

## Value Engineering Awareness Variation Among Construction Project Professionals and the Attributed Value Workshop Objectives

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**Submission date:**

13<sup>th</sup> February 2026

**Revised date:**

23<sup>rd</sup> March 2026

**Acceptance date:**

14<sup>th</sup> May 2026

**How to cite this paper:**

Bioku, J. O. & Ataguba, J. O. (2026). Value Engineering Awareness Variation Among Construction Project Professionals and the Attributed Value Workshop Objectives. Journal of Project Management Practice, 6(1), 01-20.

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**ABSTRACT**

In typical Value Engineering (VE) exercises, Value Workshops are instantiated to explore alternative perspectives to cost minimization and enhanced functionality of a construction project by a team of construction and allied professionals. Meanwhile, studies on the regional contexts of the Nigerian construction industry had been empirically implicit on the varying levels of VE awareness among these professionals, let alone the value workshop objectives (VWOs) that might have accounted for the variation. This study assessed the variation in the level of VE awareness among construction project professionals in Kogi State, Nigeria along with the attributed Value Workshop Objectives (VWOs) for the variation. 94 snowballed survey questionnaires were retrieved from seven groups of construction and allied professionals across the three regions of Kogi State. Descriptive data analysis featured the calculation of weighted mean score and standard deviation of respondents' level of VE awareness on the basis of the ten VWOs drawn from existing literature, while the normality assumption for the randomized survey data was relaxed to justify the use of the Kruskal-Wallis  $H$  test statistic. A variation in the levels of VE awareness among these professionals was affirmed from the disparity in their individually ranked VWOs. At  $p < 0.05$ , it was found that the significant variation in the levels of VE awareness among these professionals is attributed to VWOs comprising value optimization over project life cycle, minimizing adverse environmental impact of project, enhancing project flexibility, and enhancing project usability, convenience and comfort, all with medium effect sizes in the range:  $0.06 \leq \eta^2 < 0.14$ . This variation reflects the professional diversity required for an inclusive peer review of project briefs. The study contributes to the knowledge of professional diversity and inclusiveness in pre-qualification of experts for value engineered construction projects.

**Keywords:** Value Engineering, Value Workshop Objectives, Awareness, Construction project, Professionals

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## 1.0 INTRODUCTION

Discourse on the three dimensions of value methodologies comprising value analysis (VA), value management (VM), and value engineering (VE) have featured among scholars and professional organizations in the domains of construction project management and the built environment (Kelly et al., 2004; Khodeir & El Ghandour, 2019). Some authors have used these concepts interchangeably to imply enhancing value-for-money in projects, mainly through cost-saving strategies, without violating the original intent and functionality of the project (Lin & Shen, 2007); whereas others have held a contrary view, offering to define VA as the organised process of identifying and eliminating unnecessary cost (Kelly et al., 2004; Miles, 1989); VM as a soft approach for delivering optimal value of a project from the client's perspective; and VE as a hard (technical) approach of delivering optimal value of a project using available alternative materials without compromising quality and function (Wandahl, 2015). Notwithstanding the divergent views on VA, VE, and VM, the visual synergy among these value methodologies as presented by Khodeir and El Ghandour (2019) indicates that convergence of goals comprising the use of cost-effective resources that will most likely minimize costs, enhance performance and value of construction projects.

In tandem with Connaughton and Green (1996), this study views VE as a specialized case of VM aimed at delivering the functional components of a project at the lowest/optimal cost, without compromising quality and performance. Value in this context implies "value for money" or "value to the owner/user", which is typically the "investment value", or "worth" of a project (Kelly et al., 2004; Wyatt, 2013). It can be expressed as the ratio of benefits or outputs from a project to the cost or effort of inputs required to deliver the same project (RICS, 2017); and in tandem with the fundamental principle of cost-benefit analysis (Pearce et al., 2006). Hence, VE is a special dimension of cost-benefit analysis instantiated through multidisciplinary peer review of a project and its resources, leading to cost-savings, enhanced performance-, and function (value) to the benefit of the owners and users of the built facility.

Activities in VE for construction projects feature collaboration among professionals drawn mainly from the building, construction, engineering and allied disciplines (Bowen et al., 2009; Oke & Ogunsemi, 2011; Yu & Shen, 2010), who are expected to have a shared understanding of how to deploy alternative resources and procurement strategies to achieve the objectives of a typical VE exercise in construction projects. These professionals comprise Architects, Builders, Engineers, Estate Surveyors and Valuers, Project Managers, Quantity Surveyors, and Town Planners whose involvement depend on the specific stage(s) of the project. However, studies within the Nigerian construction industry had in the past provided diverging results regarding the level of VE/VM awareness among these professionals ranging from the reportage of high level of awareness (Ganiyu & Danjuma, 2022; Jiya et al., 2023), average level of awareness especially in Lagos (Oke & Ogunsemi, 2013), and low level of awareness in North-Central Nigeria and Lagos state respectively (Ilenikhena & Adindu, 2021; Ogunsanmi, 2014), probably due to the variation in the geographical scope of the study areas and maturity of construction consultancy services in these areas during the epoch of the research.

Bowen et al. (2009) and Bowen et al. (2010) attempted the ranking of specific VWOs among construction and allied professionals on the one hand, and among practicing engineers on the other hand. While these VWOs constitute the foundation for VE teamwork activities in a typical construction project, the scope of these studies could not warrant the collection of data and analysis of results featuring the areas of convergence and variation in VE awareness among these construction project professionals. Notwithstanding that insights from Bowen et al. (2009) and Lin et al. (2022), point to the possibility of a variation in levels of VE awareness among construction project professionals, and the same variation implicitly underlie the diverging results regarding the level of VE/VM awareness associated with studies credited to Ganiyu and Danjuma (2022), Ilenikhena and Adindu (2021), Jiya et al. (2023), Oke and Ogunsemi (2013), and Ogunsanmi (2014), not much is empirically known regarding the existence of this variation, as well as the value workshop objectives (VWOs) that might have accounted for the variation.

