands the existing literature. It merits attention that the study focuses on VM in a formalized and organized manner rather than an implicit one. This is due to such manner being treated as a significant attribute in measuring the capability and maturity of VM [10]. A formalized and organized VM process also facilitates the cultivation of strong awareness on value creation and enhancement for small projects, as well as the flow of VM information throughout the entire project life cycle.

3. Research methodology

3.1. Development of research instrument

The study aims to look at the major barriers to VM in small construction projects, with a view to understanding the deficiencies of current VM development and exploring improvement measures. The methodology of questionnaire survey was employed to assess the

Table 1
Potential barriers to VM in small construction projects.

Code	Barriers	References
B01	VM practice incurs additional cost	[38,42]
B02	Lack of past experience in VM	[37,38]
B03	Lack of knowledge about VM and its benefits	[39,41,43]
B04	Poor awareness of VM existence and various applications	[15,37,40]
B05	Absence of proper guidelines	[39,42]
B06	Lack of time for VM practice	[38,42]
B07	Lack of support from government/top management	[15,38]
B08	Unwillingness to entertain new ideas and changes	[40]
B09	Inadequate VM training and facilitation skills	[44]
B10	Lack of active involvement of stakeholders	[36,37]
B11	Difficulty in analyzing and evaluating project functions and alternatives	[36]
B12	Problems of integrating advanced technology in VM approach	[45]
B13	Difficulty in reaching agreements on project objectives by stakeholders	[40]
B14	Poor relationships and communications among stakeholders	[40]
B15	Self-justifying attitude of the design team	[36]
B16	Lack of corresponding legislation/incentive for VM	[37,44,46]
B17	Lack of VM experts	[37,47]
B18	Lack of manpower/difficulty in forming an available team with the right skills	[15,37]
B19	Procurement or contract methods are not suitable for project to implement VM	[42]
B20	Difficulty in generating innovative ideas and alternatives	[39,40]
B21	Changing Covid-19 circumstances and response measures affect the form and commitment of VM activities	Experts' opinion

views of construction practitioners directly involved in small projects. Such a method was designed to characterize the features of a population or a phenomenon. As the study tries to identify and classify factors that affect VM implementation, a descriptive survey would aid researchers in properly understanding the construction industry and providing corrective measures or remedial systems for low-quality products [36].

The study started with an extensive literature review to better understand the topic and synthesize information for developing survey questionnaire as the instrument for data collection. An initial questionnaire was designed and subsequently sent to five experts from both industry and academia for content validation and refinement. The experts chosen are along with ample experience/expertise in VM that considerably contributes to the validation. Also, the experts suggested that the unexpected outbreak of the Coivd-19 pandemic could lead to changes in the form and commitment of VM activities, which could impede the implementation of VM. Hence, "Changing Covid-19 circumstances and response measures affect the form and commitment of VM activities" was put forward along with the barriers gathered from literature (listed in Table 1) to assess their negative impacts on applying VM in small construction projects. A pilot survey was conducted with 20 random construction practitioners to pre-check the consistency of the questionnaire. The final questionnaire was refined according to the experts' feedback and pilot study.

The finalized questionnaire consisted of three sections. An introduction letter was provided prior to the main body of the questionnaire to clarify the definition of small projects as well as the survey objective. Section A captured the background information of respondents and the level of frequency with which they had adopted VM for small construction projects. In Section B, a total of 21 barriers to VM implementation were listed. The respondents were asked to assess the impeding extent of these barriers toward VM in small construction projects based on their perception and experience. A five-point Likert scale, i.e. 5-very high, 4-high, 3-moderate, 2-low, and 1-no/very low, was adopted for the assessment. The scale was designed to provide respondents with an elaborate range of answers based on their knowledge and experience in delivering small projects. It has been widely used in various VM studies [27,34,36–38,40] as it yields better dispersion than a three-point scale while avoiding the potential over-dispersion from a seven-/ten-point scale [10]. Moreover, such a method can subsequently suggest the critical/cutoff score that aids in analyzing and determining the degree of obstructiveness of barriers to VM implementation. In addition, open-ended questions were also included in Section C of the questionnaire to solicit respondents' opinions on the measures that are perceived effective in mitigating the barriers to VM in small projects.

3.2. Data collection

The survey was conducted in Malaysia, with questionnaires disseminated using email. Respondents were gathered from major and populous states where construction works are highly demanded, including Johor, Penang, Selangor, and the Federal Territory of Kuala Lumpur. This was considered more likely to obtain representative opinions from experienced practitioners in the areas with larger populations, more innovative, and higher construction needs [36]. Conforming to the research scope, the respondents were selected based on a premise that they have been involved in small construction projects either in the capacity of a contractor, consultant, or client. Such organizations represent the three main sectors in the Malaysian construction industry that were sampled by the method of stratification. This is given that VM remains relatively inactive in small projects, while stratified sampling could facilitate reaching specific subpopulation [48]. Meanwhile, using such sort of sampling is dedicated to providing more reliable and accurate results for researchers as the survey herein is subject to a particular topic involving VM. According to Sharma [49], the advantages of stratified sampling were suggested as: (1) to reduce biases in the selection of sample cases, leading to a sample that is highly representative of the population under investigation, and (2) to allow generalization of samples to the population.

