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A risk-based audit framework for performance-driven on-the-job training quality in computing education: Evidence from a three-year sequential cohort study

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Abstract

In the Philippines, the quality of on-the-job training (OJT) in computing programs has generally been assessed using narrative supervisor ratings and completion checklists, instead of psychometrically validated instruments. This study conceptualizes the Committee of Sponsoring Organizations of the Treadway Commission's (COSO) Enterprise Risk Management (ERM) framework, Industry 4.0 readiness, BADIR analytics, and Kolb's Experiential Learning Theory (ELT) into a single conceptual framework to develop and validate an OJT assessment tool for governance purposes. A sequential-cohort, quantitative-dominant mixed-methods design with an embedded qualitative phase was used over a three-year period (SY 2023-2024 to 2025-2026), with a sample of 64 of 99 qualified trainees at a private Catholic educational institution in the Philippines. The instrument comprised eight constructs measured through five-point Likert-scale items and four open-ended items, analyzed using reliability, descriptive, comparative, correlational, and thematic analyses. The instrument demonstrated high overall reliability (Cronbach's alpha = .928), with construct means ranging from 4.30 to 4.62 and an Overall OJT Quality mean of 4.57. Analysis of variance confirmed temporal stability, showing no significant differences across cohorts. Key Performance Indicator (KPI)-Driven Performance and Control Environment showed the strongest correlations with Overall OJT Quality, and thematic analysis of open-ended responses largely confirmed these quantitative trends. The BSCS-specific Industry 4.0 subscale showed weak internal consistency and requires further refinement. Findings are exploratory, given the single-institution, modest sample, warranting larger multi-institutional validation. The results suggest that enterprise risk-management principles can be feasibly adapted into a psychometrically supported governance tool for OJT quality assurance in Philippine computing education.

Keywords: *work-integrated learning, COSO enterprise risk management, industry 4.0, key performance indicators, Philippine higher education*

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1. Introduction

On-the-job training (OJT) is a graduation requirement for all Philippine Bachelor of Science in Computer Science (BSCS) and Bachelor of Science in Information Technology (BSIT) programs (Commission on Higher Education [CHED], 2017a). Internationally, the same practice is known as an internship, cooperative education (co-op), or Work-Integrated Learning (WIL), and is similarly embedded in computing curricula worldwide through frameworks such as Computing Curricula 2020 (CC2020 Task Force, 2020). While OJT is a critical employability and Industry 4.0 skill-development mechanism, the quality of OJT in Philippine schools has typically been assessed through narrative supervisor assessments, completion rubrics, and program-specific checklists, with only a few instruments resting on a solid theoretical or psychometric foundation. Assessment scholarship has called strongly for evidence-based systems that yield valid, actionable outcome measures and the CC2020 Task Force (2020) has identified a continuing need for assessment tools relating OJT outcomes to program-specific competency areas, a need that remains under-developed in the Philippine context.

This need is amplified by industry demand for digitally literate, Industry 4.0–ready graduates (Li, 2022; Bouwmans et al., 2024; Chans et al., 2024; IBPAP, 2022), though recent research finds substantial contextual variability in Industry 4.0 assessment tools (Zamora Iribarren et al., 2024). Internship quality is further linked to competency development, employability, and successful workplace transition (Di Pietro, 2022; Al Barwani & Azam, 2023; Casugay et al., 2024), while KPI-based and learning-analytics approaches increasingly support evidence-based quality assurance in higher education (Miah et al., 2024; Maheshwari, 2014; Hernandez-Campos et al., 2025).

This study designs, validates, and deploys a KPI-Driven OJT Evaluation Instrument that integrates COSO ERM governance principles, Industry 4.0 competency mapping, BADIR analytics, and Kolb's (1984) Experiential Learning Theory (ELT) into a single, psychometrically defensible framework for evaluating OJT quality in Philippine computing education. To the authors' knowledge, no prior study has combined all four theoretical foundations within a single OJT evaluation framework in this context, a gap that is notable given the growing tendency of higher education institutions to adapt enterprise-wide risk-management frameworks to strengthen governance, accountability, and quality assurance (Bamber, 2023).

The framework rests on the premise that OJT quality is shaped not only by instructional exposure but also by program governance: within COSO ERM, reducing implementation uncertainty across the control environment, risk management, communication, and monitoring increases the likelihood of positive outcomes, and applied to OJT these mechanisms provide the structural context for competency development and experiential learning. The problem this study addresses is threefold: Philippine computing programs lack a psychometrically validated, governance-oriented OJT instrument; no prior instrument has combined COSO ERM, Industry 4.0, BADIR analytics, and Kolb's ELT into one framework; and Philippine computing-education governance broadly lacks evidence-based tools linking oversight to experiential-learning outcomes. Four research questions operationalize this problem:

RQ1. Does the proposed KPI-driven OJT evaluation instrument demonstrate adequate internal consistency reliability when deployed across three independent cohorts?

RQ2. Are there statistically significant differences in KPI achievement and OJT quality scores across the three sequential cohorts?

RQ3. Which COSO ERM, KPI-driven, and Industry 4.0 constructs demonstrate statistically significant associations with overall OJT program quality?

RQ4. How does the psychometric performance of the BSCS-specific Industry 4.0 subscale (I4CS) compare with that of the BSIT-specific subscale (I4IT), and what content-validity implications does this divergence have for the program-specific branching design of the instrument?

Answers to these questions provide empirical defensibility for the instrument and generate evidence-based recommendations to guide OJT program improvement, while serving as a reference for program replication across the Philippine computing-education sector.

2. Literature Review

2.1. On-the-Job Training, Internships, and Work-Integrated Learning Quality

Traditional methods of moving classroom learning to the workplace include OJT, internships, and Work-Integrated Learning (WIL). Philippine student internships are governed by the Revised Guidelines for Student Internship Program (CHED Memorandum Order [CMO] No. 104, s. 2017) with additional requirements for BSIT program under CMO No. 25, s. 2015 (Commission on Higher Education, 2015, 2017 b). Evidence from systematic reviews indicates that internships contribute to skill development, workforce readiness and successful transition to employment (Di Pietro, 2022). Evidence from comparative studies indicates that hard (technical) skills and soft (interpersonal) skills are both important to workplace readiness and neither is consistently more effective than the other (Franco-Ángel et al., 2023). Studies of Philippine IT and TVET trainees also find that supervision quality, monitoring, and task relevance remain persistent concerns (Al Barwani & Azam, 2023; Casugay et al., 2024). Policy analysis further shows that HEI, the host-organization relationships remain largely compliance-driven rather than quality-driven (Santillana, 2026). The quality of the internships has also been associated with the improvement of the soft skills and digital competence of the graduates (Musa et al., 2025). Thus, evaluation instruments of OJT must evaluate the quality of governance and the process as well as the learning outcomes.

2.2. COSO Enterprise Risk Management as a Governance Lens for OJT Quality

COSO's Enterprise Risk Management (ERM) framework was initially designed for corporate governance and information technology-audit applications and consists of five interconnected components: Control Environment, Risk Assessment, Control Activities, Information and Communication and Monitoring Activities (COSO, 2017). Higher education institutions (HEIs) increasingly embrace enterprise-wide risk-management frameworks in order to improve governance, accountability, and quality assurance (QA) (Bamber, 2023; Bamber & Elezi, 2024). However, these frameworks are mostly restricted to applying this concept in financial compliance and institutional risk registers rather than in program-level learning evaluation (Engku Abdullah et al., 2025).

