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Integrating 4IR Technologies into Quantity Surveying Education in Nigeria: A Strategy for Improving Employability Outcomes

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Abstract: The Fourth Industrial Revolution (4IR) is reshaping the global construction sector through advanced digital tools such as Artificial Intelligence (AI), Building Information Modelling (BIM), Big Data, and the Internet of Things (IoT). However, quantity surveying (QS) education in Nigeria remains largely traditional, creating a digital competency gap that undermines graduate employability. This study examines the integration of 4IR technologies into QS education, identifies structural deficiencies within the Nigerian curriculum, and proposes strategic reforms to align academic training with industry needs. A quantitative survey of 250 respondents, including academics, practitioners, and regulatory representatives, was analyzed using Mean Item Score (MIS), Factor Analysis (FA), and Kruskal–Wallis tests. Results reveal high awareness but low adoption of advanced 4IR tools, highlighting systemic challenges in institutional readiness, digital infrastructure, and faculty training. The study recommends a dual reform approach: visionary strategic initiatives such as digital labs supported by institutional implementation frameworks. These findings provide practical guidance for educators, policymakers, and professional bodies seeking to modernize QS education for global competitiveness in the 4IR era.

Keywords: curriculum reform; digital technologies; employability; Fourth Industrial Revolution; quantity surveying

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Introduction

The 4IR integrates digital, physical, and biological systems to transform how industries operate (Schwab, 2016). Technologies such as AI, big data, blockchain, and the Internet of Things (IoT) are revolutionizing industrial processes and workforce expectations (Gamal et al., 2024; Hossain, 2023). Education, particularly within the built environment, is among the most impacted sectors, demanding curriculum redesign and pedagogical innovation (Krishnannair et al., 2021; Bühler et al., 2022). In Nigeria, QS education remains largely conventional, emphasizing manual measurement and traditional cost estimation approaches, with limited incorporation of 4IR competencies (Ebekozien & Aigbavboa, 2024). Such an approach creates a disconnect between academic training and the digital demands of modern QS practice. Consequently, it is imperative to revise the QS curriculum to synchronize academic training with business demands.

The construction and built environment sectors are crucial to global infrastructure development and are undergoing significant transformations due to the 4IR. Y.q. et al. 2022 noted that the construction industry is advancing due to technological developments; however, the developed nations have responded vigorously to these disruptions (Gamal et al., 2024). Nevertheless, adoption is still limited in developing countries, particularly in Nigeria (Ebekozien & Aigbavboa, 2024). Quantity surveying is crucial for cost management, project valuation, and resource efficiency (Yi et al. (2022)), which historically relied on manual processes and basic tools. The implementation of advanced technologies, such as BIM, AI-driven cost estimation, and digital project management systems, has transformed the practice of quantity surveying (Oke et al., 2022). Deshapriya et al. (2025) emphasized that the vast data handled by quantity surveyors necessitates digital solutions to enhance accuracy, decision-making, and interdisciplinary collaboration. Despite the rapid advancement of technology, the educational system has been slow to integrate new developments into pedagogy, particularly in STEM education (Oke & Fernandes, 2020). Lim et al. (2024) underscored the imperative for higher education institutions to include 4IR technologies in QS education at an early stage, preparing graduates to adequately meet industrial demands. Research has examined curriculum improvement and critical soft skills that enhance graduates' employability. Studies highlight the significance of industry-academia collaborations in bringing curricula into alignment with industrial norms. However, a disconnect persists between students' academic achievements and industry expectations (Ogundipe, 2018; Pandian, 2010; Watters, 2014). Oke and Ayodele (2019) observed that most Nigerian universities persist in following a traditional QS curriculum focused on construction technology, building services, regulation, economics, and measurement. While these courses are vital, they require frequent revisions to align with evolving business standards. This research aims to assess the awareness and implementation of 4IR technology in quantity surveying education and practice. It seeks to identify deficiencies in the existing curriculum and propose strategic improvements. The outcomes of this study will facilitate the development of a more adaptable and industry-relevant QS curriculum in Nigeria, ensuring that graduates acquire the necessary digital competencies to thrive in the evolving construction business.

Literature review

Construction syllabi in Nigeria have long been criticized for their limited global perspective and outdated structure. Olanrewaju and Anahve (2015) observed that many programmes exclude interdisciplinary courses such as political science, which are vital for contemporary construction planning, while Towey (2011) noted that environmental planning and administration remain poorly integrated. Despite accreditation by the Quantity Surveyors Registration Board of Nigeria (QSRBN) and alignment with National Universities Commission (NUC) standards, most QS programmes remain content-heavy, emphasizing construction economics, project management, and measurement with minimal attention to digital competencies. Approximately 40 universities in Nigeria offer QS degrees, and this study focuses on five key federal universities in the southwest, i.e. the University of Ibadan, the University of Lagos, Obafemi Awolowo University, the Federal University of Technology Akure, and the Federal University of Technology Oye-Ekiti. The five-year curriculum includes ten semesters of coursework and a six-month industrial placement, yet a review of course outlines reveals minimal integration of digital technologies, underscoring the urgent need for curriculum modernization to align with 4IR developments. The construction industry is being reshaped globally by 4IR technologies that enhance cost efficiency, data security, productivity, and project delivery (Ebekozien & Aigbavboa, 2024). For quantity surveyors, digitalization is redefining professional roles and workflows, requiring adaptability to large-scale data management and advanced digital tools (Lim et al., 2024). Studies highlight a growing portfolio of 4IR applications relevant to QS practice, such as Microsoft Excel, Bluebeam Revu, Revit, CostX, BIM 360, and Navisworks, each offering unique capabilities in cost modelling, documentation, and collaboration. Deshapriya et al. (2025) identified 22 core tools spanning document management, data analytics, AI, machine learning (ML), and BIM applications. Integrating these technologies into QS education is essential for equipping graduates with the digital competencies and innovative mindset required to meet evolving construction industry demands and global standards.

