Cost Reduction Techniques in Public Higher Educational Buildings in Southwestern Nigeria: Awareness Among Project Participants

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Abstract. Building projects delivered within higher educational institutions are often left unfinished or finished more than the initial cost, exceeding the duration and not up to standard. This is largely due to several factors affecting the cost and time performance of the educational building projects funded by TETfund, HEIs internally generated revenue and private organisation donors. The study assessed project participants' awareness of cost-reduction techniques in delivering educational building projects in Nigeria. This study focused on educational building projects deliver in the public HEIs in Southwestern Nigeria. A questionnaire survey was conducted among the stakeholders that participated in constructing educational buildings in the public HEIs in Southwestern Nigeria from 2012-2022 as contractors or consultants. The study employed percentage, mean, and Kruskal-Wallis H Test for data analysis. Result show supply chain management, target value design, budget control, earned value analysis and value analysis/engineering as the top known cost reduction techniques among all the project participants. The study concludes that to improve cost and time performance in the delivery of educational building projects, project participants must understand various cost reductions techniques to deliver projects within cost and time estimate.

1 Introduction

Higher Educational Buildings (HEBs) are essential facilities that promote suitable and sustainable academic administration purposes they include the premises and amenities that facilitate educational activities and instructions as well as the dormitories for students to meet their housing needs [1]. The HEB is a key factor in attracting student recruitment while creating a conducive and suitable environment supporting teaching, learning, and innovation. Students' yearly intake has erupted over the years in Nigerian higher education institutions, overstretching the available physical facilities to meet the requirement for students and staff [2]. This led to the federal government of Nigeria with the initiative to reform the education sector.

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Nonetheless, the delivery of HEBs in Nigeria over decades has improved due to government reforms and intervention within the education sector [3]. The government reforms and intervention programmes within the Nigerian education sector include Universal Primary Education in 1976, Universal Basic Education in 1999, and the Tertiary Education Trust fund (TETfund) in 2011.The government reform and intervention programmes aimed at providing funds for infrastructure development and awarding scholarships or grants to enhance staff productivity and quality education delivery in Nigerian institutions [4].The educational building projects have also enjoyed sponsorships through private donors, Internally Generated Revenue (IGR), and funding from the government utilized in carrying out capital projects [5-7]. Over the years, such allocations have improved higher institutions' infrastructure facilities, teaching, research and other ancillary services [3].

Educational building projects in higher institutions are characterized by poor performance, delay, exceeding budget and duration [3, 8, 9]. [3], noted that the shortcomings in delivering educational buildings negatively affected the quality of education in Nigerian's public higher education institutions (HEIs). Time and cost performance are common criteria used in assessing building project success because of its financial implication on clients [8, 10].The cost and time-related problems in the construction of educational buildings occur in all phases within the project life cycle due to inaccurate project estimates, design errors, administrative errors and non-planning for change orders [11]. Hence, [2, 12, 13] postulated that the building projects delivered within higher educational learning are often left unfinished or finished more than the target cost, time and not up to standard. Thus, this study seeks to answer research questions about the cost reduction techniques available to participating stakeholders in educational buildings in Nigerian public HEIs to alleviate these problems.

In light of the aforementioned, this research evaluated awareness of cost-reduction techniques among project participants in the execution of building projects for educational institutions in Nigeria. It also assessed the differences in level of awareness based on project participants' professional background and years of experience.

1.1 Overview of educational buildings funding in Nigeria

There are three classifications of higher education institutions in Nigeria, based on their owner, the federal government, state government and privately owned. The federal and state governments fund public institutions. According to [6], through the Nigerian Universities Commission (NUC), the federal government contributed about 90% of the funds to universities, while the universities generated the remaining 10%. [3, 14-16], noted that the inadequacy of the government to meet HEIs infrastructure facilities demands led to adopting other funding schemes to bridge the gaps. The TETfund was established under the Act of 2011 as a government intervention programme to improve the Nigerian education sector. The TETfund Act of 2011 mandated every registered company in Nigeria to pay a 2% Education Tax on the assessable profit to achieve the agency [17]. This also encourages HEIs to adopt strategies to generate internal revenues to bridge the infrastructure gap. [5,6], noted that HEIs in Nigeria use grants, student fees, support from individual and private firms, business ventures and consultations generated funds to bridge the infrastructures gap. However, the increase in HEIs and economic imbalance has limited the Nigerian government's education sector funding. The global construction industry faces price volatility, which affects construction contractors and clients [18].