To assure respondents' applicability, a pre-approach via phones/emails/social media was performed to confirm their experience in small construction projects as well as solicit the willingness of survey participation. Moreover, SMCs were primarily considered since the large ones with higher tender limits commonly do not undertake small projects due to their capabilities to bid for projects with higher contract value [14]. Following the manners, a total of 400 questionnaires were disseminated to willing respondents, while 162 completed responses were retrieved and ascertained suitable for analysis. A return rate of 40.5% was attained and considered adequate for the study as Olatunde et al. [50] and Aghimien et al. [51] stated that results of a survey could be biased and of little significance if the return rate was lower than 20–30%. The survey was conducted in the time span of June–September 2021, and respondents from different organizations self-administered most of the questionnaires through the assistance of electronic survey tool. Such respondents typically serve as professionals in the fields of architecture, surveying, engineering, and management in the construction and delivery of small projects. Answers gathered were derived from their knowledge and experience in respective organizations that aids their assessment in the survey.

3.3. Data analysis methods

Various statistical tests were selected to analyze the collected data through the use of SPSS 24.0. The software is widely employed for resolving problems in business and research as its ease of use, flexibility, and scalability enable it to be accessible to a wide range of users and outfit projects of various sizes and complexity [52].

For the study, frequency and percentage were used to summarize respondents' demographic data and level of frequency of VM adoption in small construction projects. The Cronbach's alpha was tested to warrant the reliability of data gathered on VM barriers, while the data's normality was examined using Shapiro-Wilk test [53,54]. Mean score ranking was adopted to understand the impeding level of each barrier to VM implementation in small construction projects. One sample *t*-test or one sample Wilcoxon signed-rank test was selected based on the tested data's normality to examine whether the barrier is significant at the medium level of obstruction. It was suggested to adopt one sample *t*-test when the data tested is normally distributed, otherwise one sample Wilcoxon signed-rank test is selected as a non-parametric method to substitute the *t*-test as it makes no assumption on sample distribution [55, 56]. The hypothesized critical value of the significance of each barrier was set as 3 as it represents the medium impeding level in the study. Since the data were derived from different background groups of respondents, intergroup comparison on the mean scores of barriers was carried out. This was done to determine which barrier existed intergroup mean difference and examine whether respondents of different backgrounds endorsed the ranking of barriers. Regarding this, analysis of variance (ANOVA) is commonly considered for testing the potential mean differences among more than two independent groups when the tested data follow normal distribution, whereas Kruskal-Wallis test is a non-parametric equivalent of ANOVA for distribution-free sample data [57].

As most barriers were recognized from literature, some likely lead to similar underlying effects. Exploratory Factor Analysis (EFA) was deemed necessary to analyze and group the barriers into more manageable and significant sizes [15]. Content analysis was adopted to analyze respondents' opinions on measures that are perceived possible in overcoming barriers. Such technique allows researchers to compress numerous textual data into fewer content categories and identify the focus of the subject matter [58]. The analysis results were discussed along with the reflection of previous literature.

4. Analysis and discussion

4.1. Background information of respondents

Table 2 presents the background information of the respondents. The results indicate that five types of construction practitioners were surveyed. The majority of respondents were civil engineers (28.4%), followed by architects (25.9%), quantity surveyors (19.1%), project managers (15.4%), and mechanical and electrical (M&E) engineers (11.1%). Three categories of construction organizations that the respondents represented were recorded, i.e. consultants (48.1%), contractors (38.9%), and clients (13.0%). It was deemed rational that consultants and contractors were sampled the most as they are mainly responsible for successfully delivering projects and face more opportunities to access VM [10]. Meanwhile, all respondents have involved in small construction projects, and more than 60% possess experience of over ten years in the industry. These assure the responses collected were reliable and trustworthy.

4.2. Level of frequency of VM in small construction projects

Fig. 1 depicts the level of frequency of VM in small construction projects by respondents. Five levels of frequency were established by adapting Oke's [59] methodology to provide respondents with an elaborate scale to assess their frequency of using VM in small construction projects. Assessing from respondents' former experiences in small projects, a scale of 0–20% projects with VM adoption was set as a very low level of frequency, followed by 21–40% as a low level of frequency, 41–60% as an average level of frequency, 61–80% as a high level of frequency, and above 80% as a very high level of frequency.

The results indicate that the majority of respondents (45.1%) executed VM for their small projects at a very low level of frequency, followed by 33.3% at a low level. Only 11.8% of respondents stated to use VM more frequently than average in small construction projects. Therefore, it can be inferred that VM is not yet widely practiced in small construction projects in Malaysia. This echoes the common perception of large and costly projects receiving more VM [8]. Also, the low frequency of VM reported affirms the assertions of Abd-Karim et al. [35] and Alshehri [13] that the deployment of VM in developing countries like Malaysia remains unsatisfactory and confined by project size. Barriers that obstruct such deployment are worth exploring.