The evolving nature of the construction industry and QS practice necessitates integrating digital technologies such as BIM and CostX (Ebekozien & Aigbavboa, 2024). However, Yogeshwaran et al. (2018) noted that the adoption of 4IR tools remains low in developing countries like Nigeria. Ayoko et al. (2023) highlighted the NUC's plan to introduce new Core Curriculum Minimum Academic Standards to enhance graduate competitiveness. Despite this, QS education in Nigeria has yet to align core competencies with industry demands driven by digital technologies (Ebekozien & Aigbavboa, 2024). Recent studies reveal significant gaps in the QS curriculum, particularly in digital literacy, technology integration, and practical training. Ibim and Dapiriteye (2023) stated that the current curriculum does not adequately equip students with the necessary skills for professional careers. They emphasized the need for IT integration to meet modern industry demands. Odubiyi (2018) highlighted the gap between academic knowledge and practical application, noting that QS graduates often lack hands-on experience. Poor orientation, ineffective teaching methods, and limited site visits hinder students' readiness for practice (Ibim & Dapiriteye, 2023). Additionally, pointed out employers' concerns regarding graduates' deficiencies in essential soft skills. To address these challenges, QS education in Nigeria must integrate technology-driven courses, expand practical training opportunities, and foster stronger industry-academic collaborations.

The 4IR requires a change in how QS education and training are done. Strategic reforms should prioritize technology integration, industry collaboration, continuous learning, and soft skills development. Ebekozien and Aigbavboa (2024) and Aghimien et al. (2020) emphasize the importance of integrating BIM and digital tools into built environment programmes, aligning with Education 4.0 initiatives. Oke and Fernandes (2020) assert that professionals must embrace technological advancements to remain relevant. Innovative pedagogical methods, such as simulations, can prepare students for real-world applications. Lifelong learning programmes and continuous professional development are essential to bridging knowledge gaps in 4IR challenges (Gamal et al., 2024). Beyond technical expertise, QS professionals require soft skills, including communication, leadership, teamwork, and decision-making, to thrive in the 4IR era (Liebenberg and Els 2022). Ebekozien and Aigbavboa (2024) emphasize the significance of transformative competencies in Education 4.0. Interdisciplinary projects and stakeholder collaboration foster these skills and enhance employability in the built environment (Yi et al. (2022); Gamal et al., 2024). By incorporating soft skills training and interdisciplinary projects into QS education, students can develop competencies needed for the evolving construction industry (Hossain, 2023). Establishing QS innovation hubs within universities can encourage research and experimentation with digital tools, fostering innovative solutions to construction challenges (Kayembe & Nel, 2019). Ali et al. (2021) suggest that policies mandating 4IR technologies in accreditation criteria can drive meaningful curriculum reforms. Implementing these strategic changes will enhance Nigerian QS graduates' employability and global competitiveness.

Methods and data

The study employed a quantitative research approach, using structured questionnaires to collect and statistically analyze numerical data. A survey design was adopted, as it is well suited for assessing perceptions and trends within defined populations, particularly in educational and professional contexts (Creswell & Creswell, 2022). Both random and purposive sampling techniques were applied. Random sampling covered respondents from academia, including five QS departments and consulting firms in Southwest Nigeria, while purposive sampling targeted representatives of the NUC and QSRBN due to their limited population (Etikan et al., 2016). A total of 287 questionnaires were distributed, yielding 250 valid responses, representing an 87% response rate.

Data analysis utilized several statistical tools. The Mean Item Score (MIS) ranked factors by importance, while the Standard Deviation (SD) showed how different the responses were. Factor Analysis (FA) was applied to identify latent relationships among variables. With a sample size of 250, 19 perceived deficiencies, and 13 proposed reforms, FA was appropriate, meeting the recommended variable-to-sample ratio of 1:5 (Lingard & Rowlinson). The Kruskal–Wallis test, a non-parametric method, was also conducted to determine statistically significant differences among groups such as academics, practitioners, and regulatory representatives. The analytical process followed best practices for quantitative educational research (Creswell & Creswell, 2022).

Results of findings

This section presents the respondents' background for the study: 18.4% are from academia, 78.0% are practicing quantity surveyors, 2% represent the Quantity Surveying Registration Board of Nigeria, and 1.6% represent the Nigerian Universities Commission. Regarding professional registration, 83.6% are certified members of the Nigeria Institute of Quantity Surveyors, while 16.4% are fellows. In terms of work experience, 24.4% have 6–10 years, 37.2% have 11–15 years, 25.2% have 16–20 years, and 13.2% have over 21 years of experience. As for academic qualifications, 0.8% hold an HND, 6.4% have a PGD, 38% have a BSc/B.Tech, 41.6% have an MSc/M.Tech, and 13.2% have a PhD. Regarding 4IR training relevant to quantity surveying, 63.2% have received relevant training or certification, while 36.8% have not. Concerning familiarity with the current QS curriculum, 58% are very familiar, while 42% are somewhat familiar. The respondent composition ensures industry relevance but highlights a digital gap, stressing the need for 4IR integration, stronger industry-academia collaboration, and curriculum reforms to improve employability and align QS education with evolving technological demands.