This requires that the available funds are utilised effectively to deliver educational buildings within budget and gain value for money. [3, 19, 20], maintained that the cost and time performance is crucial to deliver educational building projects, and it frequently causes

great anxiety for stakeholders in construction. Hence, the project participants must keep within the estimated budget as stated by the general conditions of such a project using applicable cost-reduction techniques. [21], affirmed that the most important way to realize effective cost performance in a project is through quality cost reduction techniques.

1.2 Cost reduction techniques

Cost reduction techniques are strategy to lower the overall cost of the construction project or keep the projects within the budget [22]. [21, 23], noted that cost-reduction techniques enable stakeholders to benefit economically in construction projects. [24, 25], stated that cost reduction is a constant goal for the construction industry using various techniques for cost control and project cost control software to achieve project objectives. [26], highlighted the important ways to reduce cost without quality deduction; material and process substitution, reducing cost through site organisation and site management cost.

However, different cost-reduction techniques have been used to control construction costs. [27], posited that earned value analysis is one of the primary techniques to reduce construction cost escalation and ensure cost performance. [28], maintained that the supply chain plays a significant role in construction contracts to keep the project cost under control, reduce time, cost and wastage and increase contractor profitability. Target value design offers a collaborative design in construction contracts that promote concurrent engineering and design outcomes that meet the project's budget [20, 30]. [31, 32], assessed the importance of simplifying and standardising units to achieve sustainable life cycle costs in construction contracts. Circular Economy offers a model of production and consumption, which involves sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products to gain control of cost [33-35].

[37, 37], posited that kaizen model provides diagnostic tools and analysis of the production system costing to ensure the quality of the final products and the reduction of costs of the building projects. Activity-Based costing is allocating overheads and indirect costs to activities within the project to enable cost control and performance of construction projects [38, 39]. Nonetheless, automation processes have been used in construction activities and processes to promote stakeholders' collaboration and achieve project economic value [40].

Table 1. Summary of cost reduction techniques.

Cost Reduction Techniques	**References**
Supply Chain Management	[28, 41]
Target Value Design	[29, 30]
Simplification and standardisation of units	[31,32]
Activity-Based Costing	[38, 39]
Value Analysis/Engineering	[42, 43]
Market Research	[38, 44]
Earned Value Analysis	[27, 45, 46]
Target costing	[29, 30, 44]
Material and process substitution	[26, 47]
Budgetary control	[48]
Onsite project resource control technique	[48]
Kaizen costing	[36, 37]
Standard costing	[29, 30]

Automation	[40, 54]
Cost-benefit analysis	[49, 50]
Circular economy	[33-35]

2 Materials and methods

The study assessed awareness of cost reduction techniques among project participants' in delivering educational building projects in Nigeria. This study focused on educational building projects in the public HEIs in Southwestern Nigeria. This study adopted a purposive sampling method to obtain a self-administered questionnaire from the targeted population. The respondents were the stakeholders that participated in public tertiary educational building projects in southwestern Nigeria from 2012-2022 as contractors or consultants. Information concerning each respondent was also obtained to ascertain that the right participants attempted the questionnaire as information such as highest academic qualification attained, professional characteristics (background, affiliation, membership, grade of membership), construction industry experience and category of the organisation were also sought. In identifying the participants, it was necessary first to identify the projects completed within the year mentioned, details of the project participants were retrieved from the project files, and thereafter, they were contacted to be part of the study. The researcher ensured that at least one participant per project responded to the survey. Participants that could not be reached physically were contacted through emails with the link to the questionnaire attached.