4.3. Barriers to VM in small construction projects

4.3.1. Reliability and normality of data

The impeding extents of barriers to VM in small construction projects were assessed by construction practitioners directly involved in small projects. Cronbach's alpha was initially tested to examine the reliability of the data gathered. Results in Table 3 indicate that the value of Cronbach's alpha of each item is larger than 0.80, revealing good reliability of the survey data [53]. In terms of data normality, Shapiro-Wilk test was carried out. The p-values of Shapiro-Wilk test of VM barriers were all significant at the significance

Table 2
Background information of respondents.

Category	Classification	Frequency	%
Profession	Architect	42	25.9
	Quantity surveyor	31	19.1
	Civil engineer	46	28.4
	M&E engineer	18	11.1
	Project manager	25	15.4
Organization	Contractor	63	38.9
	Consultant	78	48.1
	Client	21	13.0
Experience in the industry	0–5 years	36	22.2
	6–10 years	26	16.0
	11–15 years	29	17.9
	16–20 years	28	17.3
	Over 20 years	43	26.5
Experience in small projects	Yes	162	100.0
	No	0	0.0
Total		162	100.0

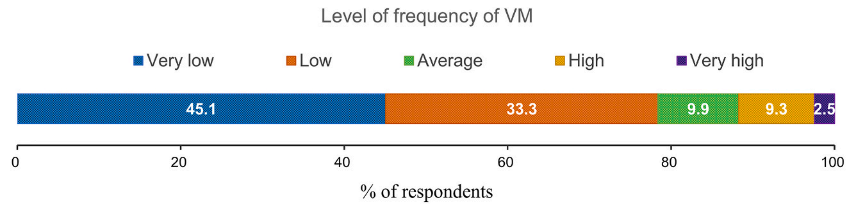

Fig. 1. Level of frequency of VM in small construction projects.

level of 0.05, suggesting a non-normal distribution of the tested data [54]. Non-parametric statistical tests were therefore considered for further analysis.

4.3.2. *Mean score ranking of VM barriers*

To examine the extent of obstruction, ranking of barriers using mean score was conducted as it was recognized as the most intuitive and effective way [60]. Results in Table 4 show that all barriers possess a mean score above the medium level of 3, ranging from 3.278 to 4.086. Also, the *p*-values of one sample Wilcoxon signed-rank test were all significant at the level of 0.05, implying that the respondents' assessment value was statistically different from the tested median of 3 [55]. These confirm that all the presented barriers have exhibited an impeding effect on the adoption of VM in small construction projects.

As there are five classifications each for respondents' profession, industrial experience, and level of frequency of VM, and three classifications for respondents' organization, Kruskal-Wallis test was selected to compare the intergroup mean differences of VM barriers. The test serves as a non-parametric statistical test that is frequently used to examine the similarity/differentiation among more than two independent groups when the tested data are not modeled by a normal distribution [61]. Results in Table 4 reveal that all items' *p*-values of Kruskal-Wallis test are larger than 0.05, except for *B02* "Lack of past experience in VM" and *B11* "Difficulty in analyzing and evaluating project functions and alternatives" in the intergroup comparison among respondents of different industrial experiences, and *B16* "Lack of corresponding legislation/incentive for VM" in the intergroup comparison among respondents with different frequencies of VM in small projects. This suggests that respondents with different industrial experiences and levels of VM frequency perceived differently on the negative impact of these barriers to VM in small projects. It seems understandable as the longer the practitioners stay in the industry, the more experience, familiarity, and recognition they tend to gain in relation to VM for small projects [35]. Therefore, the prominences of VM inexperience, difficulty of project functional analysis, and requiring legislation/incentive to stimulate VM adoption would be diminished. The overall non-significant results of Kruskal-Wallis test suggest that respondents of different backgrounds possess a similar circumstance in terms of the obstacles in applying VM in small construction projects. Such a circumstance is also endorsed by the similar Standard Deviation (SD) with relatively low values of below/around 1 in Table 4. This implies that the assessment values of respondents towards VM barriers were relatively concentrated and less deviated from the observed mean scores [62]. The presented mean ranking of VM barriers was therefore agreed upon and reflected the similar views of respondents on the obstructions of applying VM in small construction projects.

According to the rank, five most significant barriers to VM in small construction projects were identified. They are *B09* "Inadequate

Table 3
Reliability and normality test results.

Code	Cronbach's alpha	Shapiro-Wilk test		
		Statistic	df	*p*-value
B01	0.856	0.879	162	0.000*
B02	0.852	0.850	162	0.000*
B03	0.854	0.834	162	0.000*
B04	0.857	0.849	162	0.000*
B05	0.854	0.833	162	0.000*
B06	0.854	0.895	162	0.000*
B07	0.853	0.854	162	0.000*
B08	0.859	0.896	162	0.000*
B09	0.852	0.809	162	0.000*
B10	0.853	0.870	162	0.000*
B11	0.849	0.881	162	0.000*
B12	0.848	0.872	162	0.000*
B13	0.850	0.883	162	0.000*
B14	0.853	0.895	162	0.000*
B15	0.855	0.838	162	0.000*
B16	0.858	0.851	162	0.000*
B17	0.854	0.820	162	0.000*
B18	0.851	0.871	162	0.000*
B19	0.857	0.887	162	0.000*
B20	0.856	0.865	162	0.000*
B21	0.851	0.797	162	0.000*

Note: **p*-value of Shapiro-Wilk test is significant at the level of 0.05.