Survey Result on Awareness and Adoption Levels of 4IR Tools for QS Practice

Table 1 presents the ten most recognized 4IR tools in QS practice, with Microsoft Excel ranking highest (MIS = 4.65; SD = 0.519), followed by Bluebeam Revu (MIS = 4.07; SD = 0.614) and QsCard (MIS = 4.07; SD = 0.702). Other tools in the top 10 include Microsoft Project, Master Bill, AI, Mobile App, Revit, Autodesk Quantity Take-Off, and WinQs. The five least recognized tools are Document Management System (MIS = 3.04; SD = 1.180), Primavera (MIS = 2.92; SD = 1.129), Big Data (MIS = 2.90; SD = 1.262), Data Analytics and Visualization Tools (MIS = 2.84; SD = 0.880), and CATa (MIS = 2.42; SD = 0.852). In terms of adoption, the top 10 tools are Microsoft Excel (MIS = 4.28; SD = 0.870), Microsoft Project (MIS = 3.59; SD = 0.767), Mobile App (MIS = 3.45; SD = 0.728), QsCard (MIS = 3.14; SD = 0.857), Master Bill (MIS = 3.13; SD = 0.882), and others like Surveying Tools, Revit, Autodesk Quantity Take-Off, WinQs, and Qs Plus. The five least adopted tools are Data Analytics and Visualization Tools (MIS = 2.39; SD = 0.972), Big Data (MIS = 2.30; SD = 0.772), and others. The data indicate moderate to high awareness and low to moderate adoption of 4IR tools in QS practice.

Table 1. Level of awareness and adoption of 4IR tools for QS practice

	Awareness Level			Adoption Level		
4IR Tech/ Tools for QS	**MIS**	**SD**	**Rank**	**MIS**	**SD**	**Rank**
Microsoft Excel	4.65	0.519	1	4.28	0.870	1
Bluebeam Revu	4.07	0.614	2	2.59	0.702	14
QsCard	4.07	0.702	3	3.14	0.857	4
Microsoft Project	4.01	0.799	4	3.59	0.767	2
Master Bill	3.96	0.730	5	3.13	0.882	5
AI	3.90	0.689	6	2.72	1.173	12
Mobile App	3.76	0.912	7	3.45	0.728	3
Revit,	3.70	1.142	8	3.04	0.743	7
Autodesk Quantity Take-Off	3.66	0.587	9	3.01	0.662	8
WinQs	3.63	0.837	10	2.82	0.833	9
Surveying Tools	3.61	0.737	11	3.08	0.978	6
Qs Plus	3.54	0.846	12	2.81	0.983	10
CostX	3.47	1.076	13	2.53	0.628	15
Navi Work	3.40	1.154	14	2.77	1.075	11
ML	3.35	1.047	15	1.99	0.916	22
Buildspace,	3.11	0.927	16	2.08	0.765	20
BIM 360	3.04	0.975	17	2.40	0.745	17
Document Management System	3.04	1.180	18	2.52	0.937	16
Primavera	2.92	1.129	19	2.71	2.942	13
Big Data	2.90	1.262	20	2.30	0.772	19
Data Analytics and Visualization Tools	2.84	0.880	21	2.39	0.972	18
CATa,	2.42	0.852	22	2.05	0.921	21

Awareness–Adoption Gap of 4IR Tools

Table 2 presents a gap analysis comparing the awareness and adoption of 4IR tools for QS practice. Respondents showed high awareness but low adoption of key 4IR tools. Microsoft Excel ranked highest in both awareness (MIS = 4.65) and adoption (MIS = 4.28), whereas advanced tools such as Bluebeam Revu (Gap = 1.48), ML (Gap = 1.36), and AI (Gap = 1.18) exhibited wide disparities. These findings indicate that Nigerian QS professionals understand the importance of 4IR tools but face structural and institutional barriers to practical implementation. In contrast, the low gap for foundational tools like Excel and mobile apps suggests reliance on traditional digital methods rather than true technological transformation.

Table 2. Gap analysis on awareness and adoption levels of 4IR tools

	Level of Awareness		Level of Adoption			Rank
4IR Tech/ Tools for QS	**MIS**	**Rank**	**MIS**	**Rank**	**Mean Gap**	
Microsoft Excel	4.65	1	4.28	1	0.37	3
Bluebeam Revu	4.07	2	2.59	14	1.48	22
QsCard	4.07	3	3.14	4	0.93	17
Microsoft Project	4.01	4	3.59	2	0.42	5
Master Bill	3.96	5	3.13	5	0.83	16
AI	3.90	6	2.72	12	1.18	20
Mobile App	3,76	7	3.45	3	0.31	2
Revit,	3.70	8	3.04	7	0.66	12
Autodesk Quantity Take-Off	3.66	9	3.01	8	0.65	11
WinQs	3.63	10	2.82	9	0.81	15
Surveying Tools	3.61	11	3.08	6	0.53	8
Qs Plus	3.54	12	2.81	10	0.73	14
CostX	3.47	13	2.53	15	0.94	18
Navi Work	3.40	14	2.71	11	0.69	13
ML	3.35	15	1.99	22	1.36	21
Buildspace,	3.11	16	2.08	20	1.03	19
BIM 360	3.04	17	2.40	17	0.64	10
Document Management System	3.04	18	2.52	16	0.52	7
Primavera	2.92	19	2.71	13	0.21	1
Big Data	2.90	20	2.30	19	0.60	9
Data Analytics and Visualization Tools	2.84	21	2.39	18	0.45	6
CATa,	2.42	22	2.05	21	0.37	4

Test on the Awareness Level of 4IR Tools for QS Practice

Hypothesis 1: There is no significant difference in the level of awareness of 4IR tools for QS practice based on the opinion of respondents' roles and affiliations.

The Kruskal–Wallis test as presented in Table 3 assessed whether respondents' perceptions of 4IR tools differed significantly across four professional groups: academics, practicing quantity surveyors, QSRBN representatives, and NUC representatives. Results revealed that perceptions varied significantly for thirteen of the twenty-two tools ($p \leq 0.05$), indicating inconsistent levels of digital awareness among respondent categories. In particular, tools such as BIM 360, AI, and Primavera recorded statistically significant differences, suggesting a fragmented digital vision between academia, industry, and regulators. Conversely, awareness levels for tools like Bluebeam Revu, Mobile Apps, Revit, WinQS, QS Plus, CostX, Navisworks, ML, and Document Management Systems did not differ significantly ($p > 0.05$), demonstrating relatively uniform familiarity across all respondent groups.