This study translates the five ERM components into constructs for measuring program-level OJT quality assurance: (1) Control Environment (governance, ethics, supervisory competence, pre-deployment readiness); (2) Risk Assessment (task-skill alignment, duration sufficiency, resource access); (3) Control Activities (procedures, instructions, performance standards, issue resolution); (4) Information and Communication (feedback clarity, communication-channel adequacy); and (5) Monitoring Activities (institutional and host-organization oversight, issue tracking).

2.3. Industry 4.0 Competency Frameworks in Computing Education

Industry 4.0 describes the convergence of digital, physical, and analytical technologies reshaping workplace skill demands (Schwab, 2017), which are now considered essential for workforce readiness (Chans et al., 2024; Li, 2022). Reviews of Industry 4.0 competency instruments find substantial contextual variability, underscoring the need for context-specific adaptation rather than wholesale instrument transfer (Zamora Iribarren et al., 2024; Miah et al., 2024), and prior work distinguishes general digital-readiness competencies from program-specific technical competencies (Hernandez-de-Menendez et al., 2020a, 2020b), a distinction this study operationalizes through a shared Industry 4.0 subscale (I4S) and anchored on the program-dominant competencies specified in Computing Curricula 2020 (CC2020 Task Force, 2020). Recent scholarship on "University 4.0" further argues that Industry 4.0's influence on higher education extends beyond curriculum content into institutional governance and quality assurance more broadly (Ülker & Otrar, 2025). The Industry 4.0 constructs must be embedded within a governance-oriented instrument rather than treating them as a standalone competency checklist.

2.4. BADIR Analytics and KPI-Driven Performance Measurement

BADIR analytics methodology (Maheshwari, 2014) provides the study's approach to operationalizing KPIs as measurable, actionable performance signals rather than abstract learning goals. Applied to OJT, BADIR-aligned indicators (competency improvement, knowledge application, theory–practice integration, reflection, and performance improvement) translate broad competency expectations into a single KPI-driven performance construct that can be tracked, compared, and audited across cohorts, consistent with recent conceptual work proposing that well-specified KPIs form the core of the translation of institutional strategy into measurable, monitorable outcomes (Teshome, 2025). KPI-driven performance functions as the empirical bridge between the COSO ERM governance constructs and overall OJT quality.

2.5. Kolb's Experiential Learning Theory as the Criterion Framework

Kolb's (1984) Experiential Learning Theory (ELT) models learning as a cyclical process of concrete experience, reflective observation, abstract conceptualization, and active experimentation, and continues to inform how higher education structures experiential and work-based learning (Kolb & Kolb, 2022). It provides this study's theoretical anchor for overall OJT quality as the criterion variable: an OJT placement that supports the full experiential-learning cycle, not merely task completion, should be reflected in trainees' holistic quality ratings. Positioning overall OJT quality as an ELT-anchored criterion, rather than a simple satisfaction measure, allows the COSO ERM and Industry 4.0 constructs to be evaluated as predictors of substantively meaningful experiential-learning outcomes rather than of generic satisfaction.

2.6. Conceptual Framework of the Study

This study conceptualizes OJT quality as the joint product of governance inputs, competency-development processes, and experiential-learning outcomes. Table 1 summarizes this Input-Process-Output structure, which guided both instrument design and the analytic strategy.

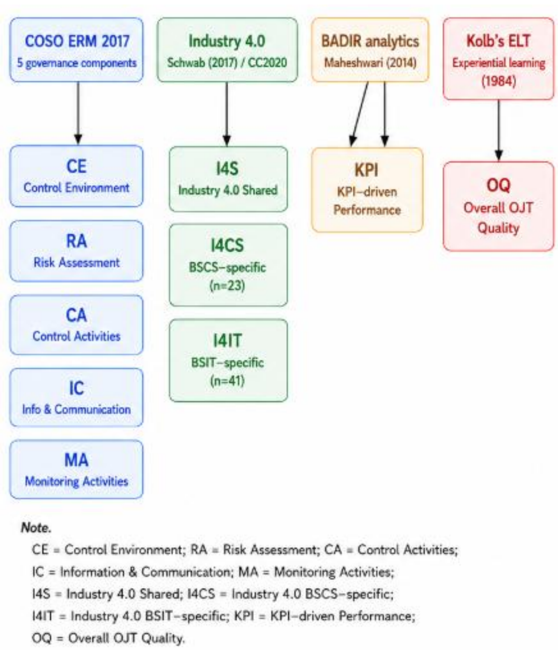
Table 1

Input-Process-Output structure linking governance, competency development, and experiential outcomes

IPO Stage	Constructs / Elements
Governance Input	The five COSO ERM components (Control Environment, Risk Assessment, Control Activities, Information & Communication, Monitoring Activities), operationalized as observable governance conditions of the OJT placement.
Competency-Development Process	Industry 4.0 readiness (shared and program-specific subscales) and KPI-Driven Performance (BADIR-aligned indicators), representing how governance conditions translate into observable competency gains.
Experiential-Learning Output	Overall OJT Quality, anchored on Kolb's (1984) Experiential Learning Theory as the study's criterion variable.

Figure 1

Conceptual framework linking COSO ERM, Industry 4.0, BADIR analytics, and Kolb's Experiential Learning Theory



3. Materials and Methods

3.1. Research Design

This study was situated within a postpositivist research paradigm, adopting a quantitative-dominant approach supplemented by an embedded qualitative component. Following Creswell and Plano Clark's (2018) embedded (concurrent) mixed-methods typology, quantitative Likert-scale data and qualitative open-ended responses were collected concurrently within the same instrument, with the qualitative strand nested within, and subordinate to, the dominant quantitative strand, serving an explanatory and triangulating function. This was operationalized through a three-year sequential cohort design (Andrade, 2022): three independent cohorts were surveyed at OJT completion, corresponding to School Years 2023–2024 (Cohort I), 2024–2025 (Cohort II), and 2025–2026 (Cohort III), producing a between-subjects comparison across the three school years, while reliability was re-estimated on the full pooled sample.

3.2. Population and Sample

The research locale was selected because its Department of Computer Studies houses both BSCS and BSIT under a single governance structure, enabling program-level comparison. It also maintains full institutional OJT records across the last three school years, enabling the sequential cohort design, and it is a mid-sized private HEI in Region XII, representative of similarly structured computing programs elsewhere in the Philippines.

Table 2

The composition of the Qualified Analytical Sample (QAS) (n = 64)

Cohort	BSCS	BSIT	Total
Cohort I (SY 2023–2024)	7	9	16
Cohort II (SY 2024–2025)	12	10	22
Cohort III (SY 2025–2026)	4	22	26
Total (n)	23	41	64

The population frame consisted of N = 99 qualified BSCS/BSIT trainees (Cohort I = 23; Cohort II = 35; Cohort III = 41). A complete-enumeration (census) sampling technique was employed given the small, fully enumerable population, rather than probability-sampling formulas such as Slovin's (Krejcie & Morgan, 1970), which are designed for selecting representative subsets from larger populations. Table 2 shows the resulting sample of 64 of 99 qualified trainees (64.65%).

