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The Deployment of Value Workshop Objectives to evaluate Value Engineering Awareness and Proficiency among Construction and Allied Professionals

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ABSTRACT

Value engineering of construction projects has been instantiated through value workshops with realizable objectives to the benefit of the project owners and end-users. However, myriads of studies have indicated varying perspectives regarding the levels of value engineering (VE) awareness among the building, construction, engineering, (BCE) and allied professionals in Nigeria. This is coupled with the observed fallout of their experiential inadequacy in VE practice. It is against this backdrop that this study evaluated using the ten value workshop objectives (VWOs), the degree of association between VE awareness and VE proficiency among the BCE and allied professionals in Kogi State, Nigeria. Sequel to a pilot study, a combination of purposive sampling, and "stratified" snowballing of 365 questionnaires among Architects, Builders, Engineers, Estate Surveyors and Valuers, Project Managers, Quantity Surveyors, and Town Planners in the study area were instantiated. Consequently, 94 usable questionnaires were successfully retrieved and validated. Cross-tabulations were used to present the results of data analyses. It was found at $p > 0.05$, that the strong levels of VE awareness among the sample of these professionals did not necessarily imply that they might exhibit high levels of proficiency in VE practice. Although the results of the Fisher's exact- and Barnard tests indicated a convergence between Project managers' expected- and existing VE skills, the Chi-square test on the seven groups of professionals, however indicated a divergence; so that their experiential inadequacies in VE practice might be attributed to this divergence. Besides availing insight into the timely review of pedagogic- and pre-qualification processes for BCE and allied professionals who intend venturing into value methodology practice in Nigeria, this study is among the novel attempts at using VWOs as instruments for assessing the degree of association between VE awareness and VE proficiency among these professionals.

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1. Introduction

The optimal balance between cost management and the realizable function of construction project constitute critical indices for measuring the project's success. This accounts for the deployment of measures including value engineering (VE) to avert adverse phenomena of cost overrun, delay in project completion, temporary/permanent abandonment of projects, and the erosion of developer's profit. The aversion of these adverse phenomena is critical to the realization of a project's function and optimal return on capital invested (Braden, 1990; Rad and Yamini, 2016).

Value Engineering (VE) or Value Management (VM) as christened by experts in the construction and allied disciplines (RICS, 2017; SAVE International, 2007), has been defined as a team-oriented strategy for optimizing project cost and function, so that value for money associated with the project could be realized (Lin et al., 2023). The realization of this goal is driven by the legacy objectives of cost reduction without compromising performance and return on investment (Braden, 1990; Rad and Yamini, 2016).

Although VE is averred to be instantiated during the technical or functional phase of a project (RICS, 2017; SAVE International, 2007), it is aimed at finding the cost-saving alternative to design, procurement, and construction that can still avail the users and owners of a built facility (project) with optimal performance; and not necessarily to reduce cost at the expense of function and quality (Dell'Isola, 1997; Emami and Emami, 2020; Kelly et al., 2004; Zhang and El-Gohary, 2015).

Suffice it to say that VE constitutes a dimension of cost-benefit appraisal that is instantiated through multidisciplinary peer review of project design, resources, and procurement options with the purpose of eliminating unnecessary costs, averting incidence of cost-overruns, and enhancing project performance, function, and value to the benefit of the owners and end-users. It provides answers to the questions of how to-, and what can be done to save costs in the course of project planning, execution, and operation, without adversely affecting function and performance; so that the preference of the project implementation team shall be skewed towards alternative designs, materials, and procurement strategies that might likely outperform the benchmarks that are set during the value workshop.

Awareness is conceptualized to imply the process of exercising cognition, knowledge, and perception of a phenomenon (Bizzarri *et al.*, 2022; Yaure, 1973). On the other hand, proficiency simply connotes a high level of demonstrable skill, competence or expertise of a phenomenon or activity by an individual (Oxford Languages, 2024). It is a behavioural attribute for which an individual exercises knowledge of extant standards, and puts in extra effort to outperform these standards in the course of carrying out specific tasks (Lantolf and Frawley, 1988).

In the first quadrant of the shaded segment in Figure 1 is the intersection between "*Activity*" and "*Proficiency*" otherwise christened as "*Activity proficiency*", for which a surrogate definition was offered as the "*ability to apply knowledge and skills to achieve intended results*" (International Standards Organisation, 2012).

Anti-clockwise from the first shaded quadrant in Figure 1 is the second quadrant named "*Activity awareness*", which is described as the extent that an individual can attest through cognition, the occurrence- or possible occurrence of an event or a phenomenon (Gutwin and Greenberg, 2002). On the basis of this theorization, VE can be perceived as an activity that entails a convolution of skills from the building, construction, engineering (BCE) and allied professionals for the purpose of maximizing value and achieving functional balance between performance, reliability, and cost of projects (Ahmed and Pandey, 2016; Bowen *et al.*, 2009; Khodeir and El Ghandour, 2019; Younker, 2003).

Variables / Phenomenon		Awareness	Proficiency
		Theorization	
Activity	Theorization	Activity awareness	Activity proficiency
Attribution		Awareness attribution	Proficiency attribution

Figure 1. Formulation of theoretical framework for the study

The third quadrant of the shaded segment of Figure 1 features "*Awareness attribution*", which ascribes the awareness of a phenomenon to specific predictive agents (Graziano, 2019), otherwise called explanatory variables. In other words, VE awareness is not instantaneous among BCE and allied professionals but is driven by explanatory variables.