Table 4
Mean score ranking of barriers to VM in small construction projects.

Code	Mean	SD	Rank	Median	*p*-value of one sample Wilcoxon signed-rank test	Intergroup comparison			
						p-value[1]	*p*-value[2]	*p*-value[3]	*p*-value[4]
B01	3.543	1.010	14	4.000	0.000*	0.646	0.463	0.660	0.639
B02	3.901	1.029	4	4.000	0.000*	0.830	0.144	0.009*	0.600
B03	3.883	0.852	6	4.000	0.000*	0.168	0.133	0.091	0.525
B04	3.796	0.886	9	4.000	0.000*	0.784	0.514	0.053	0.711
B05	3.969	0.776	2	4.000	0.000*	0.677	0.862	0.211	0.183
B06	3.438	0.965	16	4.000	0.000*	0.914	0.302	0.073	0.566
B07	3.821	0.870	7	4.000	0.000*	0.775	0.158	0.143	0.071
B08	3.278	1.017	21	3.000	0.001*	0.663	0.912	0.881	0.498
B09	4.086	0.734	1	4.000	0.000*	0.287	0.350	0.075	0.555
B10	3.611	0.907	11	4.000	0.000*	0.553	0.541	0.830	0.872
B11	3.284	0.895	20	3.000	0.000*	0.346	0.254	0.049*	0.229
B12	3.494	0.960	15	4.000	0.000*	0.549	0.870	0.085	0.123
B13	3.426	0.938	17	4.000	0.000*	0.727	0.262	0.717	0.875
B14	3.370	0.965	19	3.000	0.000*	0.868	0.589	0.204	0.204
B15	3.426	0.818	17	4.000	0.000*	0.951	0.870	0.601	0.827
B16	3.938	0.839	3	4.000	0.000*	0.866	0.626	0.064	0.019*
B17	3.895	0.824	5	4.000	0.000*	0.174	0.897	0.096	0.051
B18	3.642	0.889	10	4.000	0.000*	0.848	0.415	0.562	0.253
B19	3.549	0.953	13	4.000	0.000*	0.340	0.418	0.092	0.339
B20	3.599	0.867	12	4.000	0.000*	0.074	0.674	0.661	0.496
B21	3.809	0.902	8	4.000	0.000*	0.675	0.706	0.627	0.413

Notes:
[1]*p*-value of Kruskal-Wallis test for intergroup comparison of respondents of different professions.
[2]*p*-value of Kruskal-Wallis test for intergroup comparison of respondents of different organizations.
[3]*p*-value of Kruskal-Wallis test for intergroup comparison of respondents of different experiences in the industry.
[4]*p*-value of Kruskal-Wallis test for intergroup comparison of respondents of different levels of frequency of VM in small projects.
**p*-value of the corresponding test is significant at the level of 0.05.

VM training and facilitation skills" (mean = 4.086, rank = 1), *B05* "Absence of proper guidelines" (mean = 3.969, rank = 2), *B16* "Lack of corresponding legislation/incentive for VM" (mean = 3.938, rank = 3), *B02* "Lack of past experience in VM" (mean = 3.901, rank = 4), and *B17* "Lack of VM experts" (mean = 3.895, rank = 5). They generally reflect the views of Griffith & Headley [19] and Hwang et al. [14] that small projects tend to go with fewer professionals' involvements and guiding supports while lacking awareness and application in terms of formal and systematic management.

B09 "Inadequate VM training and facilitation skills" was reported as the only and biggest barrier that has a mean value exceeding 4. It is understandable as inadequate training/orientation on VM would result in wrong perceptions of the approach and significantly impede the success of its application [15]. Also, it is implausible for construction practitioners who do not have adequate facilitation skills to request their clients to apply VM in their projects [36]. Therefore, it is foreseeable that training VM participants with needed knowledge and skills is important if the objectives of the approach are to be achieved in small construction projects. *B16* "Lack of corresponding legislation/incentive for VM" conformed to the fact that the current VM regulation in the country excludes projects of lower costs from the scope of VM mandatory enforcement [9]. Also, given that VM is still inactive in small projects, it is logical that corresponding incentives are not yet well established. This suggests that legislative framework or incentive mechanism can serve as a critical driver for facilitating wider use of VM in projects of different sizes, which appears to be often overlooked in developing countries [37]. As another considerable barrier, *B05* "Absence of proper guidelines", emphasizes that the current guideline provided by Malaysia's authority is more suitable for those large and costly projects that need to undergo VM compulsorily [63]. In contrast, exclusive VM guideline that caters to the characteristics and conditions of small construction projects remains lacking. The adherence to proper guidelines aids in organizing the layout and carrying out the work of VM in a right and systematic manner [40]. This could be particularly vital when VM experience and experts are lacking. The outstanding position of *B02* "Lack of past experience in VM" echoes the findings in Fig. 1 that VM in small construction projects is still at a very low frequency. *B17* "Lack of VM experts" could be attributed to the innate characteristics of small projects involving less professionals and expertise [14].