3.3. Instrument

The instrument comprised eight constructs across 43 substantive five-point Likert items, two demographic items, and four open-ended items; BSCS respondents answered I4CS items and BSIT respondents answered I4IT items (Table 3), for 39 shared items plus one four-item program-specific branch per respondent. The instrument was subjected to expert content validation (10-member panel) prior to pilot testing, yielding S-CVI/Ave = .96 and S-CVI/UA = .83; 39 of 40 items achieved acceptable I-CVI (≥ .80), and one item was revised. The pilot-stage I4CS subscale (n = 7) already showed below-threshold reliability, prompting additional monitoring during deployment. Nature of Work (NW) served as a contextual variable for interpreting Industry 4.0 exposure and KPI outcomes.

Table 3

Constructs of the KPI-driven OJT evaluation instrument

Construct	Items	Theoretical Anchor
Control Environment (CE)	5	COSO ERM Component 1 (governance, ethics, supervisory competence, pre-deployment readiness)
Risk Assessment (RA)	5	COSO ERM Component 2 (task-skill alignment, duration sufficiency, resource access)
Control Activities (CA)	6	COSO ERM Component 3 (procedures, instructions, performance standards, security, issue resolution)
Information & Communication (IC)	5	COSO ERM Component 4 (feedback clarity, expectations, communication channels)
Monitoring Activities (MA)	5	COSO ERM Component 5 (institutional and host-organization monitoring, issue tracking)
Industry 4.0 Shared (I4S)	4	Schwab's (2017) digital-readiness competencies, applicable to all programs
Industry 4.0 BSCS-specific (I4CS) / BSIT-specific (I4IT)	4 each	Anchored on CC2020 program-dominant competencies; branched by respondent's program
KPI-Driven Performance (KPI)	5	BADIR analytics indicators (competency improvement, knowledge application, theory–practice integration, reflection, performance improvement)
Overall OJT Quality (OQ)	5	Criterion variable anchored on Kolb's (1984) Experiential Learning Theory

Content validation used a 10-member expert panel drawn from higher education, industry, and international academic perspectives. Following Polit and Beck (2006), I-CVI ≥ .80 was considered acceptable, and Modified Kappa values were interpreted as excellent (k ≥ .74), good (.60–.74), fair (.40–.60), or poor (< .40). Items were rated for relevance, clarity, and observability, with underperforming items revised before pilot testing.

3.4. Procedure

A Google Form enforced mandatory informed consent, program-specific conditional branching, and automatic timestamping, with the four open-ended items embedded as free-text fields. The link was distributed through Department of Computer Studies email channels to Cohorts I–III alumni from May 1–15, 2026, with reminders at 24 and 48 hours (Wu et al., 2022). Data were cleaned and anonymized under the Data Privacy Act (Republic of the Philippines, 2012): non-consenting responses were excluded, identifying information removed, and respondents pseudonymized (R1–R64). Item RA-4R was reverse-coded as RA-4.

3.5. Statistical Analysis

Analyses were conducted in Google Colab using pandas, NumPy, and SciPy.stats (Harris et al., 2020; Virtanen et al., 2020). Internal consistency was computed using Cronbach's alpha (Cronbach, 1951; Badenes-Ribera et al., 2020), with $\alpha \geq .70$ acceptable and a relaxed threshold of $\alpha \geq .65$ for four-item scales (Barbera et al., 2021; Bujang et al., 2018). Item-total and mean inter-item correlations (MIC) were additionally examined for I4CS. One-way ANOVA tested cohort differences in KPI-driven performance and overall OJT quality; Welch's t-test compared BSCS and BSIT KPI scores; Pearson correlations assessed relationships among the COSO ERM, Industry 4.0, KPI, and OJT Quality constructs, with effect sizes interpreted using η^2 (ANOVA) and Cohen's d (t-tests; Cohen, 1988). Power for the three-group ANOVA at $f = 0.25$ was $\approx .50$, so cohort comparisons were treated as exploratory.

Only the shared Industry 4.0 subscale (I4S), which met the reliability threshold, was included in the construct-correlation matrix. I4CS and I4IT were excluded, I4CS because its reliability ($\alpha = .248$) fell substantially below any defensible threshold, and I4IT because its program-specific branching would have introduced structural missingness incompatible with a pooled matrix. Both are instead reported descriptively and at the item level, pending re-validation with a larger item pool.

Shapiro–Wilk indicated no substantial non-normality for most constructs ($p > .05$), Levene's test supported homogeneity of variance ($p > .05$), and VIF values ranged 1.12–2.34, indicating no severe multicollinearity. Exploratory Factor Analysis (Principal Component Analysis, Varimax rotation; Hair et al., 2019) assessed preliminary construct structure and common method bias via the Kaiser–Meyer–Olkin statistic (Kaiser, 1974), Bartlett's test (Bartlett, 1954), and Harman's single-factor test (Harman, 1976; Podsakoff et al., 2024); the first unrotated factor explained under 50% of variance. Given the sub-threshold respondent-to-item ratio, the factor structure was interpreted as preliminary rather than definitive.

3.6. Qualitative Analysis

Qualitative data from the four open-ended items were analyzed using a deductive thematic analysis approach (Braun & Clarke, 2022), guided by the study's conceptual framework. Responses were coded against the eight pre-specified constructs (Table 3) rather than through open, inductive coding, consistent with the embedded mixed-methods design. Coding was performed by the research team in a single pass; because the dataset was analyzed by the authors rather than multiple independent coders, no inter-rater reliability statistic is reported, and the five themes should be read as the most salient recurring patterns rather than an exhaustively saturated taxonomy. These themes were triangulated with the quantitative findings.

3.7. Ethical Considerations

The study was done adhering to the National Ethical Guidelines for Health and Health-Related Research of the Philippine Health Research Ethics Board (2017) and the Data Privacy Act of 2012 (Republic of the Philippines, 2012). The participants were aged 18 years and above and given an initial compulsory consent question at the start of the Google Form; if the answer was no, the person was not included in the study. The analytical data did not contain any personally identifiable information and the linkage table that connected anonymized data to the respondent identities was stored in an encrypted, offline file accessible only to the corresponding author.

4. Results

In this section, the results are presented as follows: Sections 4.1 and 4.2 address RQ1 (instrument reliability across cohorts); Section 4.4 addresses RQ2 (inter-cohort differences); Sections 4.5 to 4.7 address RQ3 (construct associations with overall OJT quality); Section 4.2 addresses RQ4 (I4CS/I4IT psychometric comparison); and the final section, Section 4.8 presents the qualitative results that triangulate the quantitative findings.

4.1. Content Validity Results

In total, 39 items had an I-CVI score of 0.80 or more, and 33 of the items had an I-CVI score of 1.00. One item (IC-5R) was below the set threshold (I-CVI = .70) and was revised in response to validator feedback. Among the indicators retained, there was excellent agreement for most items, with modified Kappa statistics ranging from .79 to 1.00. The instrument showed an S-CVI/Ave of .96, and an S-CVI/UA of about .83 at the scale level, which was higher than the recommended excellent content validity, as shown in Table 4.