Table 3. Test on awareness level of 4IR tools

4IR Tech/ Tools for QS	**MIS**	**Rank**	**Chi-Square**	**Asymp. Sig.**
Microsoft Excel	4.65	1	18.503	0.000
Bluebeam Revu	4.07	2	6.271	0.099
QsCard	4.07	3	20.884	0.000
Microsoft Project	4.01	4	15.402	0.002
Master Bill	3.96	5	17.418	0.001
AI	3.90	6	13.622	0.004
Mobile App	3,76	7	5.658	0.129
Revit,	3.70	8	2.341	0.505
Autodesk Quantity Take-Off	3.66	9	11.503	0.009
WinQs	3.63	10	2.409	0.492
Surveying Tools	3.61	11	6.758	0.080
Qs Plus	3.54	12	6.408	0,093
CostX	3.47	13	0.625	0.888
Navi Work	3.40	14	6.671	0.083
ML	3.35	15	0.458	0.928

(*Continued*)

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Table 3. (Continued)

4IR Tech/ Tools for QS	MIS	Rank	Chi-Square	Asymp. Sig.
Buildspace,	3.11	16	15.098	0.002
BIM 360	3.04	17	22.142	0.000
Document Management System	3.04	18	0.612	0.894
Primavera	2.92	19	21.169	0.000
Big Data	2.90	20	12.255	0.007
Data Analytics and Visualization Tools	2.84	21	20.600	0.000
CATa,	2.42	22	15.403	0.002

Test on the Adoption Level of 4IR Tools for QS Practice

Hypothesis 2: There is no significant difference in the level of adoption of 4IR Tools for QS practice based on the opinion of respondents' years of working experience.

Table 4 presents the Kruskal–Wallis test results assessing differences in respondents' perceptions of 4IR tool adoption across five experience categories: 1–5 years, 6–10 years, 11–15 years, 16–20 years, and over 21 years. The test retained the null hypothesis (H_0) for thirteen out of the twenty-two tools ($p > 0.05$), indicating no statistically significant difference in perceptions among experience levels. This suggests generally consistent views on 4IR adoption among respondents. However, results also reveal that older professionals tend to adopt 4IR technologies less frequently, likely due to limited exposure or resistance to change. Notably, BIM-related tools such as Revit and Primavera exhibited significant differences ($p \leq 0.05$), implying that adoption capacity varies with professional experience and highlighting the importance of training interventions tailored to different experience levels.

Table 4. Test on adoption Level of 4IR tools

4IR Tech/ Tools for QS	MIS	Rank	Chi-Square	Asymp. Sig.
Microsoft Excel	4.28	1	17.081	0.001
Microsoft Project	3.59	2	49.193	0.000
Mobile App	3.45	3	8.687	0.034
QsCard	3.14	4	9.417	0.024
Master Bill	3.13	5	3.443	0.328
Surveying Tools	3.08	6	5.204	0.157
Revit,	3.04	7	18.171	0.000
Autodesk Quantity Take-Off	3.01	8	2.109	0.550
WinQs	2.82	9	5.278	0,153
Qs Plus	2.81	10	1.144	0.767
Navi Work	2.77	11	5.995	0.112
AI	2.72	12	5.995	0.133
Primavera	2.71	13	30.331	0.000
Bluebeam Revu	2.59	14	0.314	0.957
CostX	2.53	15	6.425	0.092
Document Management System	2.52	16	18.914	0.000
BIM 360	2.40	17	21.695	0.000
Data Analytics and Visualization Tools	2.39	18	5.134	0.162
Big Data	2.30	19	1.225	0.747
Buildspace,	2.08	20	9.992	0.020
CATa,	2.05	21	5.973	0.076
ML	1.99	22	10.702	0.013

Survey Results on Deficiencies in QS Education Relative to 4IR

Table 5 presents the mean scores of survey respondents regarding perceived deficiencies in QS education and curriculum in federal universities in Nigeria. The top ten deficiencies include inadequate staff development programmes on 4IR tools/technologies (MIS = 4.28; SD = 0.843), limited incorporation of VR/AR (MIS = 4.22; SD = 0.679), and limited industry partnerships with experts (MIS = 4.17; SD = 0.959). Other significant deficiencies include insufficient coverage of data analytics (MIS = 4.11; SD = 0.787), poor/unreliable internet connectivity (MIS = 4.09; SD = 0.869), and limited industry internships on 4IR tools (MIS = 4.09; SD = 0.914). Non-inclusion of modern technologies in the curriculum (MIS = 4.04; SD = 1.084), inadequate collaboration with industry experts (MIS = 3.97; SD = 0.875), and inadequate computer labs (MIS = 3.90; SD = 0.786) also ranked high. The five least-rated deficiencies are limited access to digital resources (MIS = 3.63; SD = 0.812), outdated software and tools (MIS = 3.61; SD = 1.338), lack of digital literacy skills/assessment (MIS = 3.55; SD = 1.212), inadequate career counselling (MIS = 3.14; SD = 1.324), and infrequent guest lectures/workshops (MIS = 3.12; SD = 1.227). The mean ratings, ranging from 3.12 to 4.28, indicate a high level of impact these deficiencies have on QS education and curriculum concerning 4IR in Nigerian universities.

