

Effectiveness of An EHR- and KPI Dashboard-Based Technology Utilization Training Intervention on Nursing Leaders' Digital Competency and KPI

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Abstract

Background: Saudi Arabia's ongoing digital health transformation has expanded the availability of electronic health records (EHRs), computerized provider order entry systems, clinical dashboards, and digital performance data. Effective digital transformation requires nursing leaders to possess the knowledge, competency, confidence, and practical skills necessary to translate digital information into leadership and performance-management activities.

Objective: To evaluate the effectiveness of an EHR- and key performance indicator (KPI) dashboard-based technology utilization training intervention in improving nursing leaders' knowledge, attitude, practice, digital competency, digital self-efficacy, perceived usefulness, perceived ease of use, technology utilization behavior, and perceived KPI management ability within the Second Medical Health Cluster, Saudi Arabia.

Methods: A quantitative quasi-experimental nonequivalent control-group pretest–posttest design was employed. The study included 148 nursing leaders, with 74 participants in the intervention group and 74 in the control group. The intervention consisted of six blended-learning sessions delivered over four weeks and focused on EHR use, KPI dashboard interpretation, digital reporting, documentation monitoring, medication and patient-safety information, and data-informed leadership decision-making. Outcomes were assessed using a structured questionnaire.

Results: At baseline, the overall mean knowledge score was 47.25%, while mean attitude and practice scores were 3.11 and 3.00, respectively. Compared with the control group, the intervention group demonstrated significantly greater improvement in knowledge (Cohen's $d=1.43$, $p<.001$), attitude ($\eta^2=.269$, $p<.001$), practice ($\eta^2=.174$, $p<.001$), digital competency ($\eta^2=.547$, $p<.001$), digital self-efficacy ($\eta^2=.357$, $p<.001$), perceived usefulness ($d=.86$, $p<.001$), perceived ease of use ($\eta^2=.382$, $p<.001$), technology utilization behavior ($\eta^2=.355$, $p<.001$), and perceived KPI management ability ($\eta^2=.570$, $p<.001$). Age, nursing experience, and leadership experience were associated with technology utilization at the bivariate level; however, no individual demographic or professional factor remained independently significant after multivariable adjustment.

Conclusion: Structured, leadership-specific EHR- and KPI dashboard-based training was associated with substantial short-term improvements in nursing leaders measured digital capabilities, technology utilization, and perceived KPI management ability. The strongest adjusted effects were observed for perceived KPI management ability and digital competency. The findings relate primarily to self-reported outcomes and should not be interpreted as evidence of direct improvement in institutional or clinical KPI performance.

Keywords: electronic health records; KPI dashboards; nursing leadership; digital competency; technology utilization; nursing informatics; Saudi Arabia; quasi-experimental study.

1. Introduction

Healthcare organizations are increasingly incorporating electronic health records (EHRs), clinical dashboards, and data-driven decision-making applications into clinical and administrative processes. The availability of digital systems, however, does not by itself ensure that nursing leaders can translate digital information into leadership, quality, safety, and performance-management actions. Nursing leaders occupy a pivotal position in technology uptake because they oversee teams, resources, documentation, patient-safety initiatives, quality improvement, and performance monitoring (Backonja et al., 2022; Altmiller & Pepe, 2022).

Saudi Arabia is undergoing health-system transformation associated with Vision 2030, with increasing use of EHRs, computerized provider order entry, digital reporting systems, telehealth, and other digital-health infrastructure (Al-Kahtani et al., 2022; Al Muhri et al., 2022; AlWatban et al., 2024). The Second Medical Health Cluster provides an important setting for examining leadership-level technology utilization because it operates across multiple

healthcare facilities and relies on digital systems for clinical and operational activities.

Previous evidence cited in the thesis indicates that Saudi nurses generally report favorable attitudes toward technology while also demonstrating gaps related to informatics competency, training, confidence, workflow integration, and organizational support (Al-Balawi et al., 2020; Alrasheeday et al., 2023; Alzghaibi & Hutchings, 2022). International evidence similarly identifies digital-literacy gaps, workflow disruption, workload, usability problems, resistance to change, and insufficient training as barriers to technology utilization among healthcare professionals (Brown et al., 2020; Borges do Nascimento et al., 2023; Wosny et al., 2023).