Table 4

Content validity summary of the KPI-driven OJT evaluation instrument

Indicator	Value	Interpretation
Number of Validators	10	Adequate Expert Panel
Items Evaluated	40	—
Items with I-CVI ≥ .80	39	Excellent
Perfect Agreement Items	33	Excellent
S-CVI/Ave	0.96	Excellent
S-CVI/UA	0.83	Excellent
Modified Kappa Range	0.79–1.00	Excellent Agreement
Items Requiring Revision	1	Revised Prior to Deployment

4.2. Reliability of the Deployed Instrument

Overall internal consistency for exploratory deployment research using Cronbach's alpha was acceptable for the 8 constructs and the 39-item shared instrument (Table 5). Risk Assessment (RA) and Industry 4.0 Shared (I4S) showed marginal but analytically usable reliability, whereas the BSCS-specific subscale (I4CS, n = 23) showed an unacceptably low alpha value of .248, which suggests high item heterogeneity. The short multidimensional scales have been known to produce artificially low alpha values when domain breadth is greater than the unidimensional assumptions (Edelsbrunner et al., 2025). The recent methodological literature cautions against using alpha as the only measure of construct quality for short scales (Zakariya, 2022). Cronbach's alpha for the BSIT-specific subscale (I4IT) was .616, which was considered acceptable and retained, given the relaxed short-scale criterion (Bujang et al., 2018). Inter-item correlations for I4CS also were weak (mean inter-item correlation ≈ .08) and ranged below the widely recommended .15–.50 range (Clark & Watson, 1995), particularly across its four remaining indicators.

Table 5

Cronbach's Alpha for the Deployment Sample (n = 64)

Construct	k	n	α	Interpretation
Control Environment (CE)	5	64	.755	Acceptable
Risk Assessment (RA)	4	64	.671	Acceptable for exploratory deployment
Control Activities (CA)	6	64	.820	Good
Information & Communication (IC)	5	64	.802	Good
Monitoring Activities (MA)	5	64	.837	Good
Industry 4.0 Shared (I4S)	4	64	.655	Marginal but usable
Industry 4.0 BSCS (I4CS)	4	23	.248	Requires further validation
Industry 4.0 BSIT (I4IT)	4	41	.616	Marginal but usable
KPI-Driven Performance (KPI)	5	64	.870	Good
Overall OJT Quality (OQ)	5	64	.837	Good
Overall Instrument	39	64	.928	Excellent

Note. Interpretation thresholds follow Barbera et al. (2021): $\alpha \geq 0.90$ Excellent; $0.80 \leq \alpha < 0.90$ Good; $0.70 \leq \alpha < 0.80$ Acceptable. A relaxed threshold of $\alpha \geq 0.65$ is used for four-item scales, per Bujang et al. (2018). RA-4R was reverse-coded during preprocessing and analyzed as RA-4.

4.3. Construct-Level Descriptive Statistics

Construct means and standard deviations are reported in Table 6 and Figure 3. All construct means exceeded the scale midpoint (3.0), indicating generally favorable perceptions of OJT quality and governance-related dimensions.

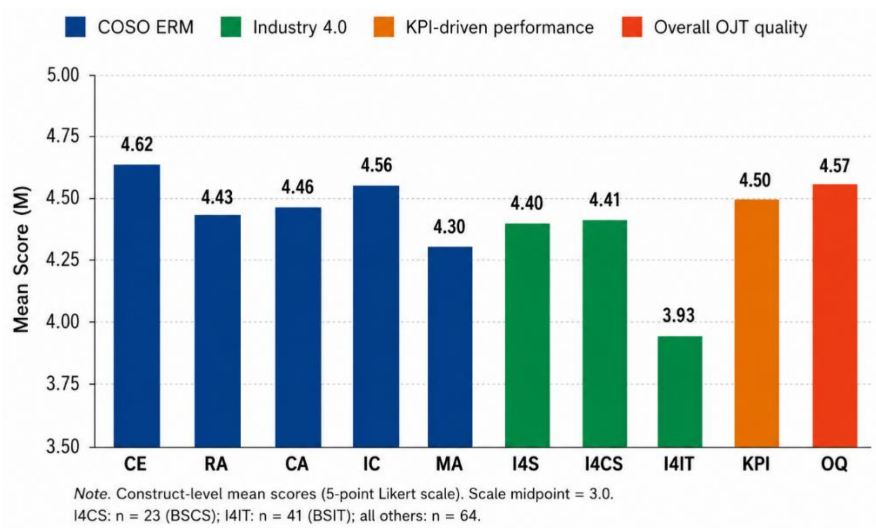
Table 6

Construct-level descriptive statistics (n = 64)

Construct	M	SD	n
Control Environment (CE)	4.62	0.44	64
Risk Assessment (RA)	4.43	0.49	64
Control Activities (CA)	4.46	0.49	64
Information & Communication (IC)	4.56	0.46	64
Monitoring Activities (MA)	4.30	0.67	64
Industry 4.0 Shared (I4S)	4.40	0.57	64
Industry 4.0 BSCS (I4CS)	4.41	0.47	23
Industry 4.0 BSIT (I4IT)	3.93	0.75	41
KPI-Driven Performance (KPI)	4.51	0.49	64
Overall OJT Quality (OQ)	4.57	0.46	64

Figure 3

Mean scores of the eight KPI-driven OJT evaluation instrument constructs (n = 64)



4.4. Inter-Cohort Comparison

One-way ANOVA examined inter-cohort differences in KPI achievement and overall OJT quality (OQ). The omnibus test found no significant difference between the three cohorts for KPI, $F(2, 61) = 1.31$, $p = .278$, nor for OQ, indicating temporal stability in both KPI achievement and overall OJT quality across the three observed cohorts.

4.5. Inter-Construct Correlations

Pearson correlations among the eight construct scores are presented in Table 7, which includes the shared Industry 4.0 construct (I4S) but excludes the unstable program-specific subscales (I4CS, I4IT; Sections 4.2–4.3). Statistically significant medium-to-large positive correlations emerged between Control Environment and OQ ($r = .61$, $p < .001$), Monitoring Activities and OQ ($r = .58$, $p < .001$), and KPI-Driven Performance and OQ ($r = .84$, $p < .001$). The five COSO ERM constructs showed moderate positive intercorrelations ($r = .19–.63$), consistent with the framework's view that the components are distinct but interconnected (COSO, 2017). I4S showed a weaker, non-significant correlation with OQ ($r = .21$, $p = .096$), suggesting general Industry 4.0 readiness is loosely coupled with holistic OJT-quality evaluations.