In the fourth quadrant of Figure 1 is "*Proficiency attribution*", which implies that competence or proficiency (as used in this study) could be ascribed to causal factors comprising those within- and those outside the control of an individual as explained by Perry and Hamm (2017). In consonance with Weiner (2000), these causal factors could be elicited through self-assessed perceptions of activity competence/proficiency; but from the perspective of the identified value workshop objectives (VWOs) for the purpose of this study.

The practice of VE is guided by array of objectives. For the purpose of this study, however, the ten value workshop objectives among which constitute those credited to Dell'Isola (1997), Bowen *et al.* (2009), and Bowen *et al.* (2010) were identified to include- minimizing capital cost of project; enhancing project functionality; enhancing project worth; optimizing value over project life cycle; minimizing adverse environmental impact of project; enhancing project usability, convenience and comfort; enhancing project flexibility; effectively managing risk; ensuring early project completion/delivery; and minimizing project operating cost. These value workshop objectives equally constituted the objectives of instantiating VE exercises for construction projects; hence, the interchangeable use of value engineering objectives (VEOs) for value workshop objectives (VWOs) in this study. It is on the basis of these VWOs that the level of VE awareness and VE proficiency among the seven groups of BCE and allied professionals in the study area were assessed and subject to rank correlation analysis.

Existing studies had indicated the significant awareness of three specific VWOs/VEOs among BCE and allied professionals to include minimizing capital cost, enhanced project functionality, and effective risk management (Bowen *et al.*, 2010; Bowen *et al.*, 2009; Ellis *et al.*, 2005). Besides these, is the reportage of insignificant awareness of the following seven VEOs, namely to enhance project worth; optimize value over project life cycle; minimize adverse environmental impact of project; enhance project usability, convenience and comfort; enhance project flexibility; early project completion/delivery; and minimize operating cost of a project (Bowen *et al.*, 2010; Bowen *et al.*, 2009). However, no attempt has been made before now to use these VWOs as benchmarks for assessing the level of VE awareness among the BCE and allied professionals, so that a rank correlation analysis of VE awareness and VE proficiency could be performed.

On the other hand are existing studies attributing proficiency to the achievement of specific VWO and its surrogates. These include cost savings (Khodeir and El Ghandour, 2019); minimized project operating cost (Rich and Holweg, 2000); enhanced project worth (Thneibat and Al-Shattarat, 2021); enhanced project functionality (Kolibácová, 2014); value optimization over project life cycle (Bennett and Mayouf, 2021); enhanced project flexibility/adaptability (Oke and Ogunsemi, 2013; Saleh *et al.*, 2009); enhanced project usability, convenience and comfort (Lee *et al.*, 2011); effective risk management (Osazuwa *et al.*, 2019); early project completion/delivery (Alsolami, 2022); and minimized adverse environmental impact of project (Othman and Abdelrahim, 2020). Just as in the case of existing studies on VE awareness among BCE and allied professionals, there has been no prior attempt to assess the extent to which these professionals, especially in Nigeria, could deploy their proficiency/competence towards realizing each specific VWO. In furtherance to this analytical trajectory, there has been no prior attempt to use these VWOs as benchmarks to assess the degree of association between VE awareness and VE proficiency among these professionals.

The VE team for construction projects in Nigeria had typically involved an array of building, construction, engineering (BCE) and allied professionals including Architects, Builders, Engineers, Estate Surveyors and Valuers, Project Managers, Quantity Surveyors, (Oke and Ogunsemi, 2011), and Town (Spatial) Planners, all of whom are expected to have mutual understanding of how to deploy innovation and alternative resources to eliminate unnecessary costs associated with projects. However, existing studies within the Nigerian context indicates conflicting results regarding the levels of VE/VM awareness among these professionals ranging from the high level of awareness (Ganiyu and Danjuma, 2022; Jiya *et al.*, 2023), average- and low levels of awareness within Lagos (Ogunsanmi, 2014; Oke and Ogunsemi, 2013), and low level of awareness in North-Central Nigeria (Ilenikhena and Adindu, 2021), where the study area, Kogi state situates.

With respect to the phenomenon of proficiency, Oke and Ogunsemi (2011) had averred that the "*familiarity with the practice of value management does not necessarily connote competences to function as a value manager….*". This statement could be recast within the context of this study to imply that the familiarity of a BCE and allied professional with VE may not likely imply competence or proficiency in VE practice. Pursuant to this is the observed problem of experiential inadequacies in VE practice among the BCE and allied professionals (Ilenikhena and Adindu, 2021; Lin *et al.*, 2022; Lin *et al.*, 2023; Oke and Ogunsemi, 2011). Fallout from these studies is the likelihood of attributing the experiential inadequacies to a gap between the existing- and expected skills for VE practice among these professionals. However, there has been no substantial follow-up, such that the levels of proficiency of each group of BCE and allied professional in delivering the objectives of a typical VE workshop could be assessed on a case-by-case basis, in the same way that similar studies credited to Bowen *et al.* (2009) and Bowen *et al.* (2010) had assessed the awareness of these professionals regarding the same value workshop objectives (VWOs).

This study aims to evaluate within the context of value workshop objectives (VWOs), the degree of association between VE awareness and VE proficiency among BCE and allied professionals in Kogi State, Nigeria. The objectives put forward to address this aim include to identify the value workshop objectives (VWOs) applicable to value engineering (VE); evaluate the level of awareness of VWOs among the professionals; evaluate the proficiency levels in the delivery of the VWOs among the professionals; evaluate the degree of association between VE awareness and VE proficiency; and assess the likelihood of gap between expected- and existing VE skills.