Within nursing leadership, the thesis identifies a specific gap: technology training commonly addresses frontline or general system use, whereas less attention has been directed toward role-specific use of EHR-derived information, KPI dashboards, digital incident reporting, documentation monitoring, safety information, and data-informed leadership decision-making. This distinction is important because nursing leaders are expected to interpret performance information and translate it into supervisory and quality-improvement action.

The present study therefore evaluated an EHR- and KPI dashboard-based technology utilization training intervention among nursing leaders in the Second Medical Health Cluster, Saudi Arabia. The intervention was designed to address EHR use, KPI dashboard interpretation, digital reporting, documentation monitoring, medication and patient-safety information, patient-flow and staff-performance monitoring, and data-based leadership decision-making.

2. Methods

2.1 Study design and setting

A quantitative quasi-experimental nonequivalent control-group pretest–posttest design was used. The study was conducted among nursing leaders working within facilities of the Second Medical Health Cluster in Saudi Arabia. The final analyzed sample comprised 148 nursing leaders, with 74 participants in the intervention group and 74 in the control group.

2.2 Participants and sampling

The study population comprised nursing leaders, including nursing managers, nursing supervisors, nursing directors, quality-related nursing leaders, administrators, and other nursing personnel with responsibilities for supervision, documentation monitoring, patient safety, quality improvement, workflow coordination, or KPI-related decision-making. Physicians, IT professionals, and floor nurses without leadership responsibilities were not included.

2.3 Intervention

The EHR- and KPI dashboard-based technology utilization training intervention used a blended-learning approach combining face-to-face instruction, online learning support, guided practice, simulation, dashboard activities, and scenario-based exercises. The intervention was delivered across four consecutive weeks in six sessions, at two sessions per week where scheduled, with each session lasting approximately 2.5 hours.

Table 1. Structure and content of the EHR- and KPI dashboard-based technology utilization training intervention.

Module	Focus area	Main content	Training activity
1	Digital leadership and KPI management	Digital transformation, nursing-sensitive KPIs, performance monitoring	Lecture and KPI discussion
2	Electronic health records	Documentation accuracy, completeness, timeliness, information retrieval	EHR demonstration and guided practice

3	CPOE and medication safety	Medication orders, alerts, medication-error reporting, near misses	CPOE demonstration and case scenario
4	KPI dashboards	Patient satisfaction, patient flow, bed occupancy, documentation compliance, safety indicators	Dashboard interpretation exercise
5	Digital incident and quality reporting	Incident reporting, trends, quality improvement, corrective action	Simulation and group discussion
6	Leadership application	Data-based decision-making, staff supervision, feedback, change management, action planning	Unit-based action-plan development

2.4 Outcome measures and data collection

Data was collected at pretest before the intervention and posttest following completion of the four-week intervention. The same structured self-administered questionnaire was used at both measurement occasions. Domains included demographics and professional background, knowledge, attitude, practice, digital competency, digital self-efficacy, perceived usefulness, perceived ease of use, technology utilization behavior, KPI management ability, and organizational support/resources.

2.5 Validity and reliability

Content validity was addressed through expert review of clarity, relevance, and suitability, with pilot testing outside the study sample described in the thesis. Internal consistency was assessed using Cronbach's alpha for multi-item measures and a KR-20/Cronbach-alpha-equivalent coefficient for knowledge. A coefficient of $\geq .70$ was considered acceptable.

2.6 Statistical analysis

Data was analyzed using descriptive statistics, reliability analysis, baseline group comparisons, assumption testing, ANCOVA, between-group change-score comparisons, Spearman correlations, independent-samples comparisons, one-way ANOVA, and multiple regression. ANCOVA compared posttest scores between groups while adjusting for corresponding pretest scores when the homogeneity-of-regression-slopes assumption was satisfied. For knowledge and perceived usefulness, this assumption was violated; therefore, between-group change-score comparisons received inferential priority. Statistical significance was set at $\alpha=.05$. Effect sizes were reported using partial eta squared (η^2) for ANCOVA effects and Cohen's d for between-group change-score comparisons.

2.7 Ethical considerations

The thesis states that institutional and relevant authority approvals were to be obtained before data collection. Participants were informed about the study purpose, procedures, voluntary participation, confidentiality, and their right to decline or withdraw without penalty. Written informed consent was described, and questionnaire responses were anonymized/coded.

3. Results

3.1 Participant characteristics

Complete data were available for the 148 participants included in the principal composite-outcome analyses, with 74 in each group. No statistically significant group-composition differences were identified for the demographic and professional characteristics reported in the thesis.