Table 7

Pearson correlations among eight construct scores (n = 64)

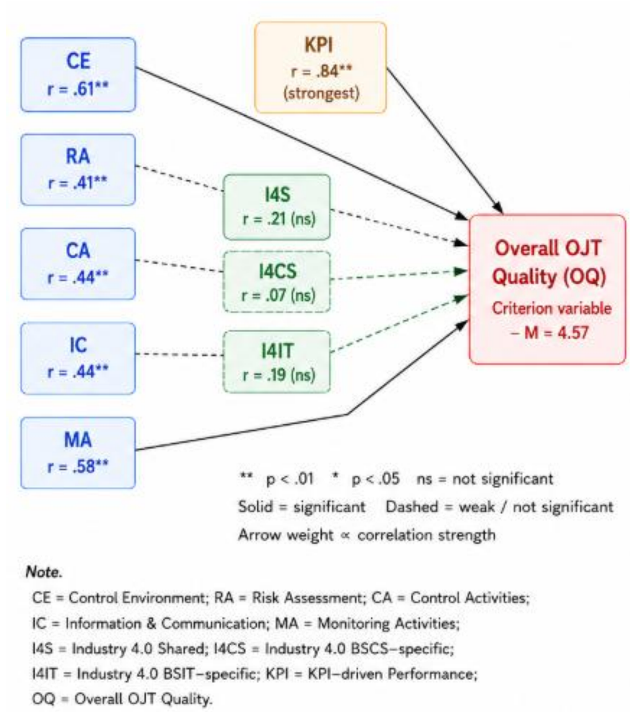
	CE	RA	CA	IC	MA	I4S	KPI	OQ
CE	—	.58**	.52**	.48**	.55**	.10	.34**	.61**
RA		—	.59**	.40**	.43**	.06	.38**	.41*
CA			—	.57**	.46**	.15	.42**	.44**
IC				—	.63**	.16	.38**	.44**
MA					—	.21	.48**	.58**
I4S						—	.32**	.21
KPI							—	.84**
OQ								—

Note. * $p < .05$; ** $p < .01$ (two-tailed). Construct code: CE = Control Environment; RA = Risk Assessment; CA = Control Activities; IC = Information & Communication; MA = Monitoring Activities; I4S = Industry 4.0 Shared; KPI = KPI-Driven Performance; OQ = Overall OJT Quality

Figure 2 visualizes the same correlation structure, illustrating the relative strength of the pairwise associations reported in Table 7, most notably the strong KPI–OQ association and the comparatively weaker Industry 4.0–OQ association.

Figure 2

Observed inter-construct correlation matrix (n = 64)



4.6. Program-Level Comparison (BSCS vs. BSIT)

An independent-samples t-test compared KPI achievement scores between BSCS ($n = 23$) and BSIT ($n = 41$) participants. The test detected no significant difference between the two programs, $t(45.7) = -0.03$, $p = .980$ (BSCS $M = 4.50$, $SD = 0.38$; BSIT $M = 4.51$, $SD = 0.54$), with a negligible effect size ($d = .01$). This substantive equivalence supports the use of pooled analyses for the COSO ERM, KPI, and OQ constructs, as well as the program-specific branching design of the industry 4.0 subscales.

4.7. Exploratory Factor Analysis Adequacy

Exploratory Factor Analysis (Principal Component Analysis, Varimax rotation) examined the underlying construct structure. KMO sampling adequacy was acceptable (0.654), and Bartlett's test was significant ($\chi^2 = 1773.34$, $p < .001$). Harman's single-factor test showed the first unrotated factor explained 28.18% of variance, below the 50% common-method-bias threshold. The five COSO ERM constructs loaded on distinguishable components, while I4CS items dispersed without a dominant loading, corroborating its low reliability. The multi-factor solution explained ≈ 67.42% of variance; given the sub-threshold respondent-to-item ratio, these findings are provisional, and confirmatory factor analysis and measurement-invariance testing are recommended for future, larger-sample studies (Hair et al., 2022).

4.8. Qualitative Findings

Responses to the four open-ended items were analyzed using framework-guided deductive thematic analysis. The quantitative results are largely corroborated by these findings, especially regarding Industry 4.0 exposure, KPI development, and Monitoring Activities (Table 8). Respondent numbers (R1–R64) are used in place of names to preserve anonymity.

Table 8

Summary of major qualitative themes and construct alignment

Theme	Representative Statement	Linked Construct
Monitoring inconsistency	"There was minimal monitoring from the school during my OJT."	Monitoring Activities (MA)
Skill and competency improvement	"I learned how to solve real-world problems and improved my coding skills."	KPI Performance (KPI)
Positive supervision	"My supervisor guided me well and clearly explained tasks."	Control Environment (CE)
Limited advanced technology exposure	"We used basic tools but not advanced technologies like AI."	Industry 4.0 (I4)
Experiential learning value	"The OJT gave me real-world experience that improved my confidence."	Overall OJT Quality (OQ)

Monitoring Activities (MA). Respondents frequently reported inconsistent institutional follow-up during OJT, consistent with MA's lowest mean score among COSO ERM constructs (M = 4.30): "*There was minimal monitoring from the school during my OJT*."

KPI Performance (KPI). Reported gains in problem-solving, technical skills, and adaptability aligned with the high KPI mean (M = 4.51): "*I learned how to solve real-world problems and improved my coding skills*."

Control Environment (CE). When it came to positive, structured supervision, this was a shared theme, with CE's mean score being M = 4.62: *"My supervisor guided me well and clearly explained tasks*."

Industry 4.0 Exposure (I4). Reactions to Industry 4.0 exposure were mixed, with some respondents stating that they had meaningful access to digital tools and others stating that they were more limited in access: "*We used basic tools but not advanced technologies such as AI*." Respondents in routine administrative roles reported low exposure to digital, whereas those in programming or systems development and networking, reported higher levels of competency development and gains in KPIs, which may provide a plausible explanation for the high descriptive mean and weak inferential association with Industry 4.0.

Overall OJT Quality (OQ). Respondents' views of overall OJT quality were high (M = 4.57), and they overwhelmingly rated the experience as valuable and confidence-building: "*The OJT gave me real-world experience that improved my confidence*." The qualitative results contextualize the quantitative findings and highlight monitoring and Industry 4.0 integration as priority areas for program improvement.

5. Discussion

The results offer preliminary evidence that enterprise IT-audit and governance philosophy can be applied to educational-program evaluation. All five COSO ERM constructs showed acceptable-to-good reliability, with Risk Assessment only slightly lower. The achieved response rate matches current survey-adequacy recommendations (Holtom et al., 2022), and Control Environment, theorized as central to COSO ERM, showed the strongest correlation with the criterion variable ($r = .61$, $p < .001$). The I4CS subscale, by contrast, was included only for exploratory content validity and is not yet a stable latent construct. The results corroborate previous internship studies that highlight the importance of structured supervision, organizational climate, and reflective learning (CC2020 Task Force, 2020; Kolb & Kolb, 2022; Román-García et al., 2024) and the need for short and context-specific competency tools (Vuorikari et al., 2026). This successful translation of COSO ERM into program-level constructs is part of a still emerging literature that has primarily limited the use of ERM in education to financial compliance and risk registers (Engku Abdullah et al., 2025). The high correlation between KPI and OQ ($r = .84$, $p < .001$) shows that KPI-aligned performance analytics can contribute meaningfully to OJT monitoring systems under CHED Memorandum Order No. 25, s. 2017 (CHED, 2017a) and PAASCU Level III criteria.