Due to the lowest mean scores, *B11* "Difficulty in analyzing and evaluating project functions and alternatives" (mean = 3.284, rank = 20) and *B08* "Unwillingness to entertain new ideas and changes" (mean = 3.278, rank = 21) were recognized as the least impactful factors that hinder VM adoption in small construction projects. General perception believed that small projects tend to possess lower complexity [64]. It is reasonable to encounter fewer difficulties in analyzing the elements and functions of these projects during the VM process. Additionally, the bottom position of *B08* "Unwillingness to entertain new ideas and changes" seems to reveal a positive and longing attitude of small projects toward new changes and innovations, which the application of VM can attain.

4.3.3. Factor analysis of VM barriers

Given that most barriers were extracted from literature, there was a likelihood that some could lead to similar underlying effects. EFA was performed to group the barriers into smaller and more significant numbers of coherent subgroups with a view to exploring similar underlying attributes. Prior to EFA being carried out, the collected data were analyzed to ascertain their suitability for the analysis.

The examination of suitability first targeted on the size of samples and number of variables. Tabachnick & Fidell [65] suggested that sample size ranges from 150 to 300 for factor analysis to be considered. Pallant [66] recommended that the acceptable sample size for factor analysis can be considered not less than the multiplication of the number of variables and responses per variable, which is 105 regarding this study. Pallant [66] also claimed that there had been little agreement among authors concerning the size of a sample for factor analysis, but suggested using a larger sample is better. The sample size employed in the study is 162, which meets the criteria suggested by Tabachnick & Fidell [65] and Pallant [66] for factor analysis. With regard to the number of variables, Aghimien et al. [15] commended that 20–50 variables were deemed appropriate for factor analysis, as the extraction of common factors becomes inaccurate if the number of variables exceeds such a range. This was also supported by the studies of Othman et al. [36] and Kineber et al. [67]. Hence, the 21 variables coupled with 162 samples employed herein were considered appropriate for conducting EFA. Such employment also led to a subject-to-variable ratio of approximately 8:1 that further fulfills the frequently acceptable rule of no less than 5:1 for good factor analysis [68]. The ratio is a necessary consideration for a stable factor structure to be obtained.

Additionally, the factorability of the gathered data was further determined using the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. KMO is a factor homogeneity metric that has been frequently used to examine whether partial correlations among variables are small [69]. The index of KMO runs from 0 to 1, with 0.6 being recommended as the minimum value for good factor analysis [65]. The use of Bartlett's test of sphericity is to determine if the matrix for the correlation is an identity matrix. Pallant [66] suggested that Bartlett's test of sphericity should be significant (<0.05) for factor analysis to be conducted. The tests of these indicators in the study were performed using SPSS 24.0, and the results are shown in Table 5. A KMO index of 0.801 and a significant level of 0.000 for Bartlett's test, along with the Cronbach's alpha (>0.80) in Table 3, indicate that the use of EFA for the data collected is appropriate.

With data fulfilling all necessary criteria, EFA was performed using Principal Component Analysis (PCA) with Varimax rotation to assess the factor structure between 21 VM barriers. Results of EFA in Table 6 illustrate that five components with eigenvalue exceeding 1 were suggested to extract, explaining a total cumulative variance of 60.569%. Fig. 2 depicts the screen plot for the extracted components as commended by Pallant [66]. Factor loading of 0.5 as the cut-off point was employed as suggested by Spector [70] that a clear component structure would significantly present when factor loading of an item exceeds such value on one component only. Due to cross-loading, item *B12* "Problems of integrating advanced technology in VM approach" was excluded from further discussion of factor extraction.

The characteristics/natures of barriers in each component extracted from EFA were carefully examined. The five subgroups of barriers to VM in small construction projects were subsequently named: knowledge and guidance barriers, cultural barriers, resource barriers, methodological barriers, and environmental barriers. Table 7 depicts the details of each subgroup as well as its mean score ranking. The subgroups are discussed according to the rank.

Knowledge and guidance barriers (mean = 3.922, rank = 1): The first-ranking subgroup consists of barriers related to stakeholders' knowledge and guidance of VM in small construction projects. It explains the highest amount of variance (26.990%) of the total variance. The specific items include: *B03* "Lack of knowledge about VM and its benefits", *B04* "Poor awareness of VM existence and various applications", *B05* "Absence of proper guidelines", *B09* "Inadequate VM training and facilitation skills", *B17* "Lack of VM experts", and *B02* "Lack of past experience in VM". As the latent characteristics of these barriers are either associated with the perceptions of VM or relevant guidelines/experiences that aid in guiding VM implementation, the subgroup of "knowledge and guidance barriers" was named. All of the barriers possessed a relatively high value of the mean, leading to the subgroup mean of 3.922 that is the largest and close to a high level of hindrance. This makes this barrier subgroup the most prominent to hinder the adoption of VM in small construction projects. The first ranking of this subgroup attained supports the views of Alshehri [13] and Olawumi et al. [8] that the awareness of VM discipline including its benefits and applicability remains insufficient in the majority of underdeveloped areas including Malaysia. This could significantly impede a wider embracement of the VM approach to be achieved among construction projects of different sizes/costs. Also, it is deemed challenging to promote VM as a new initiative in small construction projects without clear local guidelines or associated experiences as favorable guidance [42,71]. Therefore, it is foreseeable that corresponding efforts and improvements in these regards would be necessary for attaining a wider application of VM.