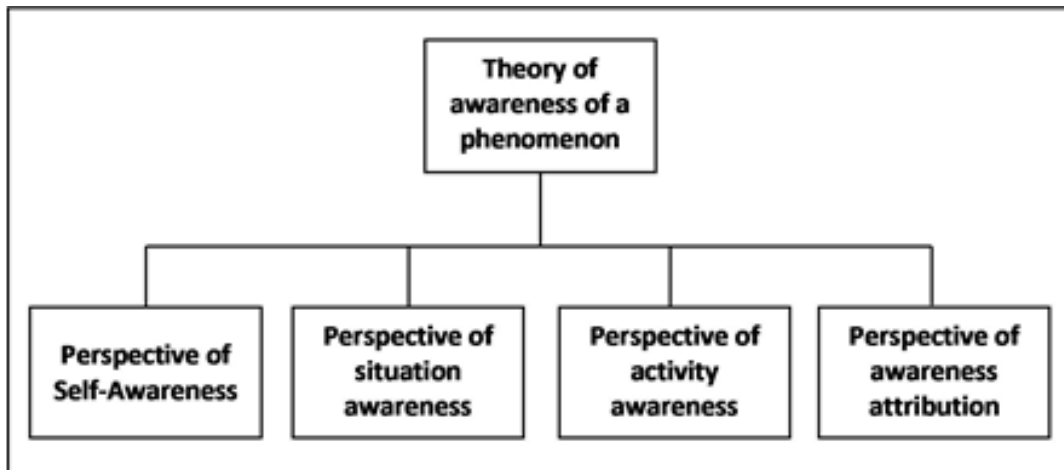
This study aims to assess the variation in the level of value engineering (VE) awareness among construction project professionals particularly in Kogi State, Nigeria and the value workshop objectives accounting for such variation. Objectives put forward to address this aim include identifying the VWOs for which each group of professional exhibit strong levels of awareness; evaluating the variation in the levels of awareness of VWOs among these professionals; and identifying the VWOs accounting for the variation in their levels of VE awareness.

This is a departure from prior studies investigating the level of VE awareness among construction and allied professionals in the regional and sub-national context of Nigeria, by using VWOs as benchmarks to unravel the question of varying levels of VE awareness among these professionals. In addition to identifying the VWOs that account for this variation, this study avails stakeholders in the construction industry with information regarding specific areas of strengths in VE service delivery that can be attributed to each professional; thereby facilitating the rational decision of selecting each professional in the VE team, based on a synergy between the strength of their awareness of these VWOs and the overall goal of the project owner/sponsor.

## 2.0 LITERATURE REVIEW

### 2.1 Theoretical Framework

Awareness is a concept used to describe the exercise of cognition, knowledge, and perception of a phenomenon or event (Bizzarri et al., 2022; Yaure, 1973). Furthermore, a phenomenon is defined as an existing or possibly existing object or situation that can be perceived by humans (Kienzler, 1991; Oxford Languages, 2024), especially that whose existence or explanation is a subject of scientific inquiry (Van de Ven, 2016). These definitions dovetail into four dimensions for the theorization of VE namely self-awareness, situation awareness, activity awareness, and awareness attribution respectively as indicated in Figure 1.



**Figure 1.** Taxonomy of related theoretical framework for the study  
Source: Authors' conception, 2025

The theory of self-awareness features the tendency for humans to focus on themselves with the intent of comparing self-prescribed standards and values with their individual outward behaviours (Duval & Wicklund, 1972). However, this theory is insufficient to constitute the theoretical foundation for this study.

Next in the trajectory of the taxonomy (Figure 1) is situation awareness or distributed cognition, which describes the mental construct of a phenomenon or system in humans (Endsley & Jones, 1997; Stanton et al., 2009). While this theory is fundamental towards understanding of the teamwork involved in VE, it inadequately addresses the causality and attribution for awareness of VE among construction project professionals.

Third is activity awareness, which describes an individual's cognition of the occurrence- or likelihood of the occurrence of an event/phenomenon (Gross et al., 2005; Gutwin & Greenberg, 2002). While this theory

forms the bedrock of the concept of VE as an activity as posited by Ahmed and Pandey (2016), it does not offer insights into attribution of the awareness of a phenomenon, including VE.

Fourth in the trajectory and of direct relevance to this study is the theory of awareness attribution which posits that human awareness of a phenomenon is not instantaneous in thoughts and behaviours, but driven by factors such as sensory- and experiential exposures to the event or phenomenon (Graziano & Kastner, 2011). Therefore, the theory of awareness attribution constitutes the baseline for identifying the significant VWOs that explain the variation in VE awareness among construction and allied professionals in this study.

Furtherance to the theory of awareness attribution, Weiner (2000) averred that the awareness of a phenomenon can be attributed to specific causal factors or explanatory variable(s) that can be identified through self-assessed perceptions. Furthermore, survey questionnaires, in spite of its inherent risk of bias and distortions constitute one of the instruments for self-assessed perceptions in a typical research (Fellows & Liu, 2015). For the purpose of this study, therefore, the requisite data for the analysis and identification of underlying VWOs that account for the variation in the levels of VE awareness among the stratified sample of construction project professionals was elicited through the administration of survey questionnaires. This survey instrument availed the respondents with a self-assessment of VE awareness and the weighting of attributed VWO, so that appropriate inferential statistics was used to identify the significant VWOs accounting for variation in their levels of VE awareness. Through appropriate design of questions in the study questionnaire, attempt was made to minimize likely incidences of bias and distortions in the responses availed by the respondents/professionals.

## **2.2 Empirical Reviews**

### **2.2.1 The Objectives of a Typical Value Engineering Workshop**

Russell et al. (1994) outlined some of the objectives of VE workshops to include cost reduction, timely delivery date of project, enhanced quality, and minimal total life cycle costs, which comprises the capital- and operating cost associated with the project respectively. Beside these, RICS (2017) identified some objectives of VE to include reducing installation cost, reducing annual energy use, maximizing project durability (life expectancy), minimizing output degradation over time (functional obsolescence), ensuring flexibility, and improving reportage of unit failure (emergency maintenance response). However, for the purpose of this study, the ten objectives of VE as streamlined from Dell'Isola (1997), Bowen et al. (2009), and Bowen et al. (2010) include to- minimize capital cost of project; enhance project functionality; enhance project worth; optimize value over project life cycle; minimize adverse environmental impact of project; enhance project usability, convenience and comfort; enhance project flexibility; manage risk effectively; ensure early project completion/delivery; and minimize project operating cost. Therefore, these objectives were used as benchmarks for assessing the variation in the level of VE awareness among the seven groups of construction and allied professionals in the study area, in addition to identifying the VWO accounting for this variation.

### **2.2.2 Awareness Levels of VE Objectives Among Construction and Allied Professionals**

Providing insights into the measurement of awareness levels of construction and allied professionals regarding value workshop objectives (VWOs) are empirical reviews of select studies. First is the VWO of minimizing capital cost or achieving "*overall cost savings*" in projects (Yassin et al., 2021). These capital costs constitute cash outflows or investment cost incurred during the project's gestation period (Dayananda et al., 2002). With recourse to South Africa, Bowen et al. (2009) and Bowen et al. (2010) found this VWO to be ranked in the 1st position and significant at  $p < 0.05$ .

