

Role of Leadership Competencies on Digital Health Adoption and the Parallel Mediation effects of Change Readiness and Training Effectiveness in a Saudi Tertiary Hospital

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HOW TO CITE:

Omar Hamed Alharbi, Farra Aidah Jumuddin (2026). Role of Leadership Competencies on Digital Health Adoption and the Parallel Mediation effects of Change Readiness and Training Effectiveness in a Saudi Tertiary Hospital. International Journal of Special Education, 41(11s), 536-549

ABSTRACT:

Background: Digital health transformation is a major factor in the journey towards fulfilling the Saudi's vision 2030. However, there has been uneven adoption trends among the leading healthcare facilities in the country, and the mediation mechanisms around leadership on the adoption success remain poorly explored.

Objective: This study examined the direct and indirect impacts of leadership competencies on digital health adoption through the mediating roles of change readiness of healthcare providers and training effectiveness at King Salman Medical City (KSMC), Madinah.

Methods: A cross-sectional analytical design was applied whereby 387 participants were recruited through stratified sampling across different healthcare professions at KSMC. Leadership competencies were assessed with the Leadership Practices Inventory, Organisational Change Readiness with an Organisational Change Readiness Scale based on Weiner's theory, and Training Effectiveness was assessed with a scale based on the principles of Kirkpatrick. Technology Acceptance Model-based scale was used to measure digital health adoption. Statistical analyses were performed using SPSS and SPSS-AMOS, version 28.

Results: The study established a direct and statistically significant impact of leadership competencies on digital health adoption ($\beta = 0.34$, $p < .001$); and at the same time, a parallel mediation effects exerted by change readiness ($\beta = 0.16$, 95% CI [0.098, 0.234]) and training effectiveness ($\beta = 0.12$, 95% CI [0.071, 0.182]). The two mediators in the model jointly accounted for 45.2% of the total effect ($\beta = 0.62$). Overall, the model accounted for 61.3% of the variance in the adoption. Enable Others to Act was noted as the most influential predictor of leadership for the adoption ($\beta = .26$).

Conclusion: Leadership competencies have significant roles on digital health adoption practices in KSMC, and this influence can be exerted through psychological and capability building pathways, which call for leadership development and training initiatives.

Keywords: leadership competencies; digital health adoption; change readiness; training effectiveness; parallel mediation; Saudi Arabia.

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1. Introduction

The application of digital health adoption platforms, such as Electronic Health Records (EHRs), telemedicine platforms, clinical decision support systems (CDSS), artificial intelligence (AI) applications, and mobile health (mHealth), continue to revolutionize health care delivery globally (Abernethy et al., 2022; WHO, 2020). Among the other countries, Saudi Arabia has been actively working towards this transformation through its Vision 2030 and the National Transformation Program, which have pledged to increase the use of electronic health records, expand the scope of telehealth, and develop competent healthcare professionals (Al-Kahtani et al., 2022; Suleiman & Ming, 2025). Although the adoption success in Saudi Arabia has been inconsistent across studies, some pieces of evidence have indicated that human and organisational factors pose the main obstacle to the sustained adoption rather than technological capability (Borges do Nascimento et al., 2023; Mair et al., 2012). The psychological aspect remains strong in the adoption journey.

Among the many possible factors, leadership has always been repeatedly cited as one of the key enablers of technology uptake in healthcare (Laukka et al., 2022). Leaders can directly impact adoption by various means, such as role modelling, resource allocation and cultural framing, among other approaches (Burgess & Honey, 2022). The mechanisms that link leadership to outcomes are, however, not been tested in a single integrated model in the Gulf Cooperation Council (GCC) and particularly at KSMC, as the power distance and collectivist cultures of the organisations might increase the effect of leadership in contrast to Western cultures (Hofstede, 2001). Two possible intervening variables thus stand out as change readiness (Weiner, 2009), and training effectiveness, which refers to whether digital health training is effective in developing sustainable competency at work (Kirkpatrick, 1994).

With such an apparent gap having been noted, this study sought data from KSMC, a tertiary

hospital in Madinah that treats more than 2.5 million residents and millions of pilgrims per year (KSMC, 2024). The study assessed a dual parallel mediation model based on the Leadership Practices Inventory (LPI) to assess leadership competencies (Kouzes & Posner, 2017). Accordingly, a set of seven hypotheses were tested: leadership competencies positively influence digital health adoption (H1), change readiness (H2), and training effectiveness (H3); change readiness (H4) and training effectiveness (H5) positively impact adoption; and change readiness (H6) and training effectiveness (H7) both significantly mediate the relationship between leadership competencies and digital health adoption.