Table 2. Demographic and professional characteristics of study participants (N=148).

Characteristic	Category	Control n (%)	Intervention n (%)	Total n (%)
Age	Under 30	10 (13.5%)	7 (9.5%)	17 (11.5%)
	30–39	25 (33.8%)	24 (32.4%)	49 (33.1%)
	40–49	23 (31.1%)	29 (39.2%)	52 (35.1%)
	50–59	13 (17.6%)	10 (13.5%)	23 (15.5%)
	≥60	3 (4.1%)	4 (5.4%)	7 (4.7%)
Gender	Male	28 (37.8%)	29 (39.2%)	57 (38.5%)
	Female	46 (62.2%)	45 (60.8%)	91 (61.5%)
Education	Diploma	6 (8.1%)	9 (12.2%)	15 (10.1%)
	Bachelor's	50 (67.6%)	42 (56.8%)	92 (62.2%)
	Master's	14 (18.9%)	20 (27.0%)	34 (23.0%)
	Doctoral	4 (5.4%)	3 (4.1%)	7 (4.7%)
Nursing experience	<5 years	10 (13.5%)	13 (17.6%)	23 (15.5%)
	5–9 years	22 (29.7%)	16 (21.6%)	38 (25.7%)
	10–14 years	24 (32.4%)	22 (29.7%)	46 (31.1%)
	15–19 years	14 (18.9%)	19 (25.7%)	33 (22.3%)
	≥20 years	4 (5.4%)	4 (5.4%)	8 (5.4%)
Prior formal digital training	No	41 (55.4%)	38 (51.4%)	79 (53.4%)
	Yes	33 (44.6%)	36 (48.6%)	69 (46.6%)
Leadership level	Frontline/supervisory	31 (41.9%)	38 (51.4%)	69 (46.6%)
	Middle management	30 (40.5%)	28 (37.8%)	58 (39.2%)
	Senior/strategic	13 (17.6%)	8 (10.8%)	21 (14.2%)

3.2 Baseline digital-system exposure

Baseline exposure to EHRs, KPI dashboards, and KPI-related decision-making was variable. For each of these indicators, sometimes was the most common response.

Table 3. Baseline exposure to digital systems and KPI-related decision-making.

Indicator	Never	Rarely	Sometimes	Often	Daily/Very often
EHR use	15 (10.1%)	33 (22.3%)	72 (48.6%)	23 (15.5%)	5 (3.4%)
KPI dashboard use	14 (9.5%)	46 (31.1%)	60 (40.5%)	25 (16.9%)	3 (2.0%)
KPI decision-making	6 (4.1%)	46 (31.1%)	57 (38.5%)	33 (22.3%)	6 (4.1%)

3.3 Reliability and baseline outcomes

All reported multi-item measures met the predefined reliability criterion of $\alpha \geq .70$ at both measurement occasions. Knowledge coefficients were .833 at pretest and .810 at posttest; the remaining scales ranged from .718 to .886 at pretest and .719 to .887 at posttest.

Table 4. Overall pretest and posttest descriptive statistics (N=148).

Outcome	Pretest M ± SD	Posttest M ± SD	Mean change
Knowledge (%)	47.25 ± 26.32	65.14 ± 24.06	17.88

Attitude	3.11 ± 0.65	3.46 ± 0.64	0.35
Practice	3.00 ± 0.69	3.29 ± 0.71	0.28
Digital competency	2.92 ± 0.64	3.43 ± 0.68	0.51
Digital self-efficacy	2.93 ± 0.63	3.32 ± 0.65	0.40
Perceived usefulness	3.22 ± 0.68	3.49 ± 0.63	0.27
Perceived ease of use	2.87 ± 0.66	3.23 ± 0.67	0.35
Technology utilization	2.83 ± 0.60	3.31 ± 0.71	0.48
KPI management ability	2.89 ± 0.68	3.28 ± 0.67	0.39

3.4 Intervention-associated effects

The groups showed no statistically significant baseline differences on the nine principal outcomes. The principal intervention comparisons are summarized below. For knowledge and perceived usefulness, change-score analyses received inferential priority because the homogeneity-of-regression-slopes assumption was violated.

Table 5. Principal intervention-associated effects on study outcomes.