The achieved sample ($n = 64$ of $N = 99$, 64.65% response rate) shows that complete-enumeration sampling in small institutional populations can be reliable and analytically useful even where classical benchmarks (Slovin's formula; Krejcie & Morgan, 1970) are not strictly met. The 7.50% margin of error is within accepted limits for small-population educational research (Memon et al., 2020) and is applicable to similarly sized Philippine HEIs (single-program OJT cohorts of roughly 30\u2013100 trainees). Given sub-.80 power and small effect sizes across cohort and program comparisons, results should be read as exploratory rather than confirmatory.

The tool used yielded some actionable findings. The lowest mean ($M = 4.30$) and the highest SD ($SD = 0.67$) for the COSO ERM construct were obtained for Monitoring Activities, which proposes that monitoring and feedback mechanisms are essential to the effectiveness of internships, suggesting that there is ample room for improvement for items MA-3 and MA-5 in SY 2026 - 2027 OJT cycle. Second, there was significant variation in the constructs of the Industry 4.0 constructs, with the Industry 4.IT construct showing a lower level value ($M = 3.93$, $SD = 0.75$) and the Industry 4.CS construct showing an unreliable value ($\alpha = .248$). This also suggests that the constructs require refinement, not that they are invalid, as noted by validity theory that multidimensional competency areas can be less homogeneous than unidimensional areas. Third, it was observed that the quality of OJT was not different in the three school years for the two variables; KPI ($p = .278$) and OQ ($p = .374$) as a basis for future reform.

The results of the qualitative analyses confirmed the quantitative trends. Monitoring was a constant improvement theme, and the level of digital-technology exposure was also found to differ by placement type, with interns in technical roles (programming, systems development, and networking roles) showing more competency development than interns in administrative roles. The emerging evidence also indicates that AI related to the workplace may support intern learning (Hernandez-de-Menendez et al., 2020b; Musa et al., 2025; Franco-Ángel et al., 2023). The two patterns collectively indicate the need for improved placement-alignment mechanisms of assignment with program outcomes and digital-workforce skills (CC2020 Task Force, 2020; Calabit & Paglinawan, 2024).

By combining COSO ERM, KPI-driven analytics, and Industry 4.0 competency mapping, the proposed framework offers a governance-driven reference model extending beyond standard internship-evaluation methods, with implications for OJT standardization policy across Philippine computing programs. Four practical recommendations follow: strengthen institutional monitoring through frequent site visits and structured feedback; expand industry partnerships to increase host-organization Industry 4.0 exposure; align placement assignments more closely with program competencies; and further develop and re-validate the I4CS subscale before wider implementation.

Several caveats qualify these findings. The study drew on a modest sample ($n = 64$ of $N = 99$) from a single private HEI in Region XII; power for the three-group ANOVA was below .80, so results should be read as exploratory, with limited generalizability. The I4CS subscale's unsatisfactory reliability ($\alpha = .248$) may reflect uneven Industry 4.0 exposure across BSCS placements, and common method bias (Kaltsonoudi et al., 2022) may also affect self-report measures. The EFA's respondent-to-item ratio (≈ 1.6:1) fell well below the 5:1–10:1 ratios conventionally recommended (Hair et al., 2019), with several cross-loading items. All EFA-based claims, including the 67.42% explained variance and I4CS's dispersed loadings, should be read as provisional. Together, the below-threshold power, unsatisfactory I4CS reliability, and underpowered EFA converge on one conclusion: the instrument is promising and internally coherent for its five COSO ERM and KPI/OQ constructs, but not yet confirmatory-grade, and should be treated as a validated screening tool pending larger, multi-institutional replication before use in high-stakes accreditation decisions.

Future research should prioritize three areas. First, predictive validity should be examined by testing whether KPI scores and Industry 4.0 competency ratings predict post-graduation employability outcomes. Emerging evidence suggests that artificial intelligence is increasingly shaping curriculum design, assessment, and competency development in ways that create new opportunities for digitally enhanced internship-evaluation systems (Liang et al., 2025; Yan et al., 2025; Teshome, 2025). Second, the framework should be validated using larger multi-institutional samples, confirmatory factor analysis, and measurement invariance testing. Third, longitudinal employability outcomes should be incorporated, and the Industry 4.0 subscales should be further refined to improve construct stability and contextual applicability.

6. Conclusion

The purpose of this study was to address four research questions regarding a KPI-Driven OJT Evaluation Instrument based on COSO ERM, Industry 4.0 competency mapping, BADIR analytics and Kolb's Experiential Learning Theory. The instrument demonstrated excellent overall internal consistency ($\alpha = .928$) that held stable across three independent cohorts, indicating the instrument is reliable for repeated institutional use (RQ1 – reliability across cohorts). For RQ2 (inter-cohort differences), findings revealed that there were no significant differences in KPI-Driven Performance and Overall OJT Quality between school years suggesting that there was no trend in perceived OJT quality. For RQ3 (construct associations with Overall OJT Quality), the strongest correlates were KPI-Driven Performance, Control Environment, and Monitoring Activities, while the Industry 4.0 constructs were more weakly associated, corroborated qualitatively by uneven monitoring and digital-technology exposure. The reliability of the BSCS-specific subscale (I4CS, $\alpha = .248$) was not satisfactory compared with the BSIT-specific subscale (I4IT, $\alpha = .616$), meaning that this program-specific branching design needs to be improved before it is widely used, especially the BSCS subscale.

The findings have three immediate implications. First, for institutional practice, the OJT program should focus on strengthening the lowest-scoring and most variable construct, Monitoring Activities, by conducting regular visits to OJT sites and implementing structured feedback mechanisms. Second, in terms of instrument design, the I4CS subscale should be further developed or reworded by adding items and/or revalidated to ensure that its competencies are aligned with the BSCS-specific competencies outlined in CC2020 before scaling the instrument to other cohorts or institutions. Third, in terms of governance policy, operationalizing the five components of COSO ERM as program-level quality assurance constructs supports the use of COSO ERM as a reference framework for OJT governance in computing programs in the Philippines. However, this proposition needs to be further validated using larger, multi-institutional samples.

The quantitative and qualitative strands worked together rather than in opposition. Monitoring Activities was the weakest and most variable construct ($M = 4.30$, $SD = 0.67$), a finding confirmed by the most common qualitative theme, inconsistent follow-up. Similarly, the weak, non-significant correlation between I4S and OQ ($r = .21$, $p = .096$) was supported by reports of uneven exposure to digital tools, except for I4CS and I4IT, which were omitted from the inferential analysis. The Nature of Work theme provided the most explanatory contribution of the qualitative strand, as exposure to Industry 4.0 varied across task categories. This variation may help explain why the descriptive means were high while the correlational measures were low. No outright contradiction between the quantitative and qualitative findings emerged. Future studies using larger samples should examine whether this convergence is maintained, particularly for the unstable I4CS subscale.

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Institutional Review Board Statement

This study was conducted in accordance with the ethical guidelines set by Notre Dame of Marbel University. The ethical review and approval were waived for this study.