Featured in Figure 2 is the conceptual foundation for the pair-wise correlation between VE awareness and VE proficiency among the BCE and allied professionals in the study area. For the purpose of the one-to-one bijective mapping of rank order of VWOs that were used to assess respondents' level of VE awareness and VE proficiency respectively, value engineering awareness = X; and value engineering proficiency = Y; so that the variables - X and Y constitute independent sets measured

using benchmarks of the same ten (10) value workshop objectives (VWOs) identified above. In this bijective mapping, an element (value workshop objective-VWO) that has been assigned a specific rank within the domain variable, *X* (VE awareness) is mapped onto the same element (VWO) within the co-domain variable, *Y* (VE proficiency) that might have been assigned a rank similar to- or distinct from that attributed to such element within the domain.

In corresponding rank-order, the VWOs or elements of the set *X* and *Y* in Figure 2 were expressed as follows:

$$X = \{\rho_1\{V\}, \rho_2\{V\}, \rho_3\{V\}, \rho_4\{V\}, \rho_5\{V\}, \rho_6\{V\}, \rho_7\{V\}, \rho_8\{V\}, \rho_9\{V\}, \rho_{10}\{V\}\} \text{and}$$

$$Y = \{\rho_1\{V\}, \rho_8\{V\}, \rho_4\{V\}, \rho_2\{V\}, \rho_3\{V\}, \rho_6\{V\}, \rho_9\{V\}, \rho_{10}\{V\}, \rho_7\{V\}, \rho_5\{V\}\}$$

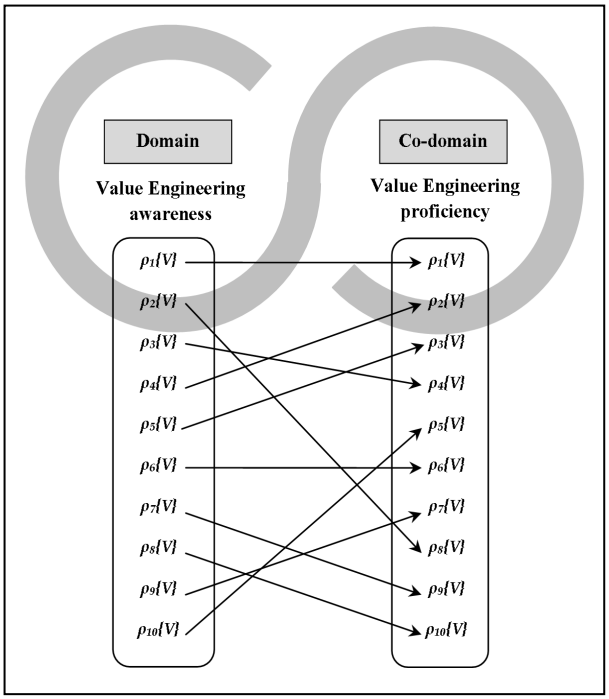

Figure 2. Conceptual framework for the study

Symbolizing the rank correlation between VE awareness, *X*, and VE proficiency, *Y* in Figure 2 is:

$$\rho_{X,Y} \Rightarrow X \infty Y$$

Consequently, inference could be drawn at 5% level of significance regarding the correlation or otherwise between VE awareness and VE proficiency among the BCE and allied professionals (respondents) in the study area.

2. Methodology

2.1 Study Population and Sample Size Determination

The study population comprises the BCE and allied professionals namely - Architects, Builders, Engineers, Estate Surveyors and Valuers, Project Managers, Quantity Surveyors, and Town Planners domiciled and practicing in Kogi State, Nigeria.

However, the study could not adopt stratified random sampling across these groups of professionals owing to the inability to obtain appropriate sample frames for Engineers and project managers in the study area. Instead, the administration of 55 and the retrieval of 21 valid pilot study questionnaires across the 7 strata of professionals in Table 1 culminated into the determination of an expected sample size of 365 respondents using the inverse Cochran's equation (Equation 1) as follows:

$$N = \frac{n\{p(R) \bullet (\neg p(R))\}^2}{\{p(R) \bullet (\neg p(R))\}^2 - ne^2} \quad (1)$$

Where N = (Total) Expected sample size to be determined, n = 21; $p(R)$ = 0.3818; $\neg p(R)$ = 0.6182 as derived from Table 1; coupled with 0.05 level of significance, e.

Thereafter, the purposive administration of 365 study questionnaire across the three data collection centres was instantiated, leading to the retrieval of 94 valid and usable questionnaires alongside the stratification across the 7 groups of professionals as indicated in Table 2.

2.2 Process Flowchart for the Study

As indicated in Figure 3, the study commenced with the identification of gaps in literature, which culminated into the problem statement. Thereafter was the deployment of the survey design which culminated into the development of paper-based questionnaire that was validated in the course of the pilot study.

The pilot study was used to instantiate a multi-stage process of purposive- and "stratified" snowball sampling; and the actual collection of data using paper-based questionnaires that elicited respondents' self-assessment of the duo of awareness of VWOs and proficiency in the delivery of the same VWOs.

Accompanying the self-assessments were ordinal responses rated on a 5 to 1 point in the range- "Very strong awareness"/"Very high proficiency" to "No awareness"/"No proficiency" respectively. In addition to this was the 4-point ordinal Likert responses in the range of "Strongly agree" to "Strongly disagree" for questions eliciting respondents' perception of the likelihood of gap between their expected- and existing VE skills.