The questionnaire sampled the level of awareness of 16 identified cost reduction techniques on a five-point Likert scale with 1 = no awareness, 2 = little awareness, 3 = Moderate awareness, 4 = high awareness, and 5 = very high. A brief explanation of identified techniques was provided in the questionnaire to allow participants to understand and avoid misinterpretation. A total of 133 responses were received and analysed. The data gathered from the questionnaire were analysed using descriptive and inferential statistics with the help of Statistical Package for Social Science (SPSS) version 21.0. The descriptive statistics include frequency, percentage and mean item score, while the inferential statistics is the Kruskal Wallis-H test which is a non-parametric substitute for one-way ANOVA used to evaluate whether there are statistically significant differences between two or more independent variables on ordinal dependent variable. Cronbach's Alpha Coefficient was used to test the internal consistency of the data obtained. The Cronbach's Alpha value result ranges from 0 to 1, with 0.7 as an acceptable reliability coefficient (Pallant, 2011). The Cronbach's Alpha value was 0.869, obtained in this study, demonstrating the reliability and validity of the survey instrument.

3 Results and discussion

3.1 Background information of the respondent

Table 2 shows the professional background of the respondents, which comprises 43 (32.3%) Quantity surveyors, 30 (22.6%) Architects, 26 (19.5%) Civil/Structural Engineers, 19 (14.3%) other disciplines, 10 (7.5%) Builders, while Electrical and Mechanical Engineers were 3 (2.3%) and 2 (1.5%) respectively.

Further, Table 2 shows the respondents' years of industrial experience, 48 (36.1%) had 21-30 years of experience, 43 (32.3%) had 11-20 years of experience, 21 (15.8%) had 1-10 years of experience while 21 (15.8%) had over 31 years of experience in the construction

industry. The result on professional background shows all the professions are represented, however the higher representations of the quantity surveyors and architects implies that these two professions are more involved in projects than other professions and because the research bothers more on cost which is supported by [51]. Also the result shows the respondents have adequate years of experience and as such has the capacity to respond to the survey.

Table 2. Background information of the respondents

Background Information	**Frequency**	**Percentage**
Professional background		
Architect	30	22.6
Quantity surveyor	43	32.3
Builder	10	7.5
Civil/Structural engineer	26	19.5
Electrical engineer	3	2.3
Mechanical engineer	2	1.5
Other	19	14.3
Total	133	100
Construction industry experience		
1-10 years	21	15.8
11-20 years	43	32.3
21-30 years	48	36.1
31-40 years	14	10.5
41-50 years	7	5.3
Total	133	100

3.2 Descriptive analysis of respondents level of awareness of cost reduction techniques in public higher educational building projects in Nigeria

Table 3 shows the respondents' awareness of cost-reduction techniques in public HEB projects in Nigeria. Supply chain management ranked first with a mean score (MS) of 4.26, target value design ranked second with MS of 4.25, and budget control ranked third with MS of 4.20.

Table 3. Respondents level of awareness of cost reduction techniques.

Cost Reduction Techniques	**1**	**2**	**3**	**4**	**5**	**Mean Score**	**Standard deviation**
Supply Chain Management	0	2	15	62	54	4.26	0.717
Target Value Design	0	5	15	55	58	4.25	0.802
Budget Control	1	8	15	49	60	4.20	0.920
Earned Value Analysis	3	3	21	57	49	4.10	0.903
Value Analysis/Engineering	1	4	23	58	47	4.10	0.843
Target Costing	4	5	23	51	50	4.04	0.988
Cost-benefit Analysis	1	11	20	51	50	4.04	0.970
Onsite Project Resource Control Technique	2	8	26	57	40	3.94	0.940
Simplification and Standardization of units	2	10	23	58	40	3.93	0.955
Market Research	1	12	30	49	41	3.88	0.980
Activity Based Costing	1	8	39	58	27	3.77	0.869