AI Declaration

The authors declare the use of Artificial Intelligence (AI) and digital research tools in the preparation of this manuscript. Specifically, ChatGPT (OpenAI) and Claude (Anthropic) were used to assist in refining academic writing, improving language clarity and coherence, organizing manuscript sections, strengthening methodological and statistical explanations, and enhancing responses to peer reviewers. QuillBot was used for language refinement, paraphrasing, grammar enhancement, and improving sentence readability. Google Forms was used for online questionnaire administration and data collection, Google Sheets for data organization, coding, and preliminary data preparation, Google Colab for statistical analyses and data visualization using Python-based libraries, and Mendeley Reference Manager for reference organization and citation management. All AI-generated outputs were carefully reviewed, verified, and edited by the authors. The authors assume full responsibility for the accuracy, originality, interpretation, integrity, and final content of the manuscript, and all scholarly judgments and conclusions remain entirely those of the authors.

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References

Al Barwani, A. A., & Azam, S. M. F. (2023). Assessing the effect of OJT training quality factors on TVET students' satisfaction in preparing for employment in Oman. *European Journal of Education Studies, 10*(8). https://doi.org/10.46827/ejes.v10i8.4910

Andrade, C. (2022). Research design: Cohort studies. *Indian Journal of Psychological Medicine, 44*(1), 93--97. https://doi.org/10.1177/02537176211073764

Badenes-Ribera, L., Silver, N. C., & Pedroli, E. (2020). Editorial: Scale development and score validation. *Frontiers in Psychology, 11*, Article 799. https://doi.org/10.3389/fpsyg.2020.00799

Bamber, C. (2023). Exploring enterprise-wide risk management system in higher education. *Management Dynamics in the Knowledge Economy, 11*(3), 267--285. https://doi.org/10.2478/mdke-2023-0017

Bamber, C., & Elezi, E. (2024). Enterprise-wide risk management in higher education: Beyond the paradigm of managing risk by categories. *Business Process Management Journal.* https://doi.org/10.1108/BPMJ-05-2024-0409

Barbera, J., Naibert, N., Komperda, R., & Pentecost, T. C. (2021). Clarity on Cronbach's alpha use. *Journal of Chemical Education, 98*(2), 257--258. https://doi.org/10.1021/acs.jchemed.0c00183

Bartlett, M. S. (1954). A note on the multiplying factors for various chi square approximations. *Journal of the Royal Statistical Society: Series B (Methodological), 16*(2), 296--298. https://doi.org/10.1111/j.2517-6161.1954.tb00174.x

Bouwmans, M., Lub, X., Orlowski, M., & Nguyen, T.-V. (2024). Developing the digital transformation skills framework: A systematic literature review approach. *PLoS ONE, 19*(7), e0304127. https://doi.org/10.1371/journal.pone.0304127

Braun, V., & Clarke, V. (2022). *Thematic analysis: A practical guide.* SAGE Publications.

Bujang, M. A., Omar, E. D., & Baharum, N. A. (2018). A review on sample size determination for Cronbach's alpha test: A simple guide for researchers. *The Malaysian Journal of Medical Sciences, 25*(6), 85--99. https://doi.org/10.21315/mjms2018.25.6.9

Calabit, M. C., & Paglinawan, J. L. (2024). Enhancing technical competency in higher education on-the-job training: Curriculum alignment, educational approach, and school governance execution. *International Journal for Multidisciplinary Research (IJFMR), 6*(3), Article IJFMR240321370. https://doi.org/10.36948/ijfmr.2024.v06i03.21370

Casugay, J. V. R., Cabauatan, W. F., Esperanza, J. A., Fontanilla, M. A. G., & Subang, A. H. (2024). Information technology students' insights from their on-the-job training: Input to an internship manual. *International Journal of Multidisciplinary Applied Business and Education Research, 5*(2), 681--695. https://doi.org/10.11594/ijmaber.05.02.27

CC2020 Task Force. (2020). *Computing curricula 2020: Paradigms for global computing education.* Association for Computing Machinery & IEEE Computer Society. https://doi.org/10.1145/3467967

Chans, G. M., Alcalá, M. A., & Morales-Menendez, R. (2024). Future skills for Industry 4.0 integration and innovative learning for continuing engineering education. *Frontiers in Education, 9*, Article 1412018. https://doi.org/10.3389/feduc.2024.1412018

Clark, L. A., & Watson, D. (1995). Constructing validity: Basic issues in objective scale development. *Psychological Assessment, 7*(3), 309-319. https://doi.org/10.1037/1040-3590.7.3.309

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203771587

Commission on Higher Education. (2015). *Revised policies, standards and guidelines for the Bachelor of Science in Information Technology (BSIT). CHED Memorandum Order No. 25, series of 2015.* CHED.

Commission on Higher Education. (2017a). *Policies, standards, and guidelines for the Bachelor of Science in Computer Science (BSCS) program. CHED Memorandum Order No. 25, series of 2017.* CHED.

Commission on Higher Education. (2017b). *Revised guidelines for student internship program in the Philippines. CHED Memorandum Order No. 104, series of 2017.* CHED. https://ofa.upd.edu.ph/wp-content/uploads/2018/04/CMO-No.104-S.2017.pdf

Committee of Sponsoring Organizations of the Treadway Commission. (2017). *Enterprise risk management --- Integrating with strategy and performance.* COSO. https://www.coso.org/SitePages/Guidance-on-Enterprise-Risk-Management.aspx

Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

Cronbach, L. J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika, 16*(3), 297--334. https://doi.org/10.1007/BF02310555

Di Pietro, G. (2022). International internships and skill development: A systematic review. *Review of Education, 10*(1), e3363. https://doi.org/10.1002/rev3.3363

Edelsbrunner, P. A., Simonsmeier, B. A., & Schneider, M. (2025). The Cronbach's alpha of domain-specific knowledge tests before and after learning: A meta-analysis of published studies. *Educational Psychology Review, 37*, Article 4. https://doi.org/10.1007/s10648-024-09982-y

Engku Abdullah, E., Yakob, R., & Bangaan Abdullah, M. (2025). A systematic review of enterprise risk management on higher education institutions' performance. *Open Education Studies, 7*(1), Article 20250108. https://doi.org/10.1515/edu-2025-0108

Franco-Ángel, M., Carabali, J., & Velasco, M. I. (2023). The internship performance of undergraduate students: Are hard or soft skills more important? *Industry and Higher Education, 37*(3), 384--396. https://doi.org/10.1177/09504222221127213

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate data analysis* (8th ed.). Cengage Learning.

Hair, J. F., Henseler, J., Dijkstra, T. K., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage. https://doi.org/10.1007/978-3-030-80519-7

Harman, H. H. (1976). *Modern factor analysis* (3rd ed.). University of Chicago Press.