2. Literature Review and Conceptual Framework

Healthcare leadership competencies have been translated into a variety of frameworks, but one of the most widely used in clinical setting is the LPI developed by Kouzes and Posner (2017) which consists of five competency domains: Model the Way, Inspire a Shared Vision, Challenge the Process, Enable Others to Act and Encourage the Heart. The direct linkage between leadership competencies and digital health adoption has strong baseline in the literature. In fact, there is consistent evidence, including from a multi-country scoping review conducted by Laukka et al. (2022), that leadership support is the most widely referenced factor that influences successful technology implementation. Evidence from Saudi-based research has also shown that leadership involvement is predicted to be a major determinant of digital health technology usage in primary care (Alzghaibi & Hutchings, 2024).

Despite the available evidence linking leadership competencies and digital health adoption, change readiness and training effectiveness also stand strong in the technology adaption approaches. Weiner's (2009) Organisational Readiness for Change Theory conceptualises readiness as a psychological collective state that encompasses change commitment (the willingness to move to change) and change efficacy (the belief in the ability to change) which is significantly influenced

by leadership communication, provision of resources and culture. The perception of support from and credibility of leaders is associated with increased readiness for technology-related change among healthcare providers (Austin et al., 2020; Boyacı & Söyük, 2025). In parallel to this psychological pathway, Kirkpatrick's four level model (reaction, learning, behaviour, results) frames training effectiveness as a capacity building process, and leadership support for training has been shown to be a more effective predictor for transfer than either motivation or programme design (Burke & Hutchins, 2007; Gegenfurtner et al., 2009).

These elements, including training effectiveness and change readiness can align with the digital health adoption techniques, often described by Technology Adaption Model (TAM), which involves perceived usefulness, perceived ease of use, behavioural intention and trust in system and support, the latter for security and reliability concerns that are relevant to clinical technology adoption (Davis, 1989; Venkatesh et al., 2003). Nevertheless, although each of the three elements (leadership–readiness, leadership–training, and leadership–adoption) have been given some empirical consideration, no prior work has tested the three simultaneously in one structural model, and the relative contribution of change readiness and training effectiveness as parallel mediators of the relationship between leadership and adoption is not yet explored, especially in the Saudi context of tertiary care.

3. Methods

Design and Setting

This study followed the principles and protocols of a cross-sectional, analytical, quantitative design, and was conducted at King Salman Medical City, which is a tertiary referral hospital in Madinah, Saudi Arabia. The design was considered most appropriate setting due to its ability to determine the existence, direction and strength of relationships between the constructs of the study through inferential statistical analysis and its use in health services and organisational behaviour literature to test theoretically based structural relationships has been widely and

consistently used (Creswell & Creswell, 2018). The choice of KSMC as a research site was determined by its requirement as a tier-one tertiary institute actively working for the digital health transformation, its size and the diversity of its healthcare workforce, and the facilitation offered by its IRB.

Participants and Sampling

A total of 387 healthcare providers participated in this study. These were healthcare professionals selected through stratified random sampling across various professional categories (physicians, nurses, allied health professionals, pharmacists, and clinical managers/supervisors) and department types (clinical and administrative-clinical), to ensure a representative cross-section of the KSMC clinical workforce. The sample size needed for questionnaire was determined based on the number of expected usable responses ($N = 350$) with a target response rate of 75% and allowing for 5% data-quality exclusion, which is consistent with other published Saudi healthcare survey studies reporting usable response rates of between 71% and 84% (Aldosari, 2014; Alzghaib & Hutchings, 2024).

Instruments

Data was collected using a research questionnaire with four main scales. The first one was the Leadership Practices Inventory adapted from Kouzes and Posner (2017), which was used to assess leadership competencies using 30 items across five subscales: Model the Way, Inspire a Shared Vision, Challenge the Process, Enable Others to Act, and Encourage the Heart. The second was the Organisational Change Readiness Scale based on Weiner's (2009) theory, consisting of 16 items across three subscales: Change Commitment, Change Efficacy, Contextual Readiness. This scale was used to measure change readiness. The third, Training Effectiveness Scale, was adapted from Kirkpatrick (1994) and used to measure training effectiveness, consisting of 12 items on four subscales: Training Relevance, Knowledge Gain, Skill Transfer, Behavioural Change.