Environmental barriers (mean = 3.856, rank = 2): The second subgroup in the rank contains the barriers associated with the external surroundings of disseminating VM in small projects in the industry. 5.715% of the variance explained was accounted for by this subgroup. The specific items included are: *B16* "Lack of corresponding legislation/incentive for VM", *B07* "Lack of government/top management support", and *B21* "Changing Covid-19 circumstances and response measures affect the form and commitment of VM activities". It is explicit by nature that such hurdles are subject to the environmental effects from the external side of VM implementation in small construction projects. The barriers were accordingly designated as "environmental barriers". The relatively high score of the mean (3.856) makes this subgroup of barriers to VM in small projects the second most prominent. This may be caused by the prevailing environment of VM in developing countries that is currently characterized by greater uses in large and costly projects

Table 5
KMO and Bartlett's test results.

Kaiser–Meyer–Olkin measure of sampling adequacy		0.801
Bartlett's test of sphericity	Approx. χ^2	1314.703
	df	210
	Sig.	0.000

Table 6
Factor loadings based on PCA with Varimax rotation.

Code	Component				
	1	2	3	4	5
B03	0.833				
B04	0.774				
B05	0.752				
B09	0.718				
B17	0.674				
B02	0.662				
B08		0.794			
B14		0.753			
B15		0.699			
B10		0.674			
B13		0.540			
B06			0.742		
B01			0.672		
B12[a]			0.605	0.529	
B18			0.569		
B11				0.707	
B19				0.625	
B20				0.612	
B16					0.758
B07					0.751
B21					0.566
Eigenvalues	5.668	2.925	1.577	1.349	1.200
Variance %	26.990%	13.930%	7.510%	6.424%	5.715%
Cumulative variance %	26.990%	40.920%	48.430%	54.854%	60.569%

Note:
[a] Item with cross-loading.

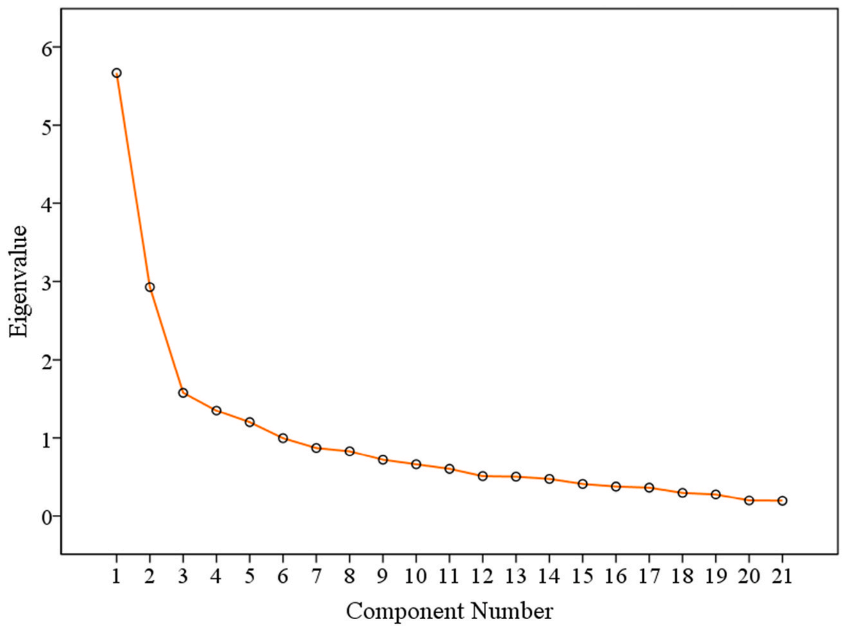

Fig. 2. Scree plot result.

[8]. Such an environment could therefore result in shorts of government/top management support, legislation, and incentives for VM in small projects. Meanwhile, it also reflects insufficient awareness and efforts in these aspects by relevant parties. Notably, the unexpected outbreak of the COVID-19 pandemic has shown a negative impact on the form and commitment of VM activities in small construction projects. This could be explained by the views of Shafi et al. [72] that construction enterprises in developing countries, particularly SMEs, appear to be expressively hit by COVID-19 as well as difficult to promptly cope with the negative impacts from the pandemic on project management, construction, and delivery.

Resource barriers (mean = 3.541, rank = 3): The third principal component extracted from EFA accounts for 7.510% of the total

Table 7
Mean score ranking of VM barriers subgroup.