The Likert scale responses were converted into their numerical equivalents as featured in Losby and Wetmore (2012) to pave the way for data analysis, and test of hypotheses. Using the relevant test statistics mentioned in Table 5, hypothesis tests were instantiated at 5% level of significance to avow the gap or otherwise between expected- and existing VE skills across each stratum of BCE and allied professionals in the study area, as well as among all the BCE and allied professionals in the study area. Thereafter, the results of the analyses were presented and discussed, after which the study was concluded.

Table 1. Distribution of pilot study questionnaire per strata of professionals across the data collection centres

Strata of BCE and allied professionals	Kogi-Central		Kogi-East		Kogi-West		Total pilot study questionnaire				
										Percentage (%)	
	Actual allocated	Actually retrieved & valid	Actual allocated	Actually retrieved & valid	Actual allocated	Actually retrieved & valid	Total allocated	Actually retrieved & valid	Total irretrievable & unused	Actually retrieved & valid	Total irretrievable & unused
Architects	3	1	2	1	5	2	10	4	6	7.27	10.91
Builders	3	1	2	1	5	2	10	4	6	7.27	10.91
Engineers	2	1	2	1	4	1	8	3	5	5.46	9.09
Estate Surv. & Valuers	3	1	3	1	5	2	11	4	7	7.27	12.73
Project Managers	1	0	1	0	1	1	3	1	2	1.82	3.64
Quantity Surveyors	2	1	2	1	4	1	8	3	5	5.45	9.09
Town Planners	1	1	1	0	3	1	5	2	3	3.64	5.45
Total	15	6	13	5	27	10	55	21	34[a.]	38.18[b.]	61.82 [c.]

Notes

[a.] Actual pilot study questionnaire retrieved, n = 21; [b.] Proportion of pilot study questionnaire retrieved, p(R) = 38.18%

[c.] Proportion of irretrievable and unused study questionnaire, ¬p(R) = 1 - p(R) = 61.82%

Table 2. Study questionnaire administered and retrieved across the strata of professionals and data collection centres

Strata of BCE and allied professionals	Kogi-Central		Kogi-East		Kogi-West		Sampling strategy and operational sample size for the study				
										Percentage (%)	
	Actual allocated	Actually retrieved & valid	Actual allocated	Actually retrieved & valid	Actual allocated	Actually retrieved & valid	Total allocated based on sample size[·]	Total actually retrieved & valid	Total irretrievable & unused	Actually retrieved & valid	Total irretrievable & unused
Architects	15	4	16	4	32	8	70	16	54	4.38	14.79
Builders	23	6	19	5	33	8	70	19	51	5.21	13.97
Engineers	15	4	15	4	24	7	52	15	37	4.11	10.14
Estate Surv. & Valuers	12	3	15	4	36	9	69	16	53	4.38	14.52
Project Managers	4	1	2	0	12	3	17	4	13	1.1	3.56
Quantity Surveyors	15	4	15	4	27	7	52	15	37	4.11	10.14
Town Planners	12	3	8	2	15	4	35	9	26	2.47	7.12
Total	96	25	90	23	179	46	365 [a.]	94 [b.]	271	25.76	74.24

Notes

[a.] Total expected sample, N was calculated to be 365 using equation (1), 5% error, e; and the parameters in the notes to Table 1.

[b.] The total operational sample size for the purpose of data analysis.

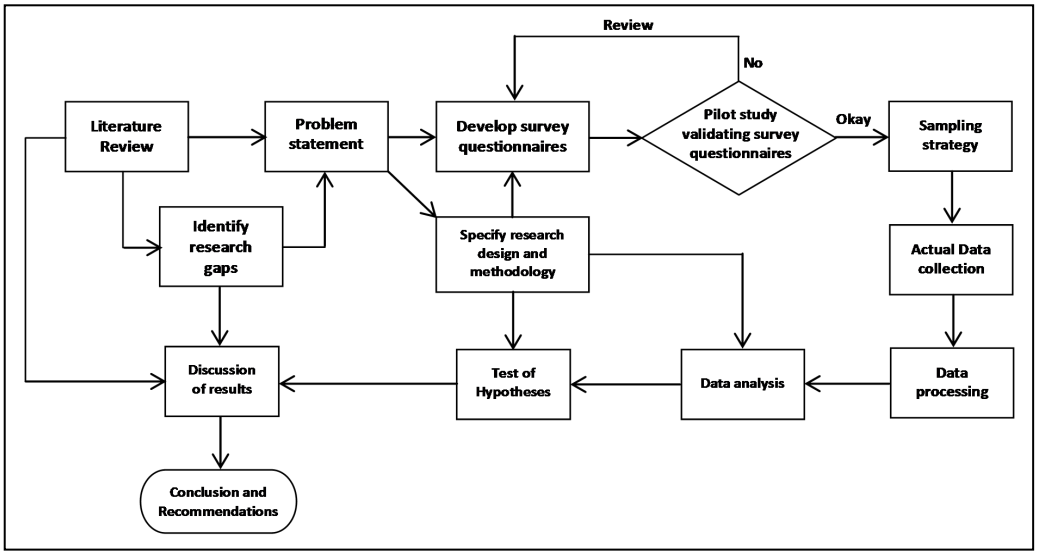

Figure 3. Overview of the research procedure

2.3 Data Validation and Selection Criteria for Hypothesis Test Statistics

The two-tailed runs test in Table 3 indicated randomness for each case of VWO deployed as benchmark for the assessment of respondents' level of VE awareness and VE proficiency at $p > 0.05$ to justify the further deployment of correlation analysis and inferential statistical tests. Furthermore, the normality assumption for the datasets had been relaxed owing to the non-synchronous results of the Jarque-Bera test on VWOs for VE proficiency and VE awareness at 5% significance level.