Table 5. Mean rating of deficiencies in QS education relative to 4IR

Statement	MIS	SD	Rank
Inadequate staff development programs on 4IR tools/technologies	4.28	0.843	1
Limited incorporation of VR/AR.	4.22	0.679	2
Limited industry partnerships with industry experts.	4.17	0.959	3
Insufficient coverage/training in data analytics	4.11	0.787	4
Poor/unreliable internet connectivity	4.09	0.869	5
Limited industry partnerships for internships on 4IR tools/technologies	4.09	0.914	6
Non-inclusion of modern/emerging technologies in the QS Curriculum	4.04	1.084	7
Inadequate collaboration with industry experts	3.97	0.875	8
Inadequate/insufficient computer labs	3.90	0.786	9
Inadequate integration of BIM	3.89	0.750	10
Inadequate feedback mechanisms	3.84	0.848	11
Lack of faculty training on 4IR.	3.82	1.018	12
Overemphasis on theoretical knowledge over practical skills.	3.79	1.012	13
Limited soft skills development programs	3.73	1.028	14
Limited access to digital resources	3.63	0.812	15
Used outdated software and tools	3.61	1.338	16
Lack of digital literacy skills/assessment	3.55	1.212	17
Inadequate career counseling and guidance:	3.14	1.324	18
Infrequent guest lectures and workshops	3.12	1.227	19

A factor analysis (FA) was conducted to identify groups of deficiencies in QS education related to 4IR. To confirm the suitability of FA, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity were used, as shown in Table 6. The KMO tests the degree of partial correlation among variables, with values closer to 1.0 considered ideal. A value above 0.7 is desirable, and above 0.6 is acceptable for smaller sample sizes (Shrestha 2021). The study revealed a KMO value of 0.687, indicating strong partial correlations, justifying the use of factor analysis.

Table 6. Results of reliability tests

KMO and Bartlett's Test		
Kaiser- Meyer- Olkin Measure of Sampling Adequacy		0.687
Bartlett's Test of Sphericity	Approx. Chi-Square	93.063
	df	36
	Sig.	0.000

Bartlett's Test of Sphericity is a statistical tool used to determine if the correlation matrix is an identity matrix, indicating that the variables are independent and unsuitable for factor analysis. A significant result ($p < 0.05$) suggests that the correlation matrix is not an identity matrix. In this study, Bartlett's test produced a large chi-square value of 93.063 with a significance value of $p = 0.00$, confirming that the correlation matrix is not an identity matrix. Tables 7 and 8 display the four-factor solution derived from principal factor extraction with varimax rotation, where eigenvalues exceed 1.0. Varimax rotation was used to simplify interpretation by grouping variables under principal component factors (Osei-Kyei et al. 2017). All variables had factor loadings of 0.50 or higher, with eleven exceeding 0.70. This confirms the appropriateness of the survey data for factor analysis. The factors are categorized as follows: eleven variables under Component 1, five under Component 2, two under Component 3, and one under Component 4.

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Table 7. Rotated component matrix of deficiencies in QS education relative to 4IR

Rotated Component Matrix				
	Component			
	1	**2**	**3**	**4**
Non-inclusion of modern/emerging technologies in the QS curriculum	0.673			
Used outdated software and tools	0.942			
Overemphasis on theoretical knowledge over practical skills.	0.746			
Lack of faculty training on 4IR.	0.889			
Inadequate/insufficient computer labs	0.632			
Limited access to digital resources	0.635			
Lack of digital literacy skills/assessment	0.937			
Inadequate feedback mechanisms	0.588			
Infrequent guest lectures and workshops	0.926			
Inadequate career counseling and guidance:	0.808			
Limited soft skills development programs	0.715			
Insufficient coverage/training in data analytics		0.888		
Limited incorporation of VR/AR.		0.602		
Inadequate staff development programs on 4IR tools/technologies		0.803		
Limited industry partnerships for internships on 4IR tools/technologies		0.660		
Inadequate collaboration with industry experts		0.957		
Limited industry partnerships with industry experts.			0.667	
Poor/unreliable internet connectivity			0.753	
Inadequate integration of BIM				0.604

Table 8. Mean rating, factor groups, and Eigenvalues of deficiencies in QS education relative to 4IR

Statement	**MIS**	**SD**	**Factor Loading**	**Eigen-Value**	**% of Variance**	**Cum, % Variance**
Instructional and Pedagogic Deficit	**3.65**			**7.122**	**37.484**	**37.484**
Non-inclusion of modern/emerging technologies in the QS curriculum	4.04	1.064	0.673			
Inadequate/insufficient computer labs	3.90	0.786	0.632			
Inadequate feedback mechanisms	3.84	0.848	0.588			
Lack of faculty training on 4IR.	3.82	1.018	0.889			
Overemphasis on theoretical knowledge over practical skills.	3.79	1.012	0.746			
Limited soft skills development programs	3.73	1.028	0.715			
Limited access to digital resources	3.63	0.812	0.635			
Used outdated software and tools	3.61	1.338	0.942			
Lack of digital literacy skills/ assessment	3,55	1.212	0.937			
Inadequate career counseling and guidance:	3.14	1.324	0.808			
Infrequent guest lectures and workshops	3.12	1.227	0.926			
Faculty Readiness and Applied Skills Gap	**4.13**			**4.421**	**23.267**	**60.751**
Inadequate staff development programs on 4IR tools/technologies	4.28	0.843	0.803			
Limited incorporation of VR/AR.	4.22	0.679	0.602			
Insufficient coverage/training in data analytics	4.11	0.787	0.888			
Limited industry partnerships for internships on 4IR tools/technologies	4.09	0.914	0.660			
Inadequate collaboration with industry experts	3.97	0.875	0.957			

(*Continued*)

Table 8. (Continued)

Statement	MIS	SD	Factor Loading	Eigen-Value	% of Variance	Cum, % Variance
Digital Infrastructure & Collaboration Deficit	**4.13**			**3.101**	**16.320**	**77.071**
Limited industry partnerships with industry experts.	4.17	0.959	0.667			
Poor/unreliable internet connectivity	4.09	0.869	0.753			
BIM Integration Deficit	**3.89**			**1.750**	**9.211**	**86.282**
Inadequate integration of BIM	3.89	0,750	0.604			

Table 8 presents the analysis of the 19 deficiencies in QS education related to 4IR, including factor loadings, eigenvalues, percentage of variance explained, and cumulative variance. The four extracted factors, with eigenvalues greater than 1, account for 86.28% of the total variance, indicating their sufficiency in representing the deficiencies. These factors are labelled as follows: Instructional and Pedagogic Deficit, Faculty Readiness and Applied Skills Gap, Digital Infrastructure & Collaboration Deficit, and BIM Integration Deficit. These findings emphasize institutional shortcomings rather than practitioner failure, pointing to the need for system-level reforms.