Subgroup	Code	Barriers	Mean	Subgroup mean	Subgroup rank
Knowledge and guidance barriers	B03	Lack of knowledge about VM and its benefits	3.883	3.922	1
	B04	Poor awareness of VM existence and various applications	3.796		
	B05	Absence of proper guidelines	3.969		
	B09	Inadequate VM training and facilitation skills	4.086		
	B17	Lack of VM experts	3.895		
	B02	Lack of past experience in VM	3.901		
Cultural barriers	B08	Unwillingness to entertain new ideas and changes	3.278	3.422	5
	B14	Poor relationships and communications among stakeholders	3.370		
	B15	Self-justifying attitude of the design team	3.426		
	B10	Lack of active involvement of stakeholders	3.611		
	B13	Difficulty in reaching agreements on project objectives by stakeholders	3.426		
Resource barriers	B06	Lack of time for VM practice	3.438	3.541	3
	B01	VM practice incurs additional cost	3.543		
	B18	Lack of manpower/difficulty in forming an available team with the right skills	3.642		
Methodological barriers	B11	Difficulty in analyzing and evaluating project functions and alternatives	3.284	3.477	4
	B19	Procurement or contract methods are not suitable for project to implement VM	3.549		
	B20	Difficulty in generating innovative ideas and alternatives	3.599		
Environmental barriers	B16	Lack of corresponding legislation/incentive for VM	3.938	3.856	2
	B07	Lack of government/top management support	3.821		
	B21	Changing Covid-19 circumstances and response measures affect the form and commitment of VM activities	3.809		

variance explained. The name "resource barriers" was subsequently addressed for this subgroup as the inherent features of the barriers included cut across the various resources necessary for VM implementation in small construction projects, such as manpower, time, financials, etc. The specific barriers are: *B06* "Lack of time for VM practice", *B01* "VM practice incurs additional cost", and *B18* "Lack of manpower/difficulty in forming an available team with the right skills". It is evident that these barriers are mainly yielded by the non-superior innate characteristics of small construction projects like the constrained financial resources, short schedules, less staff involved, etc. [14]. However, in the long run, VM for small projects can give a considerable measure of cost reductions as well as time savings and efficiency improvements when executed properly [23]. Such a dilemma is seemingly reflected by the observed middle-ranking of this subgroup. Hence, the appropriate allocation of resources appears necessary for small construction projects to better implement VM.

Methodological barriers (mean = 3.477, rank = 4): The fourth subgroup is made up of barriers with regards to the methods used in the process of VM in small construction projects. 6.424% of the total variance was explained by this component extracted from EFA. Three items of barriers were included, i.e. *B11* "Difficulty in analyzing and evaluating project functions and alternatives", *B19* "Procurement or contract methods are not suitable for project to implement VM", and *B20* "Difficulty in generating innovative ideas and alternatives". Among them, *B20* "Difficulty in generating innovative ideas and alternatives" appeared with the highest mean value. This reflects the difficulties of small project participants in coming up with innovative ideas or alternatives to optimize project functions and costs during the VM process. It also reflects the views of Hwang et al. [10] that one of the critical elements driving VM success is the participants' creative and innovative thinking. Yet such thinking appears often lacking as small construction projects tend to involve fewer professionals and experts [14].

Cultural barriers (mean = 3.422, rank = 5): The last subgroup in the rank consists of barriers associated with stakeholders' cultures and attitudes towards VM in small construction projects. A proportion of 13.930% was accounted for by this subgroup in terms of the variance explained. The specific items include: *B10* "Lack of active involvement of stakeholders", *B15* "Self-justifying attitude of the design team", *B13* "Difficulty in reaching agreements on project objectives by stakeholders", *B14* "Poor relationships and communications among stakeholders", and *B08* "Unwillingness to entertain new ideas and changes". The bottom position of this subgroup reveals a laudably positive attitude and receptiveness of adopting VM in small construction projects by stakeholders. The cultural climate formed amongst stakeholders was considered not significantly impeding the adoption of VM in small construction projects. This may be attributed to the fact that smaller projects typically involve fewer stakeholders, and are less prone to evident and considerable conflicts of interest and culture than the case of larger ones [73].

The mean score ranking of the subgroups yields that chief barriers to VM are primarily associated with the knowledge, guidance, and environment of disseminating this innovative approach in small projects in the industry. The depressed usage of VM in small construction projects can be explained by the barriers while clear focuses were established for realizing and improving the practice.

4.4. Mitigation measures for barriers to VM in small construction projects

To improve the usage of VM in small construction projects, mitigation of barriers ought to be emphasized. Some potential measures to mitigate the barriers to VM in small construction projects were summarized through the analysis of respondents' opinions from the survey.

The importance of training and education of practitioners in the effective management of construction projects cannot be overemphasized. However, construction practitioners, particularly those serving for small projects, appear to frequently fall short in this regard [74]. This has affected the utilization of favorable approaches like VM in small projects as observed in this study. Therefore, as the majority of respondents urged, there is a need in training participants of small construction projects on the principles, concepts, and techniques with relation to the VM approach. Regular internal training within organizations or external learning from professional institutes, e.g. Institute of Value Management Malaysia (IVMM), Society of American Value Engineers (SAVE), etc., are worth advocating. The education of necessary knowledge and facilitation skills is also alongside the purpose of facilitating intelligent, self-motivated, and aggressive VM participants [6]. That instructively lays the foundation of a multidisciplinary VM team for small projects to overcome the barrier of lacking competent manpower resources. Experience sharing was also commended by respondents, as continuous review and improvement of former practices aid in better achieving sustainability of VM in small construction projects. It is also deemed that participants of small projects would appreciate more of VM benefits and importance with increasing associated knowledge, awareness, and experience.