It was observed from Table 4 that the Cronbach's alphas in the range of $0.7 \leq \alpha \leq 1.0$ as averred by Habidin *et al.* (2017) for the aggregate sample of respondents ($N = 94$) provided a good basis for further statistical analyses of data.

2.4 Hypotheses Formulation and Tests Statistic

Featured in Table 5 were the three groups of hypotheses formulated for this study. The first hypothesis was tested using a two tailed *t*-statistic, with a decision rule to accept (reject) the null hypothesis, H_0 if $p > 0.05$ ($p < 0.05$); thereby ruling out (avowing) the significance of a correlation between VE awareness and VE proficiency among these professionals.

Hypotheses 2 to 8 constituting the second group of hypotheses were comparatively tested using the Fisher exact- and Barnard's unconditional tests, with a decision rule to accept (reject) H_0 where $p(X) > 0.05$ ($p(X) < 0.05$) in order to rule out (avow) the significance of a gap between expected- and existing VE skills of each group of BCE and allied professional.

Similarly, the third group of hypothesis (Hypothesis 9) entailed the deployment of Chi-square test at 5% level of significance to avow the gap or otherwise between expected- and existing VE skills for all the BCE and allied professionals in the study area.

2.5 Techniques of Data Analysis and Presentation

The processed and analyzed survey data were presented using cross-tabulations of specific themes and statistical test results respectively. The cross-tabulations comprised the frequency distribution and percentages of respondents' socio-demographic data, and dovetailed into results of non-parametric statistical tests aimed at addressing objectives of the study.

For the pair-wise theme of VE awareness and VE proficiency, the possible range of the numerical values of the weighted mean score ($W_{\bar{x}}$) on the basis of the 5-point Likert scale and their interpretations include $4.50 \leq W_{\bar{x}} \leq 5.00$ for "Very strong awareness"/"Very high proficiency"; $3.50 \leq W_{\bar{x}} \leq 4.49$ for "Strong awareness"/"High proficiency"; $2.50 \leq W_{\bar{x}} \leq 3.49$ for "Moderate awareness"/"Average proficiency"; $1.50 \leq W_{\bar{x}} \leq 2.49$ for "Minimal awareness"/"Low proficiency"; and $1.00 \leq W_{\bar{x}} \leq 1.49$ for "No awareness"/"No proficiency".

On the other hand, the possible range of numerical values of the weighted mean score ($W_{\bar{x}}$) on the basis of the 4-point Likert scale regarding the gap between expected- and existing VE skills among the respondents, and their interpretations include $3.50 \leq W_{\bar{x}} \leq 4.00$ for "Strongly agree"; $3.00 \leq W_{\bar{x}} \leq 3.49$ for "Agree"; $1.50 \leq W_{\bar{x}} \leq 2.99$ for "Disagree"; and $1.00 \leq W_{\bar{x}} \leq 1.49$ for "Strongly disagree" respectively.

Computed in connection with each observed attributes were the standard deviation (*StDev*) and modal scores respectively; whereas, the ranking of each attribute was instantiated based on the descending order of the computed weighted mean scores.
With recourse to the ten VWOs, the spearman's rank correlation coefficient between VE awareness and VE proficiency was determined using equation 2:

$$r_s = 1 - \frac{6\sum d^2}{n\left(n^2 - 1\right)} \quad (2)$$

Where d = the difference in ranks assigned across the paired data, expressed as R_X - R_Y and where both subjects of the correlation have equal number of observations; i.e. $n_X = n_Y = 10$. The result of equation 2 formed the basis for the test of hypothesis 1 formulated in Table 5.

Table 3. Randomness and normality tests on the awareness of- and proficiency in VWOs

Value Workshop Objectives (VWOs)	Two-tailed test of randomness [a.]				Jarque-Bera normality test [b.]			
	VE Awareness		VE Proficiency		VE Awareness		VE Proficiency	
	$\|Z\|$	*p*-value	$\|Z\|$	*p*-value	JB Stat	*p*-value	JB Stat	*p*-value
Minimize capital cost of project	-1.846	0.065	-1.656	0.098	9.990	0.007	2.238	0.327
Minimize project operating cost	-1.940	0.052	-1.711	0.087	3.753	0.153	5.693	0.058
Enhance project worth	-1.618	0.106	-1.073	0.283	5.804	0.055	3.608	0.165
Effective risk management	-1.899	0.058	-1.656	0.098	7.166	0.028	3.917	0.141
Early project completion/delivery	-1.572	0.116	-1.075	0.282	9.819	0.007	1.806	0.405
Value optimization over project life cycle	-1.900	0.057	-1.539	0.124	10.804	0.005	2.724	0.256
Minimize adverse environmental impact	-0.720	0.472	-1.556	0.120	8.570	0.014	3.201	0.202
Enhance project flexibility	-1.637	0.102	-0.491	0.623	5.356	0.069	4.680	0.096
Enhance project functionality	-1.711	0.087	-1.200	0.230	11.854	0.003	4.486	0.106
Enhance usability, convenience & comfort	-1.385	0.166	-0.152	0.879	10.526	0.005	3.588	0.166

Notes
a. With $Z_{0.975} = \pm 1.96$, Randomness is (in)significant where ($p < 0.05$) $p > 0.05$
b. For JB Stat $\approx \chi^2$, normality is (in)significant where ($p < 0.05$) $p > 0.05$
c. Based on operational sample size of 94 questionnaire respondents

Table 4. Cronbach's reliability tests on pair-wise correlation data [a.]