The second VWO is to enhance project functionality, which according to Kelly (2007) is measured using conformity of a project with the rated- or maximum utility or satisfaction or performance accruing to a project owner or end-user. This VWO was found to occupy the 2nd position and significant at  $p < 0.05$  following a similar study in South Africa (Bowen et al., 2009).

The third VWO analyzed in this study is to enhance project worth or "*value for money*" or "*value to the owner/user*" (Kelly et al., 2004; Mooya, 2016; Parker, 2016; Wyatt, 2013). Still within the South African

context, Bowen et al. (2009) ranked this VWO in the 5th position, but insignificant among construction and allied professionals.

The fourth VWO featured optimization of value over project life cycle, which entails adopting alternative least life cycle cost strategies (Green, 1994). With recourse to a study in South Africa, Bowen et al. (2009) had ranked this VWO in the 4th position, but insignificant among the sample of construction and allied professionals. Contrary to that result was the ranking of the same VWO in the 2nd position among practicing Engineers in South Africa (Bowen et al., 2010). A comparison of these two baseline studies indicates likelihood of varying levels of awareness of this objective among all construction and allied professionals.

The fifth VWO is to minimize adverse environmental impact of project, which is a step towards delivering sustainable projects (Al-Yousefi, 2008; Goh & Yang, 2013; Yu et al., 2018). It was however ranked in the 11th position in a study credited to Bowen et al. (2009), implying that the sample of professionals did not perceive this objective as an important objective of VM at that time. A specific study involving Engineers however indicated 8th position for this VWO (Bowen et al., 2010). Notwithstanding, a replication of similar studies might feature different results given the global paradigm shift towards integrating environmental sustainability with project management.

The sixth VWO featured the enhancement of project usability, convenience and comfort. Surrogates to this objective include enhancing the quality of life and wellbeing of users (Zhang & El-Gohary, 2015), habitability of buildings (Preiser, 1983), and user satisfaction (Russell et al., 1994). Meanwhile, Bowen et al. (2009) found this VWO to be ranked in the 9th position, although not statistically significant. It was further ranked in the 11th position in another isolated study of Engineers' awareness of VM in South Africa (Bowen et al., 2010).

The seventh VWO analyzed in this study is to enhance project flexibility, which connotes the adaptability of an artefact to changes (Saleh et al., 2009) or re-configuration requirements (Lampel, 2001). In a related study, this VWO occupied the 11th position among other assessed objectives, although not statistically significant (Bowen et al., 2009).

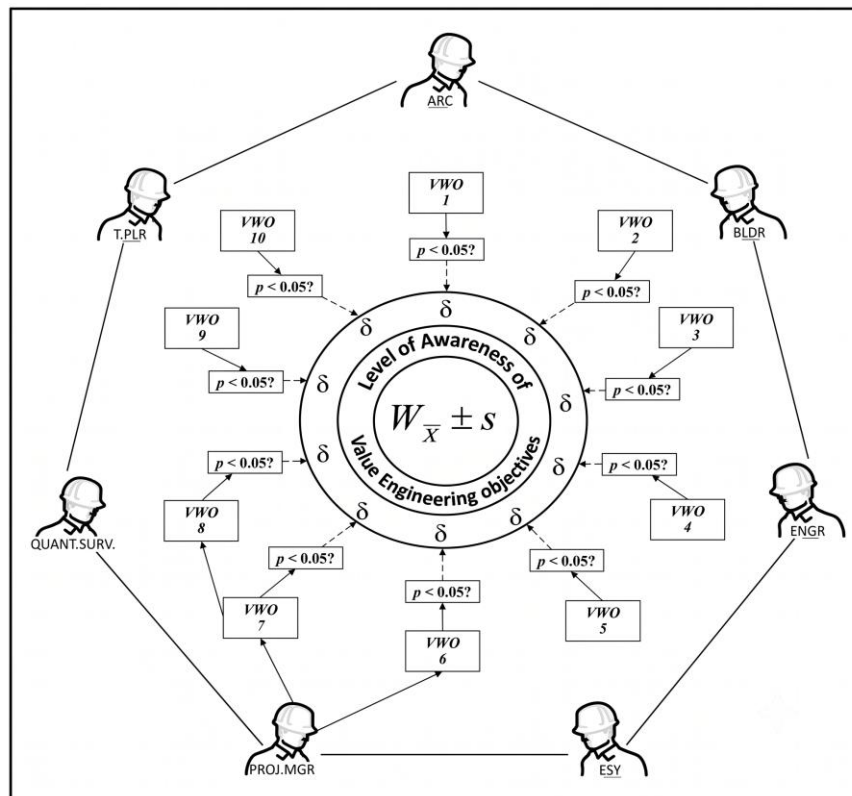
The eighth VWO was featured as effective project risks management. Baihaqi et al. (2023) and Ellis et al. (2005) had underscored the contributions of VM/VE practice towards mitigating project risks. It was deduced from Bowen et al. (2009) that construction professionals in South Africa perceived effective risk management to be a significant VWO at  $p < 0.05$  in addition to its ranking in the 6th position. This objective was further ranked 5th among practicing Engineers in South Africa (Bowen et al., 2010), to affirm its importance in value analysis of projects.

Featured as the ninth VWO addressed in this study is early project completion/delivery. In spite of its relevance, Bowen et al. (2009) and Bowen et al. (2010) found that construction and allied professionals in South Africa including Engineers do not perceive early project completion/delivery as a significant objective of VM. Notwithstanding, this VWO remains crucial to aversion of cost overruns in projects (Khodeir & El Ghandour, 2019).

The tenth VWO analyzed in this study is to minimize operating cost of a project, which comprise periodic/recurring expenditures associated with the maintenance and servicing, labour, and materials/equipment that are defrayed using the streams of cash inflows/revenue earned in the course of operating the project (Fight, 2006). Bowen et al. (2009) and Bowen et al. (2010) found this VWO to be ranked 3rd among construction and allied professionals, including Engineers, but not statistically significant at 5% level (Bowen et al., 2009). At this juncture, the variation in VE awareness levels among construction and allied professionals within the sub-national context of Kogi State in Nigeria is unknown, let alone the knowledge of the VWO attributed to such variation. Therefore, a conceptual framework has been drawn up to address this knowledge gap.