The last scale was the digital health adoption, which was used to assess adoption of digital health technology based on the TAM (Davis, 1989). This scale consists of 16 items across four sub scales: Perceived Usefulness, Perceived Ease of Use, Behavioural Intention, Trust in System and Support. The questions used were on a 5-point Likert scale. Pilot testing was done on all

the scales, and revealed acceptable to good reliability at the subscale level for all instruments. The pilot study ($n = 30$) was conducted to check for sampling adequacy, internal consistency, and discriminant validity of the constructs, and adequate results were obtained ($KMO = .87$, $\alpha = .80-.93$, $r = .41-.59$ for inter-scale) (Table 1).

Table 1. Convergent validity indices ($n = 30$)

Scale	Cronbach's α	Composite Reliability (CR)	AVE	AVE Threshold
Leadership Competencies	.93	.94	.58	$\geq .50$
Change Readiness	.91	.92	.54	$\geq .50$
Training Effectiveness	.89	.90	.51	$\geq .50$
Digital Health Adoption	.92	.93	.56	$\geq .50$

Note: Threshold values: CR $\geq .70$; AVE $\geq .50$ (Hair et al., 2019; Fornell & Larcker, 1981)

Data Analysis

After obtaining institutional ethics clearance (KSMC-IRB-2026), the questionnaires were sent electronically (e-mail) and in hard copy within 4-6 weeks, excluding periods of high activity during the Hajj/Umrah. Normality of the data collected was checked before analysis (Skewness < 2.0 and Kurtosis < 7.0). Subsequently, confirmatory factor analysis (CFA) was performed to test the hypothesized four-factor measurement model and to determine convergent and discriminant validity with the Fornell-Larcker criterion (Fornell & Larcker, 1981). Structural equation modelling (SEM) was then used to estimate the hypothesised direct and parallel indirect (mediated) paths simultaneously. In addition to modelling latent constructs with a minimum of measurement error, SEM was also chosen because of its ability to estimate direct and indirect effects within a single integrated framework (Hair et al., 2019). Indirect effects were estimated by bias-corrected bootstrapping

(5,000 resamples) and significant mediation was considered at 95%.

4. Results

Sample and Data Quality

Of 450 questionnaires distributed, 401 (89.1%) were returned with 14 questionnaires having response errors, thereby ending up with a final 86.0% response rate. Univariate outliers were found through the diagnostic checks; skewness ranged from -0.67 to 0.43 , which were within the acceptable range; kurtosis ranged from -0.52 to 1.18 , which was also within acceptable limits; variance inflation factors were less than 2.87 ; and a Harman single-factor test accounted for only 27.3% of variance, which was well below the threshold for common method bias (Podsakoff et al., 2003).

The demographic profiles show that highest proportion of respondents were nurses (35.4%), worked in the clinical departments (77.0%), females (54.3%) and from 30-49 years old (68.0%) (Table 2).

Table 2. Demographic Characteristics of Respondents (N = 387)

Variable	Category	Frequency (N)	Percentages (%)
Age Group	20-29 years	68	17.6
	30-39 years	142	36.7
	40-49 years	121	31.3
	50+ years	56	14.5
Gender	Male	177	45.7
	Female	210	54.3
Professional Category	Physicians	110	28.4
	Nurses	137	35.4
	Allied Health Professionals	55	14.2
	Pharmacists	50	12.9
	Clinical Managers/Supervisors	35	9.1
Education Level	Diploma	52	13.4
	Bachelor's Degree	184	47.5
	Master's Degree	98	25.3
	Doctorate	53	13.7
Years of Experience	< 2 years	77	19.9
	2-5 years	112	28.9
	6-10 years	107	27.6
	> 10 years	91	23.5
Department Type	Clinical	298	77.0
	Administrative-Clinical	89	23.0

Note. Percentages may not total 100% due to rounding

Descriptive Statistics and Measurement Model

Leadership competencies had the highest overall mean ($M = 3.78$, $SD = 0.68$), followed by digital health adoption ($M = 3.68$), change readiness ($M = 3.64$) and training effectiveness ($M = 3.52$, the lowest of the four constructs). Higher order Kirkpatrick outcomes (Skill Transfer, $M = 3.44$;

Behavioural Change, $M = 3.46$) scored lower than reaction-level outcomes (Training Relevance, $M = 3.71$), indicating that providers perceive that training is being informative, but not always transforming in practice. Reliabilities for all scales were very high ($\alpha = .89-.94$, composite reliability $\geq .90$; AVE = .52-.61) (Table 3).