Additionally, it is hoped for the government to provide clear policies, guidelines, and incentives as favorable means to popularize VM in small construction projects. This can be attributed to the fact that government plays a foremost role in creating and enforcing new regulations, initiatives, and guidelines within various sectors. It is particularly salient in developing countries like Malaysia as its construction sector heavily relies on the local government in achieving progress [75]. Meanwhile, it is also expecting the local government to follow the footstep of developed countries (e.g. the US, the UK, Japan, Australia, Korea, etc.) and extend the scope of VM's legislative regulation to smaller, lower-cost projects [8]. Notably, respondents cited virtual VM workshops as one of the best solutions in view of the current outbreak and conditions of COVID-19 pandemic. The use of such a form not only complies with the requirements of epidemic prevention, but also is accessible, inexpensive, and efficient [76]. However, the corresponding technical support and participating enthusiasm ought to be emphasized.

Considering the tight schedule and less disposable costs, the proper streamlining of processes and planning resources seems commendable for the case of small projects to implement VM. The integration of VM approach with other managerial activities (e.g. risk management, quality management, etc.) is an ingenious strategy that could make better benefits of VM convincing to the participants of small projects. Simultaneous implementation of multiple approaches can potentially alleviate the inadequacy of management input in small projects, while also saving time and enhancing efficiency [77]. It is worth mentioning that some respondents advocated practicing VM as a profession, not just a means to simply control costs when issues arise. For small projects, simple cost reduction seems tempting and may yield short-term benefits for clients. However, VM with professionalism would be more conducive to stimulating improvements in small project performance and value, which is more in line with the approach's intention and different parties' long-term developments.

5. Conclusions

Bold statements have been made concerning the cost ineffectiveness and poor deliverables of small construction projects in developing countries like Malaysia, while research works have proven that VM as one of the viable methods in curbing such menace is frequently overlooked. The approach remains a very low frequency of use in small construction projects in Malaysia, as confirmed by the study. Also, the study assessed the barriers to the adoption of VM in small construction projects through a structured questionnaire survey. A total of 162 construction practitioners directly involved in small projects were sampled from areas with high population and construction demands.

Various statistical analyses were conducted on the data gathered from the survey. The results indicate that barriers to VM in small construction projects can be categorized under the knowledge and guidance barriers, environmental barriers, resource barriers, methodological barriers, and cultural barriers. Major barriers were found as those mainly associated with the knowledge, guidance, and environment of disseminating VM in small construction projects. Chief of these barriers are "Inadequate VM training and facilitation skills", "Absence of proper guidelines", "Lack of corresponding legislation/incentive for VM", "Lack of past experience in VM", and "Lack of VM experts". Furthermore, some potential measures that are perceived viable in mitigating the barriers were explored.

6. Contributions

This study contributes to corroborating and explaining the relatively low use of VM approach in small construction projects in Malaysia. The similar attributes of VM barriers explored could establish the major focuses that aid in realizing and improving the practice of the approach in small projects. Also, the study considers the underlying impediment of the COVID-19 pandemic on VM activities, which provides additional insight into the impacts of the pandemic on project management in the construction industry. The methodology of intergroup comparison employed herein appears to be less common in VM studies to date. Such a method could open up more possibilities for further examining the similarity/differentiation among various views gathered from questionnaire surveys, which is worth promoting.

The study also contributes to a much clearer understanding of the current VM deployment in small construction projects in Malaysia. Its recommendations can benefit the participants of small construction projects in overcoming the barriers and improving VM usage in Malaysia as well as other countries where characteristics and execution modalities of small construction projects are similar. The execution of VM for small projects makes the implication of achieving maximum value for the least amount of money more pronounced. As few studies have focused on VM in small construction projects, this study also dedicates to enriching the body of knowledge related to the management of small projects.

7. Limitations and recommendations for future research

Despite the achievement of the objectives, this study remains some limitations. Due to the lack of a consensus on the definition of small projects, the study identified the scope of small projects through only one determinant, i.e. project cost. Thus, the results observed may not be generalizable to fully exhaustive small projects. As samples from the client side are relatively less while not all organizations surveyed are SMEs, there could be biases inherent in the sample. The study was conducted in the context of Malaysia, therefore, the results may differ in other countries with dissimilar circumstances.

Future studies could be conducted on investigating the factors that affect VM implementation in small projects in other countries/ regions, as well as the relationship between VM implementation and project performance improvements. The interrelationships among the factors influencing VM implementation in small projects could be further analyzed using techniques like structural equation modeling. It is also praiseworthy to study the framework/guideline that exclusively caters to the characteristics and conditions of small projects to better and successfully implement VM.

CRediT authorship contribution statement

Xiaobin Lin: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Ain Naadia Mazlan:** Supervision, Methodology, Writing – review & editing. **Syuhaida Ismail:** Supervision, Methodology, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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