### 2.2.3 Conceptual Framework for the Study

The outer ring heptagon in Figure 2 indicates the seven groups of construction and allied professionals sampled for the purpose of this study, comprising Architects (ARC), Builders (BLDR), Engineers (ENGR), Estate Surveyors and Valuers (ESV), Project Managers (PROJ. MGR), Quantity Surveyors (QTY SURV) and Town Planners (T.PLR). Labelled VWO 1 to 10 are the ten value workshop objectives (VWOs) for which the level of awareness among these seven groups of professionals in the study area was assessed. At the centre of the conceptual framework is the assessed level of awareness of the VWO or VE objectives for each instance of construction and allied professional, which had been measured using weighted mean score and standard deviation ( $W_{\bar{x}} \pm s$ ). The unbroken arrow linking each VWO with the hypothesized level of statistical significance at  $p < 0.05$  connotes the requisite statistical test to avow the variation or otherwise in the awareness of an instance of VWO/VE objective among these professionals. However, the broken arrow connecting the test procedure with the delta notation -  $\delta$ , signifies the expected result of the statistical test.



**Figure 2.** Conceptual framework for study  
Source: Authors' conception, 2025

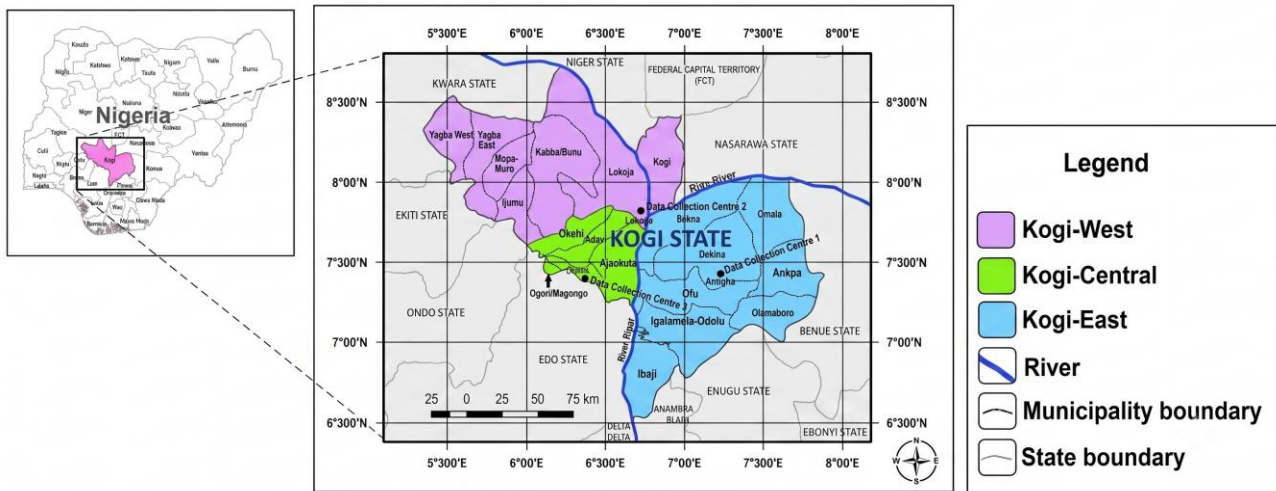
Consequently, there is (in)significant variation in the level of awareness of an instance of a VWO among these professionals if the answer to the question - " $p < 0.05?$ " is determined to be ("No") "Yes". Therefore, the outcome of the study is a deduction of possible variation in the levels of VE awareness among these professionals in addition to the attributed VWO for the variation.

## 3.0 METHODOLOGY

### 3.1 The Study Area

Kogi state, the study area is located in the North-Central Geo-political zone of Nigeria and constitutes one of the 36 states of the Nigerian Federation (Figure 3). It is within the bounds of Latitudes  $6^{\circ}30'00''$  and  $9^{\circ}00'00''$  North of the Equator, and Longitudes  $5^{\circ}00'00''$  and  $8^{\circ}00'00''$  East of the Greenwich Meridian and occupies a land mass of about 29,833 square kilometres. The state is located within the hot and humid climatic zone and

characterized by average monthly rainfall of about 103.96mm, ambient temperature in the range of 22.55±0.42°C and 33.54±0.23°C per annum, and dry grassland vegetation (Olayemi et al., 2014).



**Figure 3.** Map of the study area indicating the three data collection centres  
 Source: Authors' spatial data production, 2025

There is a prevalence of construction and allied professionals handling an array of private- and public funded construction projects in the study area. Professionals identified for this study have been featured in the conceptual framework (Figure 2). Further driving construction activities and consultancies in the study area is the sustained pedagogic and research inputs availed by higher education institutions offering middle- and upper level manpower training across the construction and allied professionals. Notwithstanding the geographical expanse of Kogi State, the commercial nerves of the three senatorial districts of the state namely Lokoja in Kogi-West, Okene in Kogi-Central, and Anyigba in Kogi-East were selected for data collection purposes.

### 3.2 Study Population and Sample Size

The study population comprises seven groups of construction and allied professionals identified in the conceptual framework (Figure 2) and practicing within the study area. The statistical sampling parameters from the conduct of a pilot study featured the return of 21 out of 55 survey questionnaires, representing a success proportion,  $p = 0.3818$ . Hence, assuming significance of sampling error at  $e = 0.05$ , the Cochran equation (Equation 1) was used to determine the maximum sample size for the study as follows:

$$N = \frac{n(p(1-p))^2}{(p(1-p))^2 - ne^2} \tag{1}$$

$$N = \frac{0.055709575(21)}{0.055709575 - 0.0025(21)} \approx 365$$

In tandem with the determined maximum sample size of 365 respondents, 365 paper-based survey questionnaires were distributed in the order of 121 for Anyigba, 121 for Okene, and 123 for Lokoja respectively. Within these three data collection zones (Figure 3), the questionnaires were administered across the seven groups of professionals through snowballing. Consequently, a total of 94 study questionnaire comprising 25 from Okene (Kogi Central), 23 from Anyigba (Kogi East), and 46 from Lokoja (Kogi West) were successful retrieved (Table 1).

**Table 1.** Operational sample size for the study.

Strata of construction and allied professionals	Sample size across data collection areas			Total
	Kogi-Central	Kogi-East	Kogi-West	
Architects	4	4	8	16
Builders	6	5	8	19
Engineers	4	4	7	15
Estate Surveyors and Valuers	3	4	9	16
Project Managers	1	0	3	4
Quantity Surveyors	4	4	7	15
Town Planners	3	2	4	9
<b>Total</b>	<b>25</b>	<b>23</b>	<b>46</b>	<b>94</b>

Therefore, the 94 respondents in Table 1 constitute the operational sample size for this study. All statistical computations were based on this actual figure of survey respondents. This operational sample size represents about 25% of the expected sample size of 365 respondents and is associated with the incidence of low response among the sample of professionals in the study area. It is cautionary however to note that there may be limitations regarding attempts to generalize the results of the study beyond this operational sample of respondents in the study area.