Material and Process Substitution	5	13	37	35	43	3.74	1.127
Standard Costing	2	21	28	53	29	3.65	1.039
Kaizen Costing	5	10	42	51	25	3.61	0.999
Automation	4	15	38	56	20	3.55	0.981
Circular Economy	14	16	32	45	26	3.40	1.231

The cost reduction techniques that ranked fourth with MS of 4.10 are earned value analysis and value analysis/engineering. This is followed by target costing and cost-benefit analysis, ranked sixth with MS 4.04. However, the five least-ranked cost-reduction techniques awareness among professionals involved in the educational building project include material and process substitution with MS 3.74, standard costing with MS 3.65, kaizen costing with MS 3.61, automation with MS 3.55 and circular economy with MS 3.40. The study of [52] however showed low level of awareness of supply chain management in the Portuguese construction industry, in like manner [30] confirms that though some aspects of target value design are in use in South Africa, but the concept remains unknown in practical terms. The discrepancies in the findings could be attributed to the differing environment and economy. The findings of this study on low level of awareness of circular economy is consistent with [33-35, 53] even in the United Nations and Hong Kong construction Industry, increased awareness level can be achieved through trainings.

3.3 Difference in level of awareness of cost reduction techniques based on project participants years of experience

Table 4 shows the respondents' awareness of cost-reduction techniques in educational building projects in Nigeria based on their years of experience. The respondents with 1-10 years of experience ranked first five cost reduction techniques awareness as follows: budget control MS of 4.52, onsite project resource control MS of 4.38, supply chain management MS of 4.24, activity-based costing MS 4.14, target value design and simplification and standardisation of units MS of 4.10 as the well known cost reduction techniques. The respondents with 11-20 years of experience ranked first five cost reduction techniques awareness as follows: budget control MS 4.35, market research MS 4.28, simplification and standardisation of units MS 4.21, cost-benefit analysis MS 4.16, and supply chain management MS 4.14. The respondents with 21-30 years of experience ranked the first five cost reduction techniques as follows: target value design MS 4.33, supply chain management MS 4.29, value analysis/engineering MS 4.19, earned value analysis MS 4.10, and target costing MS 4.08. The respondents with 31-40 years of experience ranked supply chain management MS 4.64, target value design MS 4.57, budget control and simplification and standardisation of units MS 4.0, and value analysis and target costing MS 4.43 as the first five cost reduction techniques known. The respondents with 41-50 years of experience ranked the first five cost-reduction techniques as target costing MS 4.14, supply chain management MS 4.14, budget control, onsite project resource control and materials and process substitution MS 4.00.

Table 4 also shows the Kruskal-Wallis H-test, a non-parametric test used to determine the significant difference in respondents' awareness of cost-reduction techniques based on years of experience. Using a 95% confidence level, the result of the Kruskal-Wallis test shows that some of the assessed cost-reduction techniques awareness in educational building projects has a significant p-value below 0.05. A significant difference exist in awareness level of budget control 0.012, onsite project resource control techniques 0.004, simplification and standardisation 0.000, market research 0.002, activity-based costing 0.003, material and process substitution 0.050, and standard costing 0.017. The study of [33] also discovered

significant different in respondents' awareness of circular economy however it is based on age of respondents as against years of experience in the industry.

Table 4. Difference in level of awareness of cost reduction techniques by project participants' years of experience.