Table 3. Descriptive Statistics, Reliability, and Construct-Level Indices (N = 387)

Construct / Dimension	M	SD	Skew	Kurt	α	CR	AVE
Leadership Competencies (Overall)	3.78	0.68	-0.41	0.18	0.94	0.94	0.61
Model the Way	3.76	0.72	-0.12	-0.16	0.88	-	-
Inspire a Shared Vision	3.74	0.75	-0.19	0.06	0.90	-	-
Challenge the Process	3.69	0.74	-0.28	-0.07	0.87	-	-
Enable Others to Act	3.91	0.65	-0.11	-0.10	0.89	-	-
Encourage the Heart	3.83	0.71	0.09	0.18	0.91	-	-
Change Readiness (Overall)	3.64	0.71	-0.08	0.07	0.91	0.91	0.55
Change Commitment	3.78	0.68	-0.08	-0.35	0.86	-	-
Change Efficacy	3.51	0.76	-0.06	-0.18	0.84	-	-
Contextual Readiness	3.63	0.73	0.14	-0.15	0.85	-	-
Training Effectiveness (Overall)	3.52	0.73	-0.23	0.20	0.89	0.90	0.52
Training Relevance	3.71	0.69	-0.07	-0.44	0.83	-	-
Knowledge Gain	3.58	0.74	-0.17	0.23	0.81	-	-
Skill Transfer	3.44	0.81	-0.15	0.59	0.80	-	-
Behavioural Change	3.46	0.78	-0.04	-0.06	0.82	-	-
Digital Health Adoption (Overall)	3.68	0.69	0.22	0.24	0.92	0.92	0.58
Perceived Usefulness	3.82	0.66	-0.11	-0.22	0.87	-	-
Perceived Ease of Use	3.70	0.72	0.09	0.11	0.85	-	-
Behavioural Intention	3.64	0.74	0.16	0.03	0.86	-	-
Trust in System & Support	3.49	0.77	0.04	0.00	0.84	-	-

Note. α = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted. All Cronbach's α values exceeded the 0.70 threshold; CR $\geq$ 0.90 and AVE $\geq$ 0.50 for all constructs confirm suitable psychometric features (Hair et al., 2019). All skewness and kurtosis values fall within acceptable limits.

The analysis shows confirmatory factor analysis indicating an acceptable fit for the four-factor measurement model ($\chi^2/df = 2.47$; CFI = .934; TLI = .928; RMSEA = .062; SRMR = .048), and the Fornell-Larcker criterion also confirmed discriminant validity. The square root of AVE exceeded the inter-construct correlations for all constructs (Table 4).

Table 4. Confirmatory Factor Analysis Model Fit Indices (N = 387)

Fit Index	Observed Value	Recommended Threshold
χ^2 (Chi-square)	$\chi^2(521) = 1,284.52, p < 0.001$	Non-significant (sensitive to large N)
χ^2/df Ratio	2.47	< 3.0
Comparative Fit Index (CFI)	0.934	> 0.90
Tucker–Lewis Index (TLI)	0.928	> 0.90
RMSEA	0.062	< 0.08
RMSEA 90% CI	[0.057; 0.066]	-
SRMR	0.048	< 0.08

Note. RMSEA = Root Mean Square Error of Approximation; SRMR = Standardised Root Mean Square Residual; CFI = Comparative Fit Index; TLI = Tucker-Lewis Index; CI = confidence interval; df = degrees of freedom. The significant χ^2 is expected given the large sample size (N = 387); the χ^2/df ratio of 2.47 confirms adequate fit.