### 3.3 Data Collection and Survey Instrumentation

Besides reference to retrievable scholarly publications on the subject of VE/VM practice, data were primarily harnessed using the survey questionnaire administered through snowballing to the strata of construction and allied professionals in the three data collection centres. The questionnaire comprises two sections. The first section featured questions eliciting specific socio-demographic data of respondents; whereas the second section featured questions eliciting data addressing the research objectives. For that purpose, a 5-point Likert-scaled responses with codes ranging from 5 (Very strong awareness) to 1 (No awareness) was utilized.

### 3.4 Data Validation and Selection Criterion for Non-parametric Test Statistic

Three validation tests namely Cronbach's reliability-, Randomness- and the normality tests were conducted on the dataset in order to justify the deployment of appropriate test statistic. Table 2 features aggregate internal consistency of the 5-point Likert responses to the assessment of the awareness of the ten VWO following computed Cronbach's alpha in the range of  $0.7 \leq \alpha \leq 1.0$  as averred by Habidin et al. (2015), notwithstanding that Cronbach's alpha below the 0.7 threshold was returned solely for Kogi-East data. In other words, the Cronbach's alpha reported against data from sample of respondents from Kogi-East is not likely to adversely affect the results from statistical tests conducted on the aggregate data set ( $N = 94$ ) in this study.

**Table 2.** Reliability test of assessed level of awareness.

Data collection locations	Operational sample size	Items	Cronbach's alpha, $\alpha$
Kogi-Central	$n_1 = 25$	10	0.783
Kogi-East	$n_2 = 23$	10	0.420
Kogi-West	$n_3 = 46$	10	0.731
Aggregate	$N = 94$	10	0.716

The Wald-Wolfowitz runs test in Table 3 indicates randomness of the 5-point Likert scale data on VE awareness among the respondents to justify the use of inferential statistical tests for the study. Furthermore, the Shapiro-Wilk W-normality tests across all the VWOs showed a significant departure from normality

( $p < 0.05$ ); so that the normality assumption was relaxed to pave the way for the deployment of the Kruskal-Wallis  $H$  test, which is non-parametric surrogate of the One-way Analysis of Variance (ANOVA) test.

**Table 3.** Runs- and the Shapiro-Wilk  $W$ -normality tests on the VE objectives.

Objectives of Value Engineering (VE)	a. Two-tailed runs test		b. Two-tailed normality test	
	$ Z $	$p$ -value	$W$	$p$ -value
Minimize project operating cost	-1.940	0.052	0.801	0.000
Enhance project worth	-1.618	0.106	0.834	0.000
Enhance project functionality	-1.711	0.087	0.802	0.000
Enhance project flexibility	-1.637	0.102	0.834	0.000
Enhance project usability, convenience and comfort	-1.385	0.166	0.808	0.000
Minimize capital cost of project	-1.846	0.065	0.842	0.000
Value optimization over project life cycle	-1.900	0.057	0.834	0.000
Minimize adverse environmental impact of project	-0.720	0.472	0.851	0.000
Early project completion/delivery	-1.572	0.116	0.840	0.000
Effective risk management	-1.899	0.058	0.861	0.000

Notes:

a. With  $Z_{0.975} = \pm 1.96$ , randomness is (in)significant where ( $p \leq 0.05$ )  $p > 0.05$

b. With  $W_{\alpha=0.05, n=94} = 0.947$ , normality is (in)significant where ( $p \leq 0.05$ )  $p > 0.05$

### 3.5 Data Presentation and Analysis Techniques

Data presentation and analysis featured in this study was anchored on the theory of awareness attribution, wherein, the awareness levels of VE among a sample of construction project professionals was hypothesized to be influenced by ten (10) value workshop objectives (VWOs) as discussed earlier in the conceptual framework. Featured in Table 4 is the operational construct for the study designed to map the level of VE awareness (dependent variable) to specific independent variables (VWOs), along with a specification of the measurement- and inferential statistical tool deployed.

In tandem with the operational construct of (VE) awareness attribution in Table 4, preliminary data analyses in section 4 featured the measurement of these VWOs using weighted mean score, standard deviation, and ranking respectively. Thereafter was the use of the Kruskal-Wallis  $H$ -Test, being a non-parametric surrogate of the One-way ANOVA to measure the significance of each VWO, so that inference was drawn regarding the VWOs attributed to a variation in the level of VE awareness among these professionals. The ensuing paragraphs feature a discourse of the measurement tools and inferential statistical tests deployed in this study.

Data addressing the research objectives were presented using cross-tabulations of specific statistical analysis. Among these is the cross-tabulations of frequency counts and percentiles of nominal and ordinal data on socio-demographic characteristics of respondents, cross-tabulations of weighted mean scores, standard deviations, and ranks of each VWO, and tabulations of the Kruskal-Wallis  $H$  test results respectively.

The weighted mean score and standard deviation of respondents' level of awareness of VWO on the basis of the 5-point Likert scale was calculated using equations 2 and 3 respectively:

$$W_x = \frac{\sum f_i w_i}{\sum f_i} = \frac{5(f_5) + 4(f_4) + 3(f_3) + 2(f_2) + 1(f_1)}{f_5 + f_4 + f_3 + f_2 + f_1} \quad (2)$$

$$s = \sqrt{\left( \sum f_i w_i^2 - \frac{(\sum f_i w_i)^2}{n} \right) \frac{1}{n-1}} \tag{3}$$

Where  $w$  = individual weights in the Likert scale,  $f$  = instance of frequency associated with a weight, and  $n$  = operating sample size. The weighted mean score was interpreted using the framework presented in Table 5: For instance, it can be drawn with reference to Table 5 that a weighted mean score in the range of  $2.50 \leq \bar{W}_x \leq 3.49$  implies that the respondents have a moderate level of awareness for a specific VWO being evaluated. Meanwhile, the ranking of the VWOs was instantiated in descending order of their weighted mean scores, wherein the VWO with the higher mean score is featured above those with lower mean scores.

**Table 4.** The Operational link between (VE) awareness attribution, value workshop objectives and their measurement Value Workshop objectives (Independent variables) and their measurement tools.