Outcome	Control pre→post	Intervention pre→post	Primary analysis	Statistic	p	Effect size
Knowledge	47.48→52.79	47.03→77.48	Change-score t	t=-8.72	<.001	d=1.43
Attitude	3.11→3.19	3.10→3.72	ANCOVA	F(1,145)=53.38	<.001	$\eta^2=.269$
Practice	3.07→3.11	2.94→3.47	ANCOVA	F(1,145)=30.52	<.001	$\eta^2=.174$
Digital competency	2.95→3.04	2.89→3.82	ANCOVA	F(1,145)=175.09	<.001	$\eta^2=.547$
Digital self-efficacy	2.95→3.02	2.90→3.62	ANCOVA	F(1,145)=80.48	<.001	$\eta^2=.357$
Perceived usefulness	3.19→3.22	3.25→3.77	Change-score t	t=-5.22	<.001	d=.86
Perceived ease of use	2.89→2.89	2.85→3.56	ANCOVA	F(1,145)=89.62	<.001	$\eta^2=.382$
Technology utilization	2.79→2.96	2.87→3.66	ANCOVA	F(1,145)=79.97	<.001	$\eta^2=.355$
KPI management ability	2.93→2.91	2.85→3.65	ANCOVA	F(1,145)=192.48	<.001	$\eta^2=.570$

The largest valid ANCOVA effect-size estimates were observed for perceived KPI management ability ($\eta^2=.570$) and digital competency ($\eta^2=.547$). The adjusted posttest means for technology utilization were 2.986 (95% CI 2.885–3.087) in the control group and 3.632 (95% CI 3.531–3.733) in the intervention group. For KPI management ability, the corresponding adjusted means were 2.886 (95% CI 2.807–2.965) and 3.670 (95% CI 3.591–3.749).

3.5 Demographic and professional factors

Within the intervention group (n=74), bivariate analyses identified positive associations between posttest technology utilization and age group ($p=.320$, $p=.005$), total nursing experience ($p=.380$, $p<.001$ in the reported

table), and leadership/supervisory experience ($p=.368$, $p=.001$). Educational level and leadership level were not significantly associated. Previous formal digital healthcare training did not produce a significant difference in posttest technology utilization ($p=.092$).

Table 6. Multivariable regression predicting posttest technology utilization in the intervention group (n=74).

Predictor	B	SE B	β	t	p	95% CI for B	VIF
Age group	.002	.127	.002	.012	.990	-.251 to .254	3.42
Educational level	.072	.097	.083	.746	.458	-.122 to .267	1.03
Total nursing experience	.116	.137	.217	.842	.403	-.159 to .390	5.55
Leadership/supervisory experience	.122	.146	.188	.840	.404	-.168 to .413	4.23
Previous formal digital training	.190	.139	.153	1.366	.177	-.088 to .468	1.05
Leadership level	.074	.102	.080	.726	.471	-.129 to .276	1.03

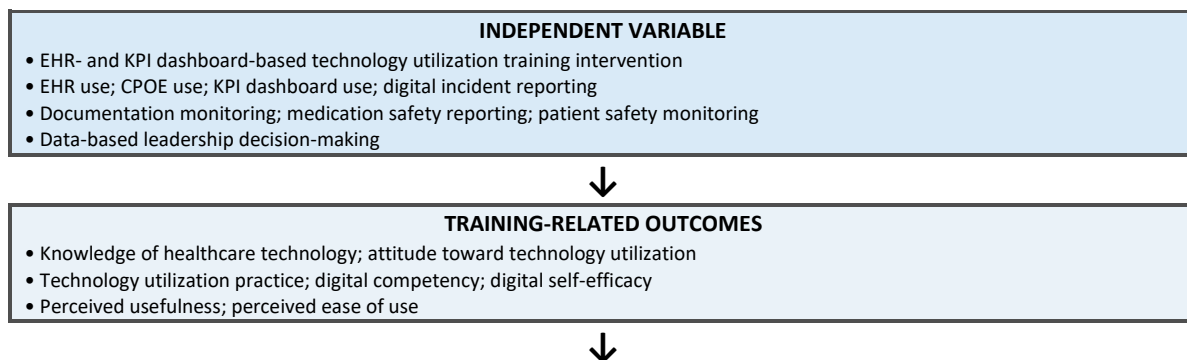
The six-predictor regression model was statistically significant overall, $F(6,67)=2.83$, $p=.016$, accounting for 20.2% of the variance in posttest technology utilization. However, no individual predictor had a statistically significant adjusted coefficient.