Survey Results on Proposed Strategic Reforms to QS Education Relative to 4IR

Table 9 shows the mean scores for strategic reforms to QS education relative to 4IR in Nigerian federal universities. The top five proposed reforms are the development of AI-based cost modelling courses (MIS = 4.53; SD = 0.602), regular curriculum reviews to incorporate evolving 4IR trends (MIS = 4.47; SD = 0.553), investment in smart classrooms with virtual and augmented reality (MIS = 4.48; SD = 0.538), establishment of digital QS laboratories/innovation hubs (MIS = 4.45; SD = 0.750), and training programs for faculty on emerging QS technologies (MIS = 4.44; SD = 0.559). The least ranked reforms are the inclusion of data analytics as a core QS subject (MIS = 4.14; SD = 0.892), the establishment of mandatory internships using 4IR technologies (MIS = 4.12; SD = 0.801), and government funding for QS digital education initiatives (MIS = 4.03; SD = 1.041). The mean ratings between 4.03 and 4.53 indicate the urgent need for these reforms to transform QS education and practice in the 4IR era.

Table 9. Mean rating of strategic reforms to QS education relative to 4IR

Statements	MIS	SD	Rank
Development of AI-based cost modeling courses	4.53	0.602	1
Regular curriculum reviews to incorporate evolving 4IR trends	4.47	0.553	2
Investment in smart classrooms with virtual and augmented reality	4.48	0.538	3
Establishment of digital QS laboratories/ Innovation hubs in universities	4.45	0.750	4
Training programs for faculty on emerging QS technologies	4.44	0.559	5
Policy frameworks to mandate 4IR education in QS accreditation	4.38	0.534	6
Inclusion of BIM certification as part of QS training	4.36	0.522	7
Formation of industry-academia partnerships for knowledge exchange	4.36	0.727	8
Incorporation of real-life 4IR case studies in teaching methods	4.30	0.747	9
Development of online QS certification programs for digital proficiency	4.21	0.076	10
Inclusion of data analytics as a core QS subject	4.14	0.892	11
Establishment of mandatory internships in QS firms using 4IR technologies	4.12	0.801	12
Government funding for QS digital education initiatives	4.03	1.041	13

The Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of sphericity were conducted to assess the degree of partial correlation among variables and their strength. The results showed a KMO value of 0.742, indicating a strong partial correlation and significant information overlap among the variables. Bartlett's test produced a chi-square value of 5612.367 with a significance value of less than 0.05 ($p = 0.00$), suggesting that the population correlation matrix is not an identity matrix. Table 10 shows a two-factor solution obtained via principal factor extraction with varimax rotation. All 13 variables had factor loadings of 0.50 or higher. Ten of them were in Component 1 and three were in Component 2. The two major factors, accounting for 81.99% of the total variance, are labelled as follows: Smart Investment and Training in Digital Tools and Innovative QS Education/Research Collaboration Initiatives. These components highlight the importance of targeted investment and collaboration to drive 4IR reforms in QS education.

Table 10. Mean rating, factor groups, and Eigen-values of strategic reforms in QS education relative to 4IR

Propose Reforms	MIS	SD	Factor loading	Eigen - Value	% of Variance	Cum. % of Variance
Institutional Implementation Framework	**4.29**			**6.552**	**50.404**	**50.404**
Investment in smart classrooms with virtual and augmented reality	4.48	0.538	0.721			
Regular curriculum reviews to incorporate evolving 4IR trends	4.47	0.553	0.736			
Training programs for faculty on emerging QS technologies	4.44	0.559	0.703			
Policy frameworks to mandate 4IR education in QS accreditation	4.38	0.534	0.723			
Inclusion of BIM certification as part of QS training	4.36	0.552	0.742			
Incorporation of real-life 4IR case studies in teaching methods	4.30	0.747	0.867			
Development of online QS certification programs for digital proficiency	4.21	0.706	0.937			
Inclusion of data analytics as a core QS subject	4.14	0.892	0.961			
Establishment of mandatory internships in QS firms using 4IR technologies	4.12	0.801	0.883			
Government funding for QS digital education initiatives	4.03	1.041	0.705			
Visionary Strategic Initiatives	**4.45**			**4.107**	**31.591**	**81.995**
Development of AI-based cost modeling courses	4.53	0.602	0.812			
Establishment of digital QS laboratories/ Innovation hubs in universities	4.45	0.750	0.921			
Formation of industry-academia partnerships for knowledge exchange	4.36	0.727	0.906			

Discussion of findings

This study offers valuable insights into the state of quantity surveying (QS) education and practice in Nigeria within the context of 4IR advancements. Despite the widespread recognition of 4IR tools like Microsoft Excel, Bluebeam Revu, and QsCard, their practical application remains scarce. Ebekozien and Aigbavboa (2024) attributed this gap to limited digital competency in QS education, which hinders professional adoption of 4IR technologies. Similarly, Oke and Fernandes (2020) and Lim et al. (2024) reported that 4IR integration in Nigerian QS practice remains weak. The high awareness and adoption gap observed in this study highlights systemic barriers such as inadequate training, resistance to change, and insufficient infrastructure. These findings affirm that the challenges are largely institutional, stemming from underfunding, outdated curricula, and poor digital infrastructure rather than individual reluctance. This supports Lim et al.'s (2024) recommendation to embed 4IR tools early in QS education to bridge the digital skills gap.