Dependent variable	Label	Description	Measure of VWO		Order of Mean Score ranking	Kruskal Wallis Test		
			Location	Dispersion		Test statistic	Basis of inference <sup>1</sup> .	Effect size <sup>2</sup> .
Level of VE Awareness	VWO 1	minimize capital cost	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 2	Enhance project functionality	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 3	Enhance project worth	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 4	Value optimization over project life cycle	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 5	Minimize adverse environmental impact of project	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 6	Enhance project usability, convenience and comfort	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 7	Enhance project flexibility	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 8	Effective project risks management	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 9	Early project completion/delivery	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$
	VWO 10	Minimize operating cost of a project	Mean Score	Std. dev.	Descending	<i>H</i> -Stat.	$p < 0.05$	$\eta^2$

Notes:

- a. The basis of inference regarding a VWO accounting for a variation in the level of VE awareness among the sample of construction professionals is a significance value:  $p < 0.05$ .
- b. The effect size (variance) that a specific VWO accounts for in the level of VE awareness was measured using the eta-squared  $\eta^2$ .

**Table 5.** Criteria for the weighted mean score for each VE objective

Assigned Likert scale	Bounds of weighted mean score	Interpretation of mean score
5	$4.50 \leq w_{\bar{x}} \leq 5.00$	Very strong awareness
4	$3.50 \leq w_{\bar{x}} \leq 4.49$	Strong awareness
3	$2.50 \leq w_{\bar{x}} \leq 3.49$	moderate awareness
2	$1.50 \leq w_{\bar{x}} \leq 2.49$	minimal awareness
1	$1.00 \leq w_{\bar{x}} \leq 1.49$	No awareness

Source: Authors' calibration, 2025

The Kruskal-Wallis  $H$  test, which is an approximation of the Chi-square test statistics (equation 4) was deployed:

$$H = \frac{n_T(n_T + 1)(n_T - 1) \left\{ \left( \frac{12}{n_T(n_T + 1)} \cdot \sum_{j=1}^k \frac{R_j^2}{n_j} \right) - 3(n_T + 1) \right\}}{n_T(n_T + 1)(n_T - 1) - \sum (t^3 - t)} \quad (4)$$

Given that  $k = 7$  independent groups of construction and allied professionals, the degrees of freedom for this test;  $d.f. = k - 1$  is determined to be 6. Allowing a 5% level of significance for the test, and 6 degrees of freedom, a hypothesized Chi-square value of 12.592 was used as benchmark for the test; so that the decision rule is to accept the null hypothesis  $H_0$  if  $H \leq 12.592$  ( $p > 0.05$ ) or reject the null hypothesis  $H_0$  if  $H > 12.592$  ( $p \leq 0.05$ ).

Associated with the Kruskal-Wallis  $H$  test is the effect size (eta-squared -  $\eta^2$ ), which measures the amount of variance in the treatment that can be explained by array of independent variables. It is expressed as:

$$\eta^2 = SSA/SST \quad (5)$$

The eta-squared for an analyzed phenomenon can be interpreted as exhibiting small effect size where  $\eta^2 < 0.06$ ; medium effect size where  $\eta^2$  is in the range:  $0.06 \leq \eta^2 < 0.14$ , or large effect size when  $\eta^2 \geq 0.14$  (University of Cambridge, 2009).

## 4.0 RESULT

### 4.1 Respondents' Professional Affiliation and Membership

With recourse to Table 6, more than 80% of the sample of construction and allied professionals are full members of their respective professional organizations. Experts belonging to the technical membership cadre of their professional organizations comprise mainly builders and engineers in the sample.

**Table 6.** Respondents' professional affiliations.

Membership cadre	Professionals							Sub-Total
	Arc	Bldr	Engr	ESV	ProjMgr	QtySurv	TPlg	
Full member	14	14	10	15	4	12	8	77
Technical member	0	3	5	N/A	0	N/A	N/A	8
Graduate member	2	2	0	1	0	3	1	9
Sub-Total	16	19	15	16	4	15	9	94

Notes on Abbreviations: Arc = Architects; Bldr = Builders, ESV = Estate Surveyors and Valuers; ProjMgr = Project Managers, QtySurv = Quantity Surveyors; TPlg = Town Planners; N/A = Not Applicable

Meanwhile, all the professionals in the sample have at least one graduate member except for the engineers and project managers. Information in Table 6 has availed a measure of confidence regarding the expertise of the survey respondents.

#### 4.2 Respondents' years of experience in construction practice

The modal class of construction industry experience of respondents is featured in Table 7 to be within the range of 11 and 20 years, but with a class mark of 15.5 years. This is besides 23.4% of respondents who have amassed between 21 and 30 years' experience in construction industry practice.

**Table 7.** Respondents' years of construction industry experience

Class interval (Years)	Class mark (Years)	Frequency	Percentage (%)
1 – 10	5.5	26	27.7
11 – 20	15.5	43	45.7
21 – 30	25.5	22	23.4
31 – 40	35.5	3	3.2
Total		94	100.0

Consequently, the over 15 years' experience amassed by over 70% of the survey respondents is an affirmation of the measure of confidence in the data availed for the purpose of this study.

#### 4.3 Awareness Levels of Value Workshop Objectives

The pooled descriptive statistics in Table 8 indicates that the seven group of construction and allied professionals exhibit strong levels of awareness ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ) in all the objectives of a typical VE exercise and consequently, VE itself. Notwithstanding, the pooled mean scores across the VWOs did not feature any insight into varying levels of VE awareness among these professionals. Meanwhile, an observation could be drawn regarding the variation in the levels of awareness of VWO among each specific group of professional. For instance, Architects, Builders, Quantity Surveyors, and Town Planners exhibited strong levels of awareness of all the ten VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ), whereas Engineers and General Practice Surveyors (Estate Surveyors and Valuers) exhibited strong levels of awareness of 9 out of the 10 VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ) except for Effective risk management ( $2.50 \leq w_{\bar{x}} \leq 3.49$ ).

However, Project Managers in the sample exhibited strong levels of awareness in 7 out of the 10 VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ) with exception of enhancing project flexibility, value optimization over project life cycle, and minimizing adverse environmental impact of project in the range:  $2.50 \leq w_{\bar{x}} \leq 3.49$ . It is on this note that the next subsection featured the result of the Kruskal-Wallis  $H$  test deployed to identify the significant VWOs that account for variations in the levels of awareness of VWO among these professionals.

**Table 8.** Distribution of the level of awareness of value workshop objectives among construction and allied professionals.