Variable	Scale of Likert responses	[b.]Items	Data collection centres			Aggregate
			Kogi-Central	Kogi-East	Kogi-West	
Group 1: VE Awareness	5-point	10	0.783	0.420	0.731	0.716
Group 2: VE Proficiency	5-point	10	0.802	0.660	0.762	0.854
Operational sample size			$n_1 = 25$	$n_2 = 23$	$n_3 = 46$	N = 94

Notes: **a.** Based on operational sample size of 94 questionnaire respondents
b.The items in each case constitute the ten value workshop objectives (VWOs)

Table 5. Outline of hypotheses formulated for the study and their associated test statistic

S/N	Designation	Null hypothesis (H_0) statement	Focus	Test statistic
1	Hypothesis 1	There is no correlation between VE Awareness and Proficiency among BCE and allied professionals in Kogi State	All the BCE and allied professionals	Test for Spearman's rank correlation
2	Hypothesis 2	There is no gap between expected- and existing VE skills-set of the sample of _____ in Kogi State	Architects	(a) Fisher's exact test (b) Barnard's test
3	Hypothesis 3		Builders	
4	Hypothesis 4		Engineers	
5	Hypothesis 5		Estate Surveyors and Valuers	
6	Hypothesis 6		Project Managers	
7	Hypothesis 7		Quantity Surveyors	
8	Hypothesis 8		Town Planners	
9	Hypothesis 9		All BCE and allied professionals	Chi-square (χ^2) test

3. Result and Discussion

3.1 Respondents' Background Data

It would be recalled from Table 2 that from a total of 365 paper-based questionnaires administered across the strata of BCE and allied professionals in the three data collection centres of the study area, only 94 constituted the operational sample size for the purpose of data analysis in this study. This was because; a total of 271 paper-based questionnaires in the unusable and irretrievable category could not be featured in the transcription and processing of data. Unless otherwise stated, all results of data analysis featured in this section were based on the operational sample of 94 respondents in the study area.

With recourse to the first theme in Table 6, respondents possessing a Bachelors degree constituted nearly 60% of the total frequency (being the modal class); whereas 14.9% and 20.2% have earned Higher National Diploma, and Master's degree respectively. The second theme in Table 6 indicated that nearly half of the sample of respondents had amassed between 11 and 20 years' experience in the building/construction industry. The third theme featured respondents' distribution according to their professional affiliation, comprising Builders (20.2%), Architects (17.0%), Estate Surveyors and Valuers (17.0%), Engineers (16.0%), Quantity Surveyors (16.0%), Town Planners (9.6%), and Project Managers (4.3%), as featured in the test of hypotheses presented in Table 9.

Underlying the cross-tabulated responses in themes 4 to 7, is the varying consensus among the BCE and allied professionals in the study area regarding their awareness of- and actual participation in project planning tasks encompassing cost-effective alternative designs and procurement strategies. This varying consensus constituted the rationale for further inferential statistical tests designed to unveil their apparent levels of VE awareness and VE proficiency, but with recourse to the value workshop objectives (VWOs).

Table 6. Background data of respondents

Category	Classification	Frequency	Percent (%)
Highest academic qualification	Doctorate degree	1	1.1
	Masters degree	19	20.2
	Bachelors degree	56	59.6
	Postgraduate Diploma	4	4.3
	Higher National Diploma	14	14.9
	Total	94	100.0
Years of experience in the building/ construction industry	1 - 10	26	27.7
	11 - 20	43	45.7
	21 - 30	22	23.4
	Over 30	3	3.2
	Total	94	100.0
Professional affiliation of respondents	Architecture	16	17.0
	Building	19	20.2
	Engineering	15	16.0
	Estate Surveying and Valuation	16	17.0
	Project Management	4	4.3
	Quantity Surveying	15	16.0
	Town Planning	9	9.6
	Total	94	100.0
Prior auditory insight into Value Engineering	Yes	66	70.2
	No	27	28.7
	No response	1	1.1
	Total	94	100.0
Respondents' participation in value engineering exercise	Yes	49	52.1
	No	44	46.8
	No response	1	1.1
	Total	94	100.0

Source: Authors' field work, 2023

Category	Classification	Frequency	Percent (%)
Number of value engineering-integrated projects handled by respondents	No response	49	52.1
	1 - 5	39	41.4
	6 - 10	4	4.3
	11 - 15	1	1.1
	Over 15	1	1.1
	Total	94	100.0
Awareness of value engineering application in Kogi state	Yes	43	45.7
	No	51	54.3
	Total	94	100.0

Source: Authors' field work, 2023

3.2 Assessed Value Workshop Objectives from the Perspective of Value Engineering Awareness

The uniform modal score of 4.00 and weighted mean scores in the range of $3.50 \leq W_{\bar{x}} \leq 4.49$ for VE awareness in Table 7 implied that the majority of these professionals exhibited strong awareness of the ten value workshop (VW)-/value engineering (VE) objectives. Specifically, respondents' awareness of minimizing project operating cost ($W_{\bar{x}} = 4.20$, $s = 0.70$), enhancing project worth ($W_{\bar{x}} = 4.07$, s = 0.86), and enhancing project functionality ($W_{\bar{x}} = 4.02$, s = 0.83) were ranked in the 1st, 2nd, and 3rd positions, whereas the VWOs of enhancing project flexibility ($W_{\bar{x}} = 3.99$, $s = 0.85$), and enhancing project usability, convenience and comfort ($W_{\bar{x}} = 3.99$, $s = 0.84$) tied in the 4th position, but with weighted mean below the modal score by 0.01 points.