	1-10 years		11-20 years		21-30 years		31-40 years		41-50 years		Overall		Kruskal Wallis Test	
Cost Reduction Techniques	**M**	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**M**	**R**	**Chi-Square**	**Asymp. Sig.**
Supply Chain Management	4.24	3	4.14	5	4.29	2	4.64	1	4.14	2	4.26	1	6.075	0.194
Target Value Design	4.10	5	4.12	6	4.33	1	4.57	2	4.29	1	4.25	2	5.053	0.282
Budget Control	4.52	1	4.35	1	3.85	7	4.50	3	4.00	3	4.20	3	12.776	0.012*
Earned Value Analysis	4.05	7	4.09	7	4.10	4	4.29	8	3.86	6	4.10	4	2.22	0.695
Value Analysis/Engineering	4.05	7	4.00	9	4.19	3	4.43	5	3.57	10	4.10	4	7.396	0.116
Target Costing	3.90	12	3.98	10	4.08	5	4.43	5	3.71	8	4.04	6	5.529	0.237
Cost benefit Analysis	3.86	13	4.16	4	4.06	6	4.00	13	3.71	8	4.04	6	2.786	0.594
Onsite Project Resource Control Technique	4.38	2	4.05	8	3.52	8	4.36	7	4.00	3	3.94	8	15.342	0.004*
Simplification and Standardization of units	4.10	5	4.21	3	3.50	9	4.50	3	3.57	10	3.93	9	21.047	0.000*
Market Research	4.05	7	4.28	2	3.46	11	4.00	13	3.57	10	3.88	10	17.085	0.002*
Activity Based Costing	4.14	4	3.91	12	3.42	12	4.14	9	3.43	14	3.77	11	15.791	0.003*
Material and Process Substitution	3.76	14	3.98	10	3.38	14	4.07	11	4.00	3	3.74	12	9.512	0.050*
Standard Costing	3.95	10	3.74	13	3.35	15	4.14	9	3.14	16	3.65	13	12.071	0.017*
Kaizen Costing	3.95	10	3.67	14	3.40	13	3.71	16	3.43	14	3.61	14	5.788	0.216
Automation	3.57	16	3.49	15	3.50	9	3.86	15	3.57	10	3.55	15	2.741	0.602
Circular Economy	3.62	15	3.30	16	3.13	16	4.07	11	3.86	6	3.40	16	8.659	0.070

3.4 Difference in level of awareness of cost reduction techniques based on project participants professional background

Table 5 shows the respondents' awareness of cost-reduction techniques in educational building projects in Nigeria based on their professional backgrounds. The 30 architects that participated in the research ranked the first five cost reduction techniques: target value design MS 4.23, target costing MS 4.10, value analysis/engineering MS 4.07, budget control, earned value analysis, and supply change management MS 4.00. The 43 quantity surveyors that participated in the research ranked the first five cost-reduction techniques: supply change

management MS 4.40, target value design MS 4.37, value analysis/engineering MS 4.23, budget control MS 4.16, and target costing MS 4.14. The 10 builders that participated in the research ranked the first five cost-reduction techniques: onsite project resource techniques MS 4.80, simplification and standardisation of units MS 4.70, target costing and cost-benefit analysis, earned value analysis, budget control and supply change management MS 4.60. The 26 civil/structural engineers that participated in the research ranked the first five cost-reduction techniques: target costing and cost-benefit analysis MS 4.33, earned value analysis and supply change management MS 4.35, and target value design MS 4.31.The 19 other participants involved in the research ranked the first five cost-reduction techniques: onsite project resource techniques MS 4.53, market research, budget control and supply chain management MS 4.34, and earned value analysis MS 3.50.

Table 5 also shows the Kruskal-Wallis H-test, a non-parametric test used to determine the significant difference in respondents' awareness of cost-reduction techniques based on their professional backgrounds. Using a 95% confidence level, the result of the Kruskal-Wallis test shows significant difference in awareness of the following cost reduction techniques with p-value of below 0.05; supply chain management 0.017, onsite project resource control techniques 0.000, simplification and standardisation 0.003, market research 0.013, material and process substitution 0.000, standard costing 0.024, kaizen costing 0.009 and circular economy 0.000. The study of [33] confirms significant difference in level of awareness of circular economy based on educational training of the respondents.

Table 5. Difference in level of awareness of cost reduction techniques by participants' professional background.