Respondents' Profession	Architects			Builders			Engineers			Estate Surv. & Valuers		
	Mean	Stdev	Rank	Mean	Stdev	Rank	Mean	Stdev	Rank	Mean	Stdev	Rank
Minimize project operating cost	4.19	0.66	2	4.21	0.63	1	4.67	0.49	1	4.13	0.62	2
Enhance project worth	4.13	0.96	3	3.95	1.03	3	4.33	0.62	2	3.75	0.86	4
Enhance project functionality	4.13	0.89	3	3.89	0.74	4	4.13	0.83	4	3.69	0.87	5
Enhance project flexibility	3.56	1.03	10	4.00	0.82	2	3.87	0.74	7	4.38	0.72	1
Enhance project usability, convenience and comfort	3.81	1.11	6	3.89	0.88	4	4.20	0.68	3	3.56	0.63	8
Minimize capital cost of project	4.25	0.93	1	3.63	0.96	8	4.13	0.92	4	3.63	1.09	6
Value optimization over project life cycle	4.13	1.02	3	3.74	1.05	6	3.67	0.90	8	3.56	0.89	8
Minimize adverse environmental impact of project	3.63	1.26	9	3.74	0.99	6	4.07	0.46	6	3.63	0.62	6
Early project completion/delivery	3.75	1.18	7	3.63	1.07	8	3.60	0.91	9	3.81	0.83	3
Effective risk management	3.75	1.24	7	3.53	1.17	10	3.47	0.92	10	3.25	1.13	10

Note: Ranks (with ties) have been assigned on the basis of calculated mean score

**Table 8.** Distribution of the level of awareness of value workshop objectives among construction and allied professionals (Continued)

VE objectives	Project Managers			Quantity Surveyors			Town Planners			Pooled statistics		
	Mean	Stdev	Rank	Mean	Stdev	Rank	Mean	Stdev	Rank	Mean	Stdev	Rank
Minimize project operating cost	3.75	0.50	4	3.93	0.70	10	4.22	1.09	4	4.20	0.70	1
Enhance project worth	4.75	0.50	1	4.07	0.70	9	4.11	0.93	6	4.07	0.86	2
Enhance project functionality	4.50	0.58	2	4.40	0.51	5	3.67	1.12	9	4.02	0.83	3
Enhance project flexibility	3.25	0.50	8	4.40	0.83	5	3.89	0.60	7	3.99	0.85	4
Enhance project usability, convenience and comfort	3.50	1.00	6	4.53	0.52	3	4.33	0.50	1	3.99	0.84	4
Minimize capital cost of project	3.75	1.26	4	4.47	0.52	1	3.78	1.09	8	3.96	0.97	6
Value optimization over project life cycle	3.25	0.96	8	4.60	0.51	2	4.22	1.09	4	3.93	0.98	7
Minimize adverse environmental impact of project	3.25	0.96	8	4.53	0.74	3	4.33	0.50	1	3.91	0.90	8
Early project completion/delivery	4.25	0.50	3	4.40	0.83	5	4.33	0.71	1	3.90	0.97	9
Effective risk management	3.50	1.29	6	4.40	0.63	5	3.67	1.32	9	3.64	1.12	10

Note: Ranks (with ties) have been assigned on the basis of calculated mean score

#### 4.4 Variation in awareness levels of Value Engineering Objectives

Table 9 features the result of the test of statistical significance of the VWO accounting for a variation in VE awareness among construction and allied professionals in the study area. Given a hypothesized level of significance at  $p < 0.05$ , inference was drawn from Table 9 regarding the six insignificant VWOs comprising to minimize capital cost of project ( $\chi^2(6) = 10.863, p = 0.093$ ), minimize project operating cost ( $\chi^2(6) = 12.262, p = 0.056$ ), enhance project worth ( $\chi^2(6) = 6.625, p = 0.357$ ), effective risk management ( $\chi^2(6) = 10.828, p = 0.094$ ), early project completion/delivery ( $\chi^2(6) = 11.099, p = 0.085$ ), and enhance project functionality ( $\chi^2(6) = 9.655, p = 0.140$ ). These VWOs were found to have exhibited minimal effect sizes in the range:  $\eta^2 \leq 0.06$ , except for the VWO of minimizing project operating cost that exhibited a medium effect size in the range:  $0.06 \leq \eta^2 < 0.14$ .

**Table 9.** Kruskal-Wallis test of professionals' awareness of the Value Workshop objectives

S/N Value Engineering objectives (VWOs)	Adjusted		Symbolic inference	Decision	Effect size ( $\eta^2$ )
	<sup>a</sup> H Statistic	<sup>b</sup> p-value			
1 Minimize capital cost of project	10.863	0.093	$p > 0.05$	Accept $H_0$	0.056
2 Minimize project operating cost	12.262	0.056	$p > 0.05$	Accept $H_0$	0.072
3 Enhance project worth	6.625	0.357	$p > 0.05$	Accept $H_0$	0.007
4 Effective risk management	10.828	0.094	$p > 0.05$	Accept $H_0$	0.056
5 Early project completion/delivery	11.099	0.085	$p > 0.05$	Accept $H_0$	0.059
6 Value optimization over project life cycle	18.143	0.006***	$p < 0.05$	Reject $H_0$	0.140
7 Minimize adverse environmental impact	16.499	0.011**	$p < 0.05$	Reject $H_0$	0.120
8 Enhance project flexibility	13.937	0.030**	$p < 0.05$	Reject $H_0$	0.091
9 Enhance project functionality	9.655	0.140	$p > 0.05$	Accept $H_0$	0.042
10 Enhance usability, convenience & comfort	16.940	0.010**	$p < 0.05$	Reject $H_0$	0.130

#### Notes:

- Test was based on Critical  $\chi^2 = 12.592$  derived from  $d.f. = 6$ , and  $\alpha = 0.05$
- \*\*\*Significant at  $p < 0.01$ ; \*\*Significant at  $p < 0.05$
- Test priori power for the entire test ( $1 - \beta$ ), is 0.974
- Bonferroni corrected alpha,  $\alpha'$  for the entire test is 0.002

The four VWOs accounting for a significant variation in the level of VE awareness among the sample of construction and allied professionals in the study area include value optimization over project life cycle ( $\chi^2(6) = 18.143, p = 0.006$ ); minimizing adverse environmental impact of project ( $\chi^2(6) = 16.499, p = 0.011$ ); enhancing project flexibility ( $\chi^2(6) = 13.937, p = 0.030$ ); and enhancing project usability, convenience and comfort ( $\chi^2(6) = 16.940, p = 0.010$ ); all of which exhibited medium effect sizes in the range:  $0.06 \leq \eta^2 < 0.14$ . The reported medium effect sizes imply that these VWO (independent variables) account for 6% to less than 14% of the variance in the level of awareness of the value workshop objectives among the sample of construction project professionals in the study area. It suggests that in spite of the moderate variation in level of awareness of these VWO among the ranked distribution of professionals, the difference among these groups of professionals is substantial enough to be reported.