3.6 Organizational support

Organizational support was treated as a contextual variable rather than a principal intervention outcome. The control group changed from 2.85 ± 0.66 to 2.94 ± 0.59 , while the intervention group changed from 3.00 ± 0.77 to 3.05 ± 0.58 . The between-group change was not statistically significant ($t=.70$, $p=.482$).

3.7 Conceptual framework

The thesis conceptual framework proposes a developmental sequence from training through knowledge/attitude/practice, digital skill and self-efficacy, perceived usefulness/ease of use, technology use, and KPI management ability. The thesis explicitly states that this sequence was not formally tested as a mediation or causal-ordering model.



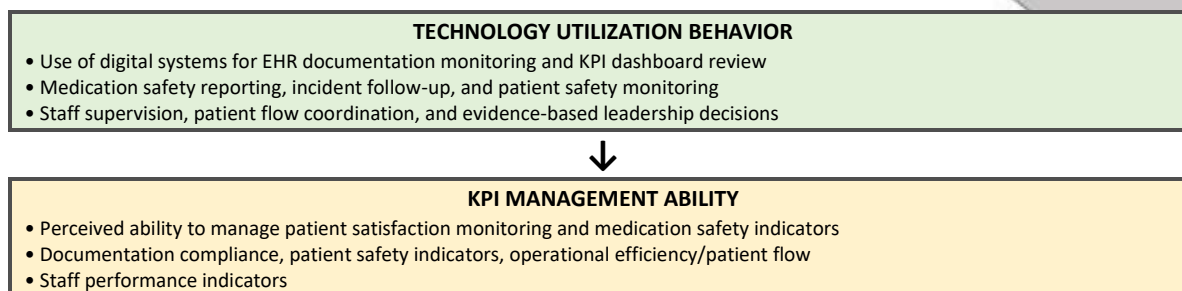


Figure 1. Conceptual framework of the EHR- and KPI dashboard-based technology utilization training intervention.

4. Discussion

The principal finding was a consistent pattern of greater short-term improvement in the intervention group across the measured technology-related outcomes. The intervention was associated with significant differences in knowledge, attitude, practice, digital competency, digital self-efficacy, perceived usefulness, perceived ease of use, technology utilization behavior, and perceived KPI management ability.

The baseline findings indicate a distinction between working in a digitally enabled environment and possessing advanced digital-leadership capability. Mean baseline knowledge was 47.25%, while attitude and practice were 3.11 and 3.00, respectively. Exposure to EHRs, KPI dashboards, and KPI-related decision-making was variable, with “sometimes” the most common response. This pattern supports the thesis distinction between technology availability and leadership-level utilization.

Knowledge demonstrated a large between-group change ($d=1.43$). The intervention directly addressed EHRs, dashboards, CPOE, digital reporting, documentation monitoring, medication safety, patient safety, and data-based decision-making through instruction, guided practice, scenarios, and simulation. The magnitude is compatible with the multimethod educational approach described in the thesis and with the cited systematic-review evidence on digital-competence education (Kulju et al., 2024).

Attitude and practice also improved, although the effect for practice ($\eta^2=.174$) was smaller than the effects for digital competency and KPI management ability. This difference is important because knowledge and perceptions can change more rapidly than behavior embedded in established workflows. The thesis emphasizes that sustainable technology use also depends on time, system access, technical support, workflow, and organizational reinforcement.

Digital competency showed one of the strongest effects ($\eta^2=.547$), consistent with the intervention’s direct focus on role-specific digital tasks. Participants practiced EHR navigation, information retrieval, KPI interpretation, medication-safety and incident-reporting information, and translation of digital performance information into leadership action. The finding is consistent with the thesis literature emphasizing role-specific and competency-based digital training (Nguyen et al., 2024; Longhini et al., 2022).

Digital self-efficacy also increased substantially ($\eta^2=.357$). Repeated guided practice and successful completion of digital tasks provide a plausible explanation for increased confidence. However, the study did not test mediation; therefore, the findings do not establish that competency caused self-efficacy or that self-efficacy subsequently caused technology utilization.

Perceived usefulness and perceived ease of use both improved. These findings are consistent with the Technology Acceptance Model literature cited in the thesis (Davis, 1989; Tetik et al., 2024). The intervention linked technology to concrete leadership functions, including safety monitoring, documentation compliance, KPI review, operational management, staff supervision, and corrective action. Nevertheless, TAM was not formally tested as a structural causal model in this study.