The Kruskal–Wallis test further revealed significant differences in awareness levels among academia, practitioners, and regulatory agencies, indicating a fragmented digital vision across these groups. However, adoption levels were generally consistent across experience categories, with older professionals less inclined to adopt digital tools, reflecting Oni and Aina's (2020) observation that long-serving staff often resist technological change. Factor analysis identified four major clusters of deficiencies in QS education. The first, Instructional and Pedagogic Deficit, explained 37.48% of the variance (eigenvalue = 7.12) and comprised eleven variables with high loadings (0.588–0.942), indicating the absence of modern digital technologies in curricula and limited alignment with industry needs (Oke & Ayodele, 2019; Ebekozien & Aigbavboa, 2024; Aghimien et al., 2020). The second, Faculty Readiness and Applied Skills Gap, explained 23.27% of the variance (eigenvalue = 4.42) with five variables (loadings 0.602–0.957), pointing to weak collaboration between academia and industry practitioners, which limits exposure to real-world 4IR applications (Ibim & Dapiriteye, 2023). The third, Digital Infrastructure and Collaboration Deficit, explained 16.32% of the variance (eigenvalue = 3.10) with two variables (loadings 0.667 and 0.753), confirming Odubiyi's (2018) assertion that inadequate infrastructure constrains digital adoption. The 4IR, BIM Integration Deficit, accounted for 9.1% of the variance (eigenvalue = 1.75, loading 0.604), revealing that despite global attention on BIM, its systematic incorporation into Nigerian QS education remains limited (Olanrewaju & Anahve, 2015). Collectively, these four clusters explain over 86% of the total variance, demonstrating a profound structural digital lag that undermines the profession's competitiveness and responsiveness to global standards.

The study also categorized proposed reforms into two broad clusters. The first, Institutional Implementation Framework, consists of ten variables explaining 50.40% of the variance (eigenvalue = 6.55; loadings 0.703–0.961) and includes policy reforms, curriculum review, faculty training, and increased government funding. The second, Visionary Strategic Initiatives, includes three variables explaining 31.59% of the variance (eigenvalue = 4.11; loadings 0.812–0.921), emphasizing innovation-driven collaborations, digital research partnerships, and the establishment of QS technology hubs. These reforms align with global trends outlined by Gamal et al. (2024), who stress the need for QS education to evolve with digital transformations to enhance employability. Similarly, Ebekozien and Aigbavboa (2024) underscored the necessity of coordinated academia–industry partnerships to close persistent skills gaps. Together, these findings highlight that visionary reform in QS education cannot succeed without robust institutional commitment and sustainable financial support.

This study emphasizes the urgent need for a coordinated national strategy to integrate 4IR technologies into QS education and practice in Nigeria. Despite growing awareness of digital tools, adoption remains limited due to pedagogic, infrastructural, and institutional barriers. The findings call for comprehensive reforms to bridge the digital divide, improve employability, and align QS education with global Education 4.0 standards. A coherent 4IR integration framework should focus on four key priorities. First, curriculum reform must embed digital competencies such as BIM, AI-driven cost estimation, and data analytics into QS programmes to equip graduates with relevant and market-ready skills. Second, faculty capacity building should be prioritized through continuous professional development, workshops, and industry partnerships to strengthen digital teaching proficiency and reduce the academia–industry gap. Third, sustained investment in digital infrastructure is essential. Government agencies, the Nigerian Institute of Quantity Surveyors (NIQS), and regulatory bodies such as the NUC and QSRBN should fund and support the establishment of smart classrooms, digital QS laboratories, and improved internet connectivity. Finally, policy realignment and enforcement of digital accreditation standards are critical to ensure institutional accountability and continuous improvement.

Conclusion

The study concludes that Nigeria's QS education system stands at a defining moment in its evolution. While awareness of 4IR technologies is high, meaningful adoption remains constrained by structural and institutional weaknesses. Implementing targeted reforms by combining curriculum innovation, faculty development, digital infrastructure investment, and policy alignment will modernize QS education and strengthen its responsiveness to global technological trends. Sustained collaboration among universities, industry stakeholders, and regulatory bodies is essential to drive a unified digital transformation agenda that enhances graduate employability, supports national development goals, and positions the Nigerian QS profession for long-term competitiveness in the 4IR era.

Declarations

Interdisciplinary Scope: This article adopts an interdisciplinary approach by examining issues of digital transformation, and professional education within the context of Quantity Surveying (QS) education and Fourth Industrial Revolution (4IR) technologies. The insights provided are relevant to students and scholars across education, management, and the social sciences. Accordingly, the article contributes to broader interdisciplinary debates on research rigor, curriculum reform, and evidence-based decision-making.

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References

Aghimien, D., Aigbavboa, C., Oke, A., & Thwala, W. (2020). Digital competence and readiness in built environment education. *Engineering, Construction and Architectural Management*, *27*(10), 2601–2619. https://doi.org/10.1108/ECAM-11-2019-0602

Ali, B., Zahoor, H., Aibinu, A., Nasir, A. R., Tariq, A., Imran, U., & Khan, R. M. (2021). BIM aided information and visualization repository for managing construction delay claims. *Journal of Information Technology in Construction*, *26*(Dec), 1023–1040. https://doi.org/10.36680/j.itcon.2021.054

Ayoko, V. O., Peter, T., & Jegede, D. O. (2023). Inadequacy of infrastructural facilities in public universities in Nigeria: Causes, effects and solutions. *International Journal on Integrated Education*, *6*(3), 36–45.

Bühler, M. M., Jelinek, T., & Nübel, K. (2022). Training and preparing tomorrow's workforce for the Fourth Industrial Revolution. *Education Sciences*, *12*(11), 782. https://doi.org/10.3390/educsci12110782

Creswell, J. W., & Creswell, J. D. (2022). *Research design: Qualitative, quantitative, and mixed methods approaches*. (6th ed.). SAGE Publications.