## 5.0 DISCUSSION

Four issues could be deduced from a cursory observation of Tables 8 and 9. First, it is observed from Table 8 that Architects, Builders, Quantity Surveyors, and Town Planners exhibited strong levels of awareness of all the ten VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ). This might have been triggered by their pedagogy and construction industry experience. A comparison of findings credited to Bowen et al. (2009) indicates less than 50% concordance

rate in the delivery of all VWOs by Architects, whereas Quantity Surveyors recorded above 50% concordance rate in the achievement of only four VWOs namely minimizing project capital- and operating costs, enhancing project functionality, and value optimization over project life. In further contrast with Bowen et al. (2009) is the over 50% concordance rating of 5 out of the 10 VWOs by South African construction managers (Builders). Meanwhile the strong awareness of all VWO exhibited by Town Planners in the study is a reflection of their environmental- and building control skills (Kelly et al., 2004).

Except for effective risk management, Engineers and General Practice Surveyors exhibited strong levels of awareness of 9 out of the 10 VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ). For Engineers, this finding is in contrast with Bowen et al. (2010) regarding over 50% concordance rating of 6 out of the 10 VWOs by South African Engineers. There is a possibility that Engineers featured in this study have prioritized compliance with environmental standards, contrary to the practice over the past decades (Bowen et al., 2010). The strong levels of VE awareness among Estate Surveyors and Valuers as featured in this study, underscores their expertise of soft- and managerial skills in handling pre- and post-construction activities in the built environment (Connaughton & Green, 1996; RICS, 2013).

Thirdly, Project Managers in the sample exhibited strong levels of awareness of 7 out of the 10 VWOs ( $3.50 \leq w_{\bar{x}} \leq 4.49$ ) with exception of enhancing project flexibility, value optimization over project life cycle, and minimizing adverse environmental impact of project in the range  $2.50 \leq w_{\bar{x}} \leq 3.49$ . Bowen et al. (2009), in a similar study, chose to merge project- and construction managers such that the four comparatively common VWOs with modal responses include minimizing project capital- and operating costs, enhancing project functionality, and effective risk management. Meanwhile, their awareness of the use of VE to actualize early project completion/delivery, minimizing project capital- and operating costs, enhancing project functionality, and effective risk management as featured in this study are reflections of their traditional roles in the construction industry (Lin et al., 2022).

As observed in Table 9, the VWO of minimizing adverse environmental impact of projects was significant ( $p < 0.05$ ) among construction and allied professionals in Kogi State, Nigeria, contrary to results on the same VWO in a study credited to Bowen et al. (2009). This replicative analysis after more than a decade of the study credited to Bowen et al. (2009) have underscored Africa's response to the global paradigm shift towards sustainability practice in construction project management.

The Kruskal-Wallis  $H$  test in Table 9 at  $p < 0.05$  indicated that construction and allied professionals in the study area exhibited similarity in their levels of awareness regarding the use of VE to minimize capital cost of project; minimize project operating cost; enhance project worth; effectively manage risk; achieve early project completion/delivery; and enhance project functionality; but with a varied level of awareness/understanding regarding the use of VE to optimize value over project life cycle; minimize adverse environmental impact of project; enhance project flexibility; and enhance project usability, convenience and comfort.

It would be recalled that awareness attribution as posited by Graziano and Kastner (2011) was chosen as the theoretical baseline for identifying the significant VWOs that explain the variation in VE awareness among construction and allied professionals in this study. To underscore the relevance of awareness attribution theory within the context of this study, results have featured how the level of VE awareness among the sample of construction project professionals in the study area can be attributed to their demonstrable ability of four value workshop objectives (VWOs) namely value optimization over project life cycle; minimizing adverse environmental impact of project; enhancing project flexibility; and enhancing project usability, convenience and comfort. This study is therefore an affirmation of the insights availed by studies credited to Bowen et al. (2009) and Lin et al. (2022) regarding variation in the levels of VE awareness among construction and allied professional as well as the identification of the value workshop objectives (VWOs) that significantly account for such variation.

## 6.0 CONCLUSION

This study assessed the variation in the level of value engineering awareness among construction project professionals in Kogi State, Nigeria, and the attributed VWOs for such variation. Consequently, the attributed VWOs for the variation include value optimization over project life cycle, minimizing adverse environmental impact of project, enhancing project flexibility, and enhancing project usability, convenience and comfort. This variation is a reflection of their professional diversity aimed at facilitating inclusiveness in pre-qualification for a typical VE exercise. In contrast, these professionals have a shared understanding regarding the use of VE to minimize capital cost of project, minimize project operating cost, enhance project worth, effectively manage risk, foster timely project completion/delivery, and enhance project functionality. In view of their varied and shared understanding of VWOs, this study is a contribution to insights aimed at promoting inclusiveness in the pre-qualification of professionals for a value engineered construction project.

The study is fraught with some limitations. First is the low response rate of professionals towards completing the survey questionnaire in spite of the snowballing approach adopted. Prior to this, the deployment of online survey forms was explored and discarded owing to the prevailing cases of scam phobia associated with web page links among potential respondents. A second limitation is traceable to the use of closed-ended response mechanism in the study questionnaire. Hence, further research on the subject should explore the administration of compact data collection instruments especially during planned events of professional organizations, where large-scale attendance is guaranteed. A further dimension to this study should explore the combined use of open- and closed-ended responses or data collection instruments, leading to the use of mixed methodologies that blend quantitative-and qualitative approaches to data analysis.

## 7.0 ACKNOWLEDGEMENT

The authors express their profound gratitude to the Tertiary Education Trust Fund (TETFUND), an organ of the Federal Ministry of Education in Nigeria for availing them with research grant (ETF/DR&D/CE/POLY/IDAH/RG/2020/VOL.1) that facilitated the conduct of the Institutional-based research (IBR) from where this article was drawn. Also appreciated are data collection assistants, survey participants, and the editorial team of this journal for their efforts.

## 8.0 AUTHOR CONTRIBUTIONS

Olufemi Joseph Bioku led the conceptualization of the study, contributed to review of literature, developed the methodology and survey instrumentations. Both authors supervised the data collection process. Joseph Obaje Ataguba led data processing, analysis, and interpretation of results, while Olufemi Joseph Bioku led the editing and proofreading of the original manuscript. All authors have agreed to assume full responsibility for the content and published version of this article.

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