Technology utilization behavior increased from 2.87 to 3.66 in the intervention group compared with 2.79 to 2.96 in the control group, with a significant adjusted group effect ($\eta^2=.355$). This extends the observed pattern beyond knowledge and perceptions toward self-reported behavior. However, utilization was not verified through EHR audit logs or dashboard-access records, and the posttest assessed only short-term change.

Perceived KPI management ability produced the largest valid ANCOVA effect ($\eta^2=.570$). The strong effect is plausibly related to the close alignment between intervention content and the outcome construct. The training addressed KPI dashboards, documentation monitoring, medication safety, patient safety, operational flow, staff performance, root-cause analysis, and corrective-action planning. The finding therefore supports improvement in perceived capability to manage KPI-related information, but not improvement in the institutional KPIs themselves.

The demographic findings were mixed. Age, nursing experience, and leadership experience were positively associated with technology utilization in bivariate analyses, but none remained independently significant in the multivariable model. The thesis notes overlap among age and experience variables and VIF values of 3.42, 5.55, and 4.23. Accordingly, the findings do not support demographic determinism or claims that age or professional experience independently predicts successful technology adoption after adjustment.

Organizational support did not change significantly. This distinction is important: the intervention targeted individual knowledge, capability, confidence, perceptions, and behavior, whereas organizational support reflects a broader implementation environment. The result therefore separates individual capability development from organizational transformation. Taken together, the findings are consistent with the conceptual sequence proposed in the thesis training, knowledge/attitude/practice, digital skill and self-efficacy, perceived usefulness/ease of use, technology utilization, and KPI management ability. However, the sequence remains conceptual. No mediation, structural-equation, cross-lagged, or longitudinal causal analysis was performed.

4.1 Strengths

- The control-group pretest–posttest structure allowed intervention-group to change to be interpreted in relation to contemporaneous change in the control group.
- Baseline measurement enabled examination and statistical adjustment of baseline outcome variation.
- ANCOVA was used where assumptions were satisfied, while assumption violations for knowledge and perceived usefulness were explicitly recognized and change-score analyses were prioritized.
- Effect sizes were reported alongside p-values.
- All reported scales met the predefined reliability criterion at both measurement occasions.
- The intervention was specifically tailored to nursing leadership responsibilities rather than general end-user technology orientation.

4.2 Limitations

- The quasi-experimental nonequivalent-group design does not provide the causal certainty of a randomized trial, and residual selection bias cannot be excluded.
- Most primary outcomes were self-reported, creating potential for social desirability, response-shift, recall, and over- or under-estimation of actual capability.
- The training content was closely aligned with several measured outcomes, creating the possibility of strong short-term near-transfer effects.
- Objective institutional KPI outcomes were not measured. Changes in patient satisfaction, medication errors, falls, pressure injuries, documentation compliance, length of stay, patient flow, or staff turnover therefore cannot be inferred from the present findings.
- No longer-term follow-up was reported, so sustainability of the improvement observed is unknown.
- Potential contamination between intervention and control participants within the same health-cluster setting cannot be conclusively excluded.
- The RQ6 regression was based on 74 intervention participants and included six predictors, with overlap among age and experience variables.

- Multiple testing was present in the exploratory RQ6 analyses, and no multiplicity correction was reported.
- Unmodeled organizational clustering may have affected individual-level analyses because participants were drawn from multiple facilities and organizational settings.

5. Conclusion

In this quasi-experimental study of nursing leaders in the Second Medical Health Cluster, Saudi Arabia, participation in a structured EHR- and KPI dashboard-based technology utilization training intervention was associated with significantly greater short-term improvement than the control condition across knowledge, attitude, practice, digital competency, digital self-efficacy, perceived usefulness, perceived ease of use, self-reported technology utilization behavior, and perceived KPI management ability. The strongest valid adjusted effects were observed for perceived KPI management ability and digital competency.

The findings support the view that leadership-specific digital capability can be developed through structured, applied training. However, the study measured primarily individual-level and self-reported outcomes and did not demonstrate improvements in institutional or clinical KPIs, sustained implementation, or a causal mediation pathway. The evidence therefore supports an association between the intervention and short-term improvement in measured digital-health leadership outcomes rather than proof of direct organizational or clinical performance improvement.

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