Structural Model and Hypothesis Testing

The model exhibited a good fit ($\chi^2/\text{df} = 2.51$; CFI = .929; TLI = .922; RMSEA = .064; SRMR = .052) and accounted for 61.3% of variance in the digital health adoption, 33.6% in change readiness, and 26.0% in training effectiveness. Each of the seven hypotheses was supported at $p < .001$. The direct effect of the leadership

competencies on the adoption was moderate (H1: $\beta = .34$), the direct effect of the leadership competencies on the readiness to change was strong (H2: $\beta = .58$, the strongest path in the model), and the direct effect of the leadership competencies on the training effectiveness was strong (H3: $\beta = .51$). Both readiness (H4: $\beta = .28$) and training effectiveness (H5: $\beta = .24$) were significant predictors of adoption (Table 5).

Table 5. Structural Model Results and Hypothesis Testing Summary (N = 387)

H	Path	β	SE	CR	p
H1	The direct positive effect of LC on DHA	0.34	0.052	6.54	< 0.001
H2	The direct positive effect of LC on CR	0.58	0.048	12.08	< 0.001
H3	The direct positive effect of LC on TE	0.51	0.051	10.00	< 0.001
H4	The direct positive effect of CR on DHA	0.28	0.054	5.19	< 0.001
H5	The direct positive effect of TE on DHA	0.24	0.056	4.29	< 0.001
H6	The indirect positive effect of LC on DHA via CR	0.16	-	-	< 0.001
H7	The indirect positive effect of LC on DHA via TE	0.12	-	-	< 0.001

Note. LC = Leadership Competencies; CR = Change Readiness; TE = Training Effectiveness; DHA = Digital Health Adoption. β = standardised path coefficient; SE = standard error; CR = critical ratio. Indirect effects (H6, H7) tested via bootstrapping (5,000 resamples, bias-corrected 95% CIs). $p < .001$ for all paths.

Disaggregating leadership into its five LPI dimensions showed that Enable Others to Act was the strongest predictor of all three downstream outcomes ($\beta = .31$ on change readiness, .22 on training effectiveness, .26 on adoption), while Challenge the Process contributed least. At the subscale level, Change Commitment ($r = .38$) was the strongest readiness predictor of adoption, ahead of Change Efficacy and Contextual Readiness, while Skill Transfer ($r = .37$) and Behavioural Change ($r = .34$) outperformed Training Relevance ($r = .19$) as training-related predictors, indicating that

satisfaction with training does not, by itself, predict adoption.

Mediation Analysis

The total effect of leadership competencies on adoption was $\beta = .62$, comprising a direct effect ($\beta = .34$, 54.8% of total effect) and indirect effects via change readiness (H6: $\beta = .16$, 95% CI [.098, .234], 25.8%) and training effectiveness (H7: $\beta = .12$, 95% CI [.071, .182], 19.4%). Confidence intervals for both partial mediation pathways were far from zero, indicating significant mediation for both pathways with the second being change readiness (Table 6).

Table 6. Mediation Analysis Results — Bootstrapped Indirect Effects

Pathway	β Direct	β Indirect	95% CI	p	% Total Effect
LC to DHA via CR	0.34	0.16	[.098, .234]	< 0.001	25.8%
LC to DHA via TE	0.34	0.12	[.071, .182]	< 0.001	19.4%
Combined indirect (H6 + H7)	0.34	0.28	-	< 0.001	45.2%
Total effect (LC to DHA)	-	-	-	< 0.001	100%

Note. All indirect effects tested using bias-corrected bootstrap confidence intervals (5,000 resamples). Confidence intervals not crossing zero confirm statistically significant mediation. LC = Leadership Competencies; CR = Change Readiness; TE = Training Effectiveness; DHA = Digital Health Adoption.

The direct and mediation effects are illustrated in Figure 1.

Figure 1. Dual-Mediation Model showing the Leadership Competencies and Digital Health Adoption (N = 387)

Subgroup Differences

There were differences in change readiness by professional category, with clinical managers at the high end of the spectrum (M = 3.92), and

allied health professionals at the low end (M = 3.47); however, there was no significant difference between physicians and other categories of nurses ($F(4, 382) = 4.87$, $p = .001$, $\eta^2p = .049$). Staff who had over 10 years' experience had higher scores on the adoption than staff with less than 2 years' experience ($F(3, 383) = 3.64$, $p = .013$, $\eta^2p = .034$). The training effectiveness was slightly higher for men than for women ($t(385) = 2.31$, $p = .022$, $d = .24$) but not for education level or for department type.