Cost Reduction Techniques	Architect		Quantity Surveyor		Builder		Civil/Structural Engineer		Electrical Engineer		Mechanical Engineer		Others		Overall		Kruskal Wallis Test	
	M	R	M	R	M	R	M	R	M	R	M	R	M	R	M	R	Chi-Square	Asymp. Sig.
Supply Chain Management	4.00	4	4.40	1	4.60	3	4.35	3	3.67	7	3.00	11	4.32	2	4.26	1	15.406	0.017*
Target Value Design	4.23	1	4.37	2	4.50	9	4.31	5	4.33	1	3.50	5	3.84	9	4.25	2	8.296	0.217
Budget Control	4.00	4	4.16	4	4.60	3	4.35	3	4.33	1	2.50	15	4.32	2	4.20	3	11.350	0.078
Earned Value Analysis	4.00	4	3.81	7	4.60	3	4.38	1	4.00	3	4.00	1	4.26	5	4.10	4	10.232	0.115
Value Analysis/Engineering	4.07	3	4.23	3	4.30	14	3.96	11	3.67	7	3.50	5	4.05	7	4.10	4	5.475	0.485
Target Costing	4.10	2	4.14	5	4.60	3	4.04	7	4.00	3	3.50	5	3.47		4.04	6	10.126	0.119
Cost-benefit Analysis	3.83	9	4.09	6	4.60	3	4.00	8	3.33	15	3.00	11	4.21	6	4.04	6	10.803	0.095
Onsite Project Resource Control Technique	3.83	9	3.51	9	4.80	1	4.00	8	4.00	3	4.00	1	4.53	1	3.94	8	27.208	0.000*
Simplification and Standardization of units	3.90	8	3.58	8	4.70	2	4.38	1	3.67	7	4.00	1	3.79	11	3.93	9	20.043	0.003*
Market Research	3.93	7	3.44	11	4.50	9	4.00	8	3.67	7	4.00	1	4.32	2	3.88	10	16.105	0.013*
Activity Based Costing	3.77	13	3.49	10	4.40	12	3.88	14	3.67	7	3.50	5	3.95	8	3.77	11	10.388	0.109
Material and Process Substitution	3.83	9	3.14	15	4.60	3	4.31	5	4.00	3	3.00	11	3.74	12	3.74	12	24.184	0.000*
Standard Costing	3.73	14	3.26	14	4.40	12	3.92	12	3.67	7	3.00	11	3.68	13	3.65	13	14.577	0.024*
Kaizen Costing	3.83	9	3.33	13	4.50	9	3.62	15	3.67	7	2.50	15	3.53	14	3.61	14	17.221	0.009*
Automation	3.67	16	3.35	12	4.30	14	3.54	16	3.00	16	3.50	5	3.53	14	3.55	15	8.881	0.180
Circular Economy	3.70	15	2.47	16	4.20	16	3.92	12	3.67	7	3.50	5	3.84	9	3.40	16	32.671	0.000*

4 Conclusion

The study assessed project participants' awareness of cost-reduction techniques in delivering educational building projects in Nigeria. The TETFund, higher education institutions IGR and private organisation donors funded the educational building projects in public HEIs.

Based on the study's findings, the level of awareness of cost-reduction techniques among project participants in educational buildings in Nigeria is commendable. However, there is a significant difference in respondents' level of awareness based on years of experience on the techniques such as budget control, onsite project resource control techniques, simplification and standardisation, market research, activity-based costing, material and process substitution, and standard costing. Significant difference also exist based on professional background on techniques such as supply chain management, onsite project resource control techniques, simplification and standardisation, market research, material and process substitution, standard costing, kaizen costing and circular economy.

The practical implication of this study's findings will aid the stakeholders in delivering educational building projects within the estimated budget and schedule based on the understanding and application of cost reduction techniques. The finding will also aid the project monitoring team in measuring the cost, time and quality performance of delivering educational building projects in public HEIs in Nigeria and avoid project delay, uncompleted projects and cost and time overrun. The findings of this study are limited because it only involves the opinion of the professionals involved in public higher education institutions in southwestern Nigeria. Further study can be carried out with a larger population involving professionals in the construction industry generally without restricting their involvement in higher education buildings to compare their awareness level in cost reduction techniques. Also, further study can assess the impact of cost reduction techniques on project performance.

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