Awareness of the use of VE to minimize capital cost of project ($W_{\bar{x}} = 3.96$, $s = 0.97$) was ranked in the 6th position, notwithstanding its significance to VE practice (Bowen *et al.*, 2009; Braden, 1990; Green, 1994; Khodeir and El Ghandour, 2019).

It was however observed from the first part of Table 7 that these professionals did not prioritize the awareness of VE as a tool for ensuring environmental sustainability, time- and risk control compared to the first three objectives of minimizing project operating cost, enhancing project worth, and enhancing project functionality.

Table 7. Descriptive statistics and ranking of workshop objectives for VE awareness and proficiency

Value Workshop Objectives (VWOs)	Value Engineering awareness				Value Engineering proficiency			
	[a]·Mean score	[a]·StDev	[a]·Mode	[b]·Rank	[a]·Mean score	[a]·StDev	[a]·Mode	[b]·Rank
Minimize project operating cost	4.20	0.70	4.00	1	4.10	0.76	4.00	1
Enhance project worth	4.07	0.86	4.00	2	3.91	0.81	4.00	8
Enhance project functionality	4.02	0.83	4.00	3	4.04	0.82	4.00	4
Enhance project flexibility	3.99	0.85	4.00	4.5	4.09	0.81	4.00	2.5
Enhance usability, convenience & comfort	3.99	0.84	4.00	4.5	4.09	0.77	4.00	2.5
Minimize capital cost of project	3.96	0.97	4.00	6	4.01	0.75	4.00	6
Value optimization over project life cycle	3.93	0.98	4.00	7	3.88	0.79	4.00	9
Minimize adverse environmental impact	3.91	0.90	4.00	8	3.82	0.89	4.00	10
Early project completion/delivery	3.90	0.97	4.00	9	3.99	0.74	4.00	7
Effective risk management	3.64	1.12	4.00	10	4.03	0.71	4.00	5

Notes: **a.** Based on operational sample size of 94 questionnaire respondents
b. Ranks with ties have been adjusted

3.3 Assessed Value Workshop Objectives from the Perspective of Value Engineering Proficiency

Pursuant to a modal score of 4.00 and weighted mean scores in the range of $3.50 \leq W_{\bar{x}} \leq 4.49$, it could be observed in the other half of the major column of Table 7 that majority of these professionals exhibited high proficiency in the delivery of VWOs. The weighted mean scores of respondents' proficiency in the delivery of the first six VWO fell within the numerical bounds of the modal score, unlike proficiency in early project completion/delivery ($W_{\bar{x}} = 3.99$, $s = 0.74$) that recorded a weighted mean that is numerically below the modal score.

The modal scores for each case of VWO in the pair wise phenomena of VE awareness and VE proficiency in Table 7 did

not present any analytical insight into the correlation between these two variables; hence the need to carry out correlation analysis and further test the degree of association between the two variables with recourse to VWOs as benchmarks

3.4 Correlation Between VE Awareness and VE Proficiency Among Respondents

Insights from the conceptual framework indicated that only two VWOs occupied the same ranks in the 1st and 6th positions respectively; that is:

$$X \cap Y = \{\rho_1\{V\}, \rho_8\{V\}\} \quad (3)$$

Where $\rho_1\{V\}$ = minimize project operating cost; and $\rho_6\{V\}$ = minimize capital cost of project.

Therefore, the probability, $\boldsymbol{Pr}\{X \cap Y\} = 0.20$; so that $\neg\boldsymbol{Pr}\{X \cap Y\} = 0.80$. Consequently, there is an 80% chance that a strong degree of association between VE awareness and VE proficiency among these professionals in the study area might not be guaranteed from the available dataset.

Table 8. Spearman's rank correlation between VE awareness and VE proficiency

Parameter	Value/Result
Item Sample size (n) [a.]	10
Degrees of freedom, $d.f. = n - 2$	8
Spearman's rank correlation coefficient (R_s)	0.503[b.]
Level of significance	0.05
Hypothesized t-statistic (2-tailed)	±2.306
Computed t-statistic, $\|t\|$	1.646
p-value (2-tailed)	0.138
Decision	Accept H_0

Note
a. Item sample size in this instance refers to the ten (10) value workshop objectives (VWO)
b. Correlation is insignificant at $p > 0.05$

With recourse to Table 8, the test of the spearman's rank correlation (Hypothesis 1) in Table 5 indicated the acceptance of the null hypothesis ($R_s(8) = 0.503$, $p = 0.138$). Therefore, the available data provided insignificant evidence to avow that 50.03% variation in the level of the respondents' proficiency in value engineering is explained by a variation in their levels of VE awareness.

It can be inferred that the level of VE awareness exhibited by the sample of BCE and allied professionals in the study area might not necessarily imply that these professionals are proficient in VE practice. Insight to this result has been availed in existing studies credited to Ganiyu and Danjuma (2022), Ilenikhena and Adindu (2021), Jiya *et al.* (2023), and particularly to Oke and Ogunsemi (2011) where it was deduced that the familiarity with VE does not necessarily imply competence or proficiency in VE practice.