Harris, C. R., Millman, K. J., van der Walt, S. J., Gommers, R., Virtanen, P., Cournapeau, D., Wieser, E., Taylor, J., Berg, S., Smith, N. J., Kern, R., Picus, M., Hoyer, S., van Kerkwijk, M. H., Brett, M., Haldane, A., del Río, J. F., Wiebe, M., Peterson, P., ... Oliphant, T. E. (2020). Array programming with NumPy. *Nature, 585*(7825), 357--362. https://doi.org/10.1038/s41586-020-2649-2

Hernández-Campos, M., Gonzalez-Torres, A., & García-Peñalvo, F. J. (2025). Learning outcomes evaluation through learning analytics systems in higher education: A systematic literature review. *SAGE Open, 15*(3). https://doi.org/10.1177/21582440251347374

Hernandez-de-Menendez, M., Escobar Díaz, C. A., & Morales-Menendez, R. (2020a). Engineering education for smart 4.0 technology: A review. *International Journal on Interactive Design and Manufacturing (IJIDeM), 14*(3), 789--803. https://doi.org/10.1007/s12008-020-00672-x

Hernandez-de-Menendez, M., Morales-Menendez, R., Escobar, C. A., & McGovern, M. (2020b). Competencies for Industry 4.0. *International Journal on Interactive Design and Manufacturing (IJIDeM), 14*(4), 1511-1524. https://doi.org/10.1007/s12008-020-00716-2

Holtom, B., Baruch, Y., Aguinis, H., & Ballinger, G. A. (2022). Survey response rates: Trends and a validity assessment framework. *Human Relations, 75*(8), 1560-1584. https://doi.org/10.1177/00187267211070769

IT and Business Process Association of the Philippines. (2022). *Philippine IT-BPM industry roadmap 2028.* IBPAP. https://admin.ibpap.org/storage/hub-resources/1fntWJGQKvZg4CfwP4yfXs0Jr1n85DVR1vYXJvSn.pdf

Kaiser, H. F. (1974). An index of factorial simplicity. *Psychometrika, 39*(1), 31--36. https://doi.org/10.1007/BF02291575

Kaltsonoudi, K., Tsigilis, N., & Karteroliotis, K. (2022). Common method bias in research designs using self-report tools: Literature overview and recommended remedies. *Psychology: The Journal of the Hellenic Psychological Society, 27*(1), 210--231. https://doi.org/10.12681/psyhps.30843

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development.* Prentice-Hall.

Kolb, A. Y., & Kolb, D. A. (2022). Experiential Learning Theory as a guide for experiential educators in higher education. *Experiential Learning and Teaching in Higher Education, 1*(1), 38. https://doi.org/10.46787/elthe.v1i1.3362

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*(3), 607--610. https://doi.org/10.1177/001316447003000308

Li, L. (2022). Reskilling and upskilling the future-ready workforce for Industry 4.0 and beyond. *Information Systems Frontiers, 26*(5), 1697--1712. https://doi.org/10.1007/s10796-022-10308-y

Liang, J., Stephens, J. M., & Brown, G. T. L. (2025). A systematic review of the early impact of artificial intelligence on higher education curriculum, instruction, and assessment. *Frontiers in Education, 10*, Article 1522841. https://doi.org/10.3389/feduc.2025.1522841

Maheshwari, A. (2014). *Data analytics made accessible.* Amazon Digital Services.

Memon, M. A., Ting, H., Cheah, J.-H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. *Journal of Applied Structural Equation Modeling, 4*(2), i--xx. https://doi.org/10.47263/JASEM.4(2)01

Miah, M. T., Erdei-Gally, S., Dancs, A., & Fekete-Farkas, M. (2024). A systematic review of Industry 4.0 technology on workforce employability and skills: Driving success factors and challenges in South Asia. *Economies, 12*(2), 31. https://doi.org/10.3390/economies12020031

Musa, S., Nurhayati, S., & Boriboon, G. (2025). The effect of internships on graduates' employability, soft skills, and digital competence. *Educational Process: International Journal (EDUPIJ).* https://doi.org/10.22521/edupij.2025.17.306

Philippine Health Research Ethics Board. (2017). *National ethical guidelines for health and health-related research* (2017 ed.). Department of Science and Technology -- Philippine Council for Health Research and Development. https://ethics.healthresearch.ph/

Podsakoff, P. M., Podsakoff, N. P., Williams, L. J., Huang, C., & Yang, J. (2024). Common method bias: It's bad, it's complex, it's widespread, and it's not easy to fix. *Annual Review of Organizational Psychology and Organizational Behavior, 11*, 17--61. https://doi.org/10.1146/annurev-orgpsych-110721-040030

Republic of the Philippines. (2012). *Data Privacy Act of 2012 (Republic Act No. 10173).* Official Gazette. https://www.officialgazette.gov.ph/2012/08/15/republic-act-no-10173/

Román-García, S., Almansa-Martínez, A., & Cruz-Díaz, M. R. (2024). Exploring digital competencies in higher education: Design and validation of instruments for the era of Industry 5.0. *Frontiers in Education, 9*, Article 1415800. https://doi.org/10.3389/feduc.2024.1415800

Santillana, P. M. P. (2026). *Proposed quality internship framework for host training establishments (HTEs)* (UP CIDS Discussion Paper Series 2026-04). University of the Philippines Center for Integrative and Development Studies. https://cids.up.edu.ph/wp-content/uploads/2026/03/Proposed-Quality-Internship-Framework-for-Host-Training-Establishments-HTEs.pdf

Schwab, K. (2017). *The fourth industrial revolution.* Crown Business.

Teshome, S. W. (2025). Key performance indicators in higher education: A systematic review of the conceptualization, dimensions, frameworks, and challenges of KPIs. *International Journal of Education, Management, and Technology, 3*(2), 611--623. https://doi.org/10.58578/ijemt.v3i2.6493

Ülker, N., & Otrar, M. (2025). University 4.0 essentials: Influence of Industry 4.0 on higher education. *Industry and Higher Education, 39*(5), 528–538. https://doi.org/10.1177/09504222241295625

Virtanen, P., Gommers, R., Oliphant, T. E., Haberland, M., Reddy, T., Cournapeau, D., Burovski, E., Peterson, P., Weckesser, W., Bright, J., van der Walt, S. J., Brett, M., Wilson, J., Millman, K. J., Mayorov, N., Nelson, A. R. J., Jones, E., Kern, R., Larson, E., ... SciPy 1.0 Contributors. (2020). SciPy 1.0: Fundamental algorithms for scientific computing in Python. *Nature Methods, 17*(3), 261--272. https://doi.org/10.1038/s41592-019-0686-2

Vuorikari, R., Pokropek, A., & Castaño Muñoz, J. (2026). Enhancing digital skills assessment: Introducing compact tools for measuring digital competence. *Technology, Knowledge and Learning*, 31, 519–546. https://doi.org/10.1007/s10758-025-09825-x

Wu, M.-J., Zhao, K., & Fils-Aime, F. (2022). Response rates of online surveys in published research: A meta-analysis. *Computers in Human Behavior Reports, 7*, Article 100206. https://doi.org/10.1016/j.chbr.2022.100206

Yan, J., Tian, H., Sun, X., & Song, L. (2025). Role of artificial intelligence in enhancing competency assessment and transforming curriculum in higher vocational education. *Frontiers in Education, 10*, Article 1551596. https://doi.org/10.3389/feduc.2025.1551596

Zakariya, Y. F. (2022). Cronbach's alpha in mathematics education research: Its appropriateness, overuse, and alternatives in estimating scale reliability. *Frontiers in Psychology, 13*, Article 1074430. https://doi.org/10.3389/fpsyg.2022.1074430

Zamora Iribarren, M., Garay-Rondero, C. L., Lemus-Aguilar, I., & Peimbert-García, R. E. (2024). A review of Industry 4.0 assessment instruments for digital transformation. *Applied Sciences, 14*(5), 1693. https://doi.org/10.3390/app14051693