Table 7. Subgroup Analysis Results — Mean Scores by Demographic Category (N = 387)

Demographic Variable / Category	LC M (SD)	CR M (SD)	TE M (SD)	DHA M (SD)	Test Statistic	p	Effect Size
Gender (t-test; df = 385)							
Male (n = 177)	3.83 (0.61)	3.70 (0.63)	3.66 (0.68)	3.79 (0.66)	t = 0.82	.411	-
Female (n = 210)	3.77 (0.62)	3.63 (0.72)	3.50 (0.69)	3.70 (0.70)	t = 2.31*	.022*	d = .24 Small
Professional Category (ANOVA; df = 4, 382)							
Physician (n = 110)	3.61 (0.62)	3.44 (0.66)	3.57 (0.69)	3.72 (0.70)	LC: F = 3.04*	.017*	$\eta^2p = .031$ Small
Nurse (n = 137)	3.86 (0.60)	3.76 (0.69)	3.57 (0.73)	3.77 (0.71)	CR: F = 4.88**	.001**	$\eta^2p = .049$ Sm–Med
Allied Health (n = 55)	3.83 (0.65)	3.54 (0.66)	3.61 (0.66)	3.70 (0.64)	TE: F = 0.47	.756	Neg.
Pharmacist (n = 50)	3.90 (0.56)	3.81 (0.60)	3.63 (0.62)	3.74 (0.68)	DHA: F = 0.16	.959	Neg.
Clin. Manager (n = 35)	3.81 (0.62)	3.79 (0.64)	3.44 (0.70)	3.70 (0.62)			
Years of Experience (ANOVA; df = 3, 383)							
< 2 years (n = 77)	3.80 (0.63)	3.67 (0.71)	3.63 (0.77)	3.52 (0.62)	LC: F = 0.33	.803	Neg.
2–5 years (n = 112)	3.84 (0.61)	3.68 (0.64)	3.52 (0.68)	3.70 (0.73)	CR: F = 0.14	.937	Neg.
6–10 years (n = 107)	3.79 (0.64)	3.62 (0.69)	3.49 (0.66)	3.80 (0.69)	TE: F = 1.86	.137	Small
> 10 years (n = 91)	3.75 (0.59)	3.66 (0.69)	3.69 (0.66)	3.89 (0.63)	DHA: F = 4.55**	.004**	$\eta^2p = .034$ Small

5. Discussion

Leadership is a significant direct contributor of digital health adoption, and this finding concurs with a large amount of international evidence. For instance, leadership support was reported in most studies (47 of 48) across all of the 15 countries in the systematic review conducted by Laukka et al. (2022). At the same time, in the public sector context, AlNuaimi et al. (2022) discovered that digital transformational leadership was a key factor in the successful execution of digital transformation and identified leadership effects as being channelled through organisational agility. At a microlevel, within Saudi Arabia, Alzghaibi and Hutchings (2024) found transformational leadership behaviours to be a significant predictor of EHR implementation success at three regions of the country. Other researchers have also showed that leadership commitment was a success factor for the adoption of health information system in tertiary care (Mwogosi & Kibusi, 2024; Syahbana et al., 2026).

The present study builds on these regional findings by breaking leadership down into its component LPI practices, and the results show that Enable Others to Act has a greater regional importance compared with the other four domains. This observation aligns with theory of distributed leadership which suggests that the adoption of innovation is more successful when leadership influence is distributed throughout various levels of the healthcare hierarchy, rather than it being centralized at the top of the hierarchy (Fitzgerald et al., 2013).

It is noteworthy that the size of the leadership effect that was found at KSMC seems higher than the effects found in similarly structured Western healthcare environments (Ingebrigtsen et al., 2014; Sligo et al., 2017). A cultural-amplification interpretation of high power-distance norms may be a key player in this observation: in the Saudi Arabian culture, subordinate employees are more likely to respond to leadership direction and more likely to be sensitive to leadership signals than in cultures with lower power-distance norms (Hofstede, 2001). Interestingly, the same

observation had been reported in the finding of Callen, Braithwaite & Westbrook (2007), indicating that high social conformity norms in a collectivist organisation culture amplify the influence of leadership on technology adoption.