The correlation analysis further indicated that their perceptions and expertise tend to differ regarding project planning, cost control, and the operational management of a built facility/infrastructure; which in the long run, is a reflection of their professional diversity.

The attempted use of VWOs as benchmarks for measuring VE awareness and VE proficiency has accorded theoretical insight into attribution theory (Graziano, 2019; Kelly *et al.*, 2014; Perry and Hamm, 2017; Weiner, 2000), especially as it pertains to the ranking of each VWO associated with the pair-wise variables of VE awareness and VE proficiency. This study equally provided insight into the use of VWOs to instantiate the pre-qualification of experts with project management background as VE facilitators, besides the other BCE and allied professionals in the VE team, so that the competently selected VE team might be motivated to deliver the objectives of a value engineered project.

3.5 Assessment of Gap Between Expected- and Existing VE Skills Among Respondents

For the six groups of professionals in Table 9 where individual sample sizes are less than 30 ($n < 30$), the Fisher exact- and Barnard's unconditional tests returned converging result leading to the rejection of the null hypothesis at $p < 0.01$ and conclusion that there is a gap between their expected- and existing value engineering skills. This is with the exception of a sample ($n < 30$) of Project Managers for which the Fisher exact test returned $p > 0.05$, whereas the Barnard's unconditional test returned a staggering $p \geq 0.05$; to avow insignificant evidence of a gap between the expected- and existing value engineering skills for the sample of Project Managers.

As an affirmation of the insignificantly positive correlation between VE awareness and VE proficiency among these professionals, the Chi-square (χ^2) test on the pooled sample of all categories of professionals ($N = 94$) in Table 9 lead to the rejection of the null hypothesis (H_0) at $p < 0.05$, and a conclusion that there is generally a gap between expected- and existing VE skills among the entire sample of BCE and allied professionals in the study area.

Table 9. Statistical test for the Likelihood of gap between expected- and existing Value Engineering skills

Strata of BCE and allied professional	Attributes and Ordinal scale				Sample size	Sample size rule for selected tests	Modal Score	Weighted Mean Score	StDev	*p*-value Fisher's exact test	*p*-value Barnard's test	*p*-value Chi-square test
	Strongly agree	Agree	Disagree	Strongly disagree								
	4	3	2	1								
	Frequencies											
Architects	3	9	3	1	16	$n < 30$	3.00	2.88	0.81	0.007^{***}	0.001^{***}	N/A
Builders	2	13	4	0	19	$n < 30$	3.00	2.89	0.57	0.000^{***}	0.000^{***}	N/A
Engineers	4	9	1	1	15	$n < 30$	3.00	3.07	0.80	0.001^{***}	0.000^{***}	N/A
Estate Surv. & Valuers	7	6	3	0	16	$n < 30$	4.00	3.25	0.77	0.004^{***}	0.001^{***}	N/A
Project Managers	1	1	2	0	4	$n < 30$	2.00	2.75	0.96	0.171	0.050	N/A
Quantity Surveyors	6	8	1	0	15	$n < 30$	3.00	3.33	0.62	0.000^{***}	0.000^{***}	N/A
Town Planners	1	5	0	3	9	$n < 30$	3.00	2.44	1.13	0.013^{**}	0.002^{***}	N/A
Total	24	51	14	5	94	$n \geq 30$	3.00	3.00	0.79	N/A	N/A	0.000^{***}

Note

1. N/A = Not Applicable
2. The Fisher's- and Barnard's Exact tests of categorical data were performed on each strata of BCE and allied professional in the study area with sample size of less than 30 respondents ($n < 30$) and amounting to a total of 94 respondents ($n \geq 30$) for the Chi-square test.
3. The number of categorical variables (ordinal responses) for all the statistical tests, $m = 4$
4. For all the tests, level of significance, $\alpha = 0.05$
5. Critical value of Chi-square test statistic (χ^2) = 7.814 drawn from $\alpha = 0.05$ and $d.f. = m - 1 = 3$
6. ***Significant at $p < 0.01$; **Significant at $p < 0.05$

This result is in tandem with similar studies by Ilenikhena and Adindu (2021) and Jiya *et al.* (2023) which reported VE/VM skills gap among BCE and allied professionals in Nigeria and the need to address the gap through capacity building and improvement in professional standards for VE/VM practice in Nigeria.

4. Conclusion

This study is among the novel attempts at using VWOs, being common indices to the three dimensions of value methodologies in construction namely- VA, VE, and VM to measure the degree of association between VE awareness and VE proficiency among the BCE and allied professionals. On the basis of the ten value workshop objectives (VWOs) evaluated in this study, the insignificantly moderate positive relationship between VE awareness and VE Proficiency is an affirmation that the familiarity of a BCE and allied professional in the study area with VE does not necessarily imply competence or proficiency in VE practice.

It was however impossible to adopt the conventional stratified random sampling strategy for the study, mainly due to the inconsistencies across the strata of sample frames for project managers and engineers in the study area. By implication, the findings of this study might not be generalized beyond the study area. Notwithstanding, a purely randomized approach to data collection in future studies of similar nature and probably on a larger regional scale across the states of North-Central Nigeria might be instantiated when the issue of inconsistencies in the sample frames of Project Managers and Engineers in the study area might have been addressed.

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