Deshapriya, L. A. M., Perera, B. A. K. S., Ilangakoon, I. W. M. A. D., & Weerasooriya, D. (2025). Management of adverse effects of construction digitalization on the quantity surveying key roles: A qualitative Delphi study. *Journal of Engineering, Design and Technology*, *23*(6), 1815–1837. https://doi.org/10.1108/JEDT-04-2024-0239

Ebekozien, A., & Aigbavboa, C. O. (2024). Improving quantity surveying education through continually updating curriculum digitalisation to meet industry requirements. *Journal of Engineering, Design and Technology*, *22*(5), 1523–1543. https://doi.org/10.1108/JEDT-01-2022-0043

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, *5*(1), 1. https://doi.org/10.11648/j.ajtas.20160501.11

Gamal, M., Ibrahim, O. A., Hamed, H. F., & Abd-Elnaby, S. F. M. (2024). Engineering's next leap: How Fourth Industrial Revolution is shaping the future of the Industry. *ERURJ*, *3*(2), 970–992.

Hossain, K. A. (2023). Analysis of present and future use of Artificial Intelligence (AI) in line of the Fourth Industrial Revolution (4IR). *Scientific Research Journal (SCIRJ)*, *9*(8), ISSN.

Ibim, A. A., & Dapiriteye, A. (2023). The role of education in professional skills development in quantity surveying: Students' perspective on the curriculum of Nigerian tertiary institutions. *NOLEGEIN Journal of Organizational Behavior Management*, *6*(2). https://doi.org/10.37591/NJOBM

Kayembe, C. and Nel, D., 2019. Challenges and opportunities for education in the Fourth Industrial Revolution. *African Journal of Public Affai*rs, 11(3), pp.79-94.

Krishnannair, A., Krishnannair, S., & Krishnannair, S. (2021). Learning environments in higher education: Their adaptability to the 4th Industrial Revolution and the social transformation discourse. *South African Journal of Higher Education*, *35*(3), 65–82. https://doi.org/10.20853/35-3-4098

Liebenberg, G., & Els, M. M. (2022). The impact of the 4th industrial revolution on quantity surveying education in South Africa: A qualitative overview on soft skill requirements. In *Building smart, resilient and sustainable infrastructure in developing countries* (pp. 79–88). https://doi.org/10.1201/9781003325321-9

Lim, M. L. W., Wong, S. Y., & Ding, C. S. (2024). Challenges of industrial revolution 4.0: Quantity surveying students' perspectives. *Engineering, Construction and Architectural Management*, *31*(6), 2496–2512. https://doi.org/10.1108/ECAM-07-2022-0636

Odubiyi, T. B. (2018). Bridging the gap between academic quantity surveying and quantity surveying in practice. *Academia Journal of Educational Research*, *6*(7), 196–200.

Ogundipe, K. E. (2018). Missing Gaps in Safety Education and Practices: Academia Perspectives. *International Journal of Civil Engineering and Technology*, *9*(1), 273–289.

Oke, E. A., & Ayodele, T. D. (2019). Challenges of quantity surveying curriculum for construction industry practice in Ondo state, Nigeria. *Discovery*, *55*(278), 40–48.

Oke, A., & Fernandes, F. A. P. (2020). Innovations in teaching and learning: Exploring the perceptions of the education sector on the 4th Industrial Revolution (4IR). *Journal of Open Innovation*, *6*(2), 31. https://doi.org/10.3390/joitmc6020031

Oke, A. E., Kineber, A. F., Olanrewaju, O. I., Omole, O., Jamir Singh, P. S., Samsurijan, M. S., & Ramli, R. A. (2022). Exploring the 4IR drivers for sustainable residential building delivery from social work residential perspective: A structural equation modeling approach. *Sustainability*, *15*(1), 468. https://doi.org/10.3390/su15010468

Olanrewaju, A., & Anahve, P. J. (2015). Duties and responsibilities of quantity surveyors in the procurement of building services engineering. *Procedia Engineering*, *123*(8), 352–360. https://doi.org/10.1016/j.proeng.2015.10.046

Oni, O. J., & Aina, Y. J. (2020). Employers' perspectives on critical quantity surveying soft skills. *International Journal of Innovative Research and Advanced Studies (IJIRAS)*, *7*(8), 139–144.

Osei-Kyei, R., Chan, A. P., & Ameyaw, E. E. (2017). A fuzzy synthetic evaluation analysis of operational management critical success factors for public-private partnership infrastructure projects. *Benchmarking: An International Journal*, *24*(7), 2092–2112.

Pandian, A. (2010). University curriculum and employability needs. *Higher Education Leadership Research Bulletin*, *12*(2), 55–62.

Schwab, K. (2016). *The Fourth Industrial Revolution. World Economic Forum, 91–93 Route de la Capite, CH-1223 Cologny/Geneva, Switzerland*. www.weforum.org

Shrestha, N. (2021). Factor Analysis as a Tool for Survey Analysis. *American Journal of Applied Mathematics and Statistics*, *9*(1), 4–11. https://doi.org/10.12691/ajams-9-1-2

Towey, D. (2011). *Construction quantity surveying: A practical guide for the contractor's QS*. Wiley-Blackwell.

Watters, J. J. (2014). Vocational education in science, technology, engineering, and math (STEM). *Curriculum Innovation through School Industry Partnership*, 89–110.

Yi, Y. Q., Majid, A. S., Aziz, N. M., & Yang, L. W. (2022). Digitalization among the quantity surveyors: Strategies to embracing the change. *Journal of Project Management Practice*, *3*(1), 44–76. https://doi.org/10.22452/jpmp.vol3no1.3

Yogeshwaran, G., Perera, B. A. K. S., & Ariyachandra, M. R. M. F. (2018). Competencies expected of graduate quantity surveyors working in developing countries. *Journal of Financial Management of Property and Construction*, *23*(2), 202–220. https://doi.org/10.1108/JFMPC-06-2017-0019

Y.q., Y., A.s., A.-M., N.m., A., & L.w., Y. (2022). Digitalization Among the Quantity Surveyors: Strategies to Embracing the Change. *Journal of Project Management Practice*, *3*(1), 44–76. https://doi.org/10.22452/jpmp.vol3no1.3