The finding that the strongest predictor of change readiness being leadership competencies supports Weiner's (2009) theoretical proposition that collective motivation and capability are influenced more by leadership behaviour than by the characteristics of the organisation. This is consistent with Mosadeghrad and Ansarian (2014) who found that transformational leadership was the most important factor in predicting readiness for quality management implementation in Iranian hospitals and Holt and Vardaman (2013) who showed that leaders' communication of change was more influential than individual characteristics and structural factors in predicting readiness. The present findings indicate that for KSMC providers, the motivation for changing (Change Commitment) is a better predictor of readiness for KSMC than is confidence in technical capacity to change (Change Efficacy), and that Change Commitment is itself substantially influenced by leader communication and behaviour (Burnes & Bargal, 2017).

The strong relationship between leadership competency and training effectiveness further supports a substantial body of literature that relates supervisory support to training transfer. Supervisor support emerged as the most consistent situational factor affecting training effectiveness, outperforming the training design quality and learner motivation in the study by Burke and Hutchins (2007). The same relationship had been noted in the meta-analysis of 30 studies by Gegenfurtner et al. (2009). These two situational factors explained significant variance in training transfer: leader-provided opportunity creation and resource provision. Still, in the field of health technology training, Boonstra et al. (2014) found that in 12 hospitals in the Netherlands, the most powerful predictor of the success of EHR training was the commitment of the hospital's leadership to training. Skill Transfer as a training related

predictor of adoption was particularly noteworthy for training design given that Alliger et al. (1997) found this to be the strongest predictor of workplace performance in a meta-analysis of training, and Gagnon et al. (2012) found that on-the-job coaching and peer support were more likely to sustain EHR use than formal classroom training alone.

The finding of significant, partial, and parallel mediation through change readiness and training effectiveness is a critical theoretical finding of this study. Unlike other explanations, the two pathways are complementary ways by which leadership influences adoption, providing a more complex picture than has been provided in previous research, which generally analyzed a single pathway between leadership and adoption separately. The marginally stronger change readiness pathway corroborates Shea et al.'s (2021) claim that, conversely, the key role of good leadership in digital health transformation is motivational, not instructional. Moreover, Edmondson and Lei (2014) also describe psychological safety as a leadership-cultivated precondition for the effective use of training and other capability investments. Simultaneously, the training effectiveness pathway was still independently significant, in line with the result of Sousa and Rocha (2019) who found that leadership behaviour influences training quality conditions in Portuguese and Brazilian health organisations, and Sung and Choi (2022) who showed that perceived leader developmental support amplifies the link between training quality and transfer.

The significant direct effect of leadership on adoption suggests that change readiness and training effectiveness do not cover all mechanisms by which leadership operate. Role modelling, for example, can be achieved through leaders' visible use of digital tools setting behavioural norms for others to follow, and structural support, whereby leaders allocate funding, time and technical resources, making it operationally feasible to adopt (Specchia et al., 2021). Additionally, the finding by this subgroup that physicians gave leadership comparatively lower ratings is consistent with a pattern in the

medical sociology literature that shows leadership is not viewed as very effective in physician-dominated clinical settings, which could make leadership development interventions that specifically target physicians' engagement with leadership more valuable for improving leadership's effectiveness in adoption in these settings (Spurgeon et al., 2011).

Limitations

The cross-sectional design of the study may not allow for clear causal inference about the temporal order of the factors of leadership, readiness, training, and adoption. However, the hypotheses posited in the direction of the causal relationships were based on existing theory that has specified leadership as the antecedents of both mediators. Also, the single-site approach may reduce the generalisability to similar contexts in tertiary hospitals in Saudi Arabia, while the self-report data collection of all constructs may introduce common method variance, which has been partially addressed by using psychometrically validated, multidimensional instruments.

6. Conclusion and Recommendations

This study is the first empirical test in a Saudi tertiary health care facility of the effect of the leadership competencies operating concurrently via parallel psychological and capability building pathways on digital health adoption. The findings reveal a direct relationship between leadership competencies and adoption and two distinct and significant mediating factors (change readiness and training effectiveness) that together explain almost half of the impact of leadership.

To reinforce enabling leadership practices along with commitment to provider change, the leadership at KSMC and other similar facilities should seek to implement integrated strategies that includes reinforcing empowering leadership practices, as well as building provider change commitment through ongoing and regular leadership communication, and redesign training programmes to focus on transfer of workplace skills rather than provider satisfaction alone. The model should be tested longitudinally and in various healthcare settings to provide temporal

ordering of the proposed pathways and to determine the extent to which the model could be generalised to other contexts.

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