OPEN ACCESS

Saudi Journal of Nursing and Health Care

Abbreviated Key Title: Saudi J Nurs Health Care
ISSN 2616-7921 (Print) |ISSN 2616-6186 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Effect of Digital Transformation on the Quality and Safety of Healthcare Services in Saudi Arabia

Faris Al-Husayni[1]*, Talaat Eldemerdash[2]

[1]Master Student, Department of Health Services and Hospitals Administration, King Abdulaziz University, Jeddah, Saudi Arabia
[2]Professor of Health Economics, Department of Health Services and Hospitals Administration, King Abdulaziz University, Jeddah, Saudi Arabia

DOI: https://doi.org/10.36348/sjnhc.2026.v09i04.002 | **Received:** 11.02.2026 | **Accepted:** 06.04.2026 | **Published:** 16.04.2026

***Corresponding author:** Faris Al-Husayni
Master Student, Department of Health Services and Hospitals Administration, King Abdulaziz University, Jeddah, Saudi Arabia

Abstract

***Background**:* Digital transformation (DT) is a critical driver of improvements in healthcare quality and patient safety globally. In Saudi Arabia, national initiatives such as Vision 2030 have accelerated digital health implementation; however, empirical evidence on DT's direct impact on hospital quality and safety outcomes remains limited. ***Objective**:* To examine the effect of DT on healthcare quality and patient safety at King Fahd Hospital in Medina, Saudi Arabia, across seven core DT components. ***Methods**:* A quantitative cross-sectional study was conducted among 278 healthcare professionals using a structured questionnaire covering seven DT domains: electronic medical record systems, digital prescribing systems, online appointment booking systems, automation of clinical tasks, automation of pharmacy dispensing systems, claims, billing and finance systems, and telemedicine platforms. Data was analyzed using SPSS with descriptive statistics, chi-square tests, and correlation analyses. ***Results**:* Participants reported consistently positive perceptions across all DT domains, with mean scores ranging from 4.00 to 4.33 on a five-point Likert scale. Online appointment booking systems showed the highest perceived contribution to quality and safety (M = 4.08), followed by electronic medical record systems (M = 4.04) and digital prescribing systems (M = 4.02). All DT components were significantly associated with perceived improvements in healthcare quality and patient safety ($p < .001$). ***Conclusion**:* DT was found to significantly and positively influence perceived healthcare quality and patient safety at King Fahd Hospital, underscoring the need for continued investment in digital health and optimization of key DT tools supported by ongoing training and strong governance.

Keywords: Digital Transformation, Healthcare Quality, Patient Safety, Electronic Medical Records, Digital Prescribing, Telemedicine, Saudi Arabia, Vision 2030.

INTRODUCTION

Digital transformation (DT) was a significant process that provided essential organizational changes using information and communication technology (Vial, 2019). DT had transformed various industries, driven by developments in advanced technologies with substantial potential to reshape multiple sectors and industries (Garcia-Perez *et al*., 2023). In the healthcare industry, DT encompassed transformations associated with digital health technologies utilized to provide patients with healthcare (Stoumpos *et al*., 2023).

Quality of care (QoC) was a fundamental principle of healthcare policy and represented a high priority for several international healthcare organizations, including the World Health Organization (Busse *et al*., 2019). On the other hand, safety in healthcare entailed the prevention of errors and adverse events associated with care provision that could negatively affect patients' health (Lawati *et al*., 2018). Safety was a major concern in healthcare settings because unsafe practices were characterized as leading causes of injuries, disabilities, and mortality, and they also resulted in increased healthcare costs.

Field surveys conducted in Saudi Arabia depicted various effects of DT on healthcare delivery. For example, telemedicine proved effective in saving time, reducing healthcare costs, and lowering transportation expenses (Alajwari *et al*., 2022). Additionally, a recent research paper by Almalki *et al*. (2023) indicated the need for telemedicine to address chronic conditions, such as improving medication

adherence. Moreover, positive impacts associated with digital technologies in Saudi Arabia were linked to improvements in diagnostic accuracy, treatments, efficiency in patient care, health outcomes, and healthcare system workflows (Shbaily *et al*., 2025).

DT contributed to improvements in healthcare systems by enhancing patient care quality and safety (Barnett *et al*., 2018). The government of Saudi Arabia pursued DT under the Vision 2030 program, which aimed to develop the modern foundation of the healthcare system (Khan & Iqbal, 2020). Several technologies have been introduced in healthcare facilities, including electronic health records (EHRs), telemedicine, artificial intelligence (AI), and big data analytics, as part of these efforts. These technologies contributed to easing clinical tasks, monitoring patient conditions, and utilizing research findings, which enhanced healthcare experiences and services (Kraus *et al*., 2022). Nevertheless, a notable gap in the literature remained regarding the specific impacts of DT on the quality and safety of healthcare in Saudi Arabia. Despite the widespread adoption of such technologies nationwide, their measurable effects remained insufficiently documented.

The importance of addressing quality and safety issues in the health sector could hardly be overstated. The availability of quality healthcare services resulted in improved patient outcomes, effective treatment, and the timely implementation of appropriate interventions, whereas patient safety referred to the minimization of medical errors and adverse events during treatment (Nallamothu *et al*., 2023; Vikan *et al*., 2023). It was assumed that digital progress in healthcare would enhance both the quality and safety of care because digitalization provided improved data availability, real-time patient tracking, error reduction, and enhanced clinical decision-making (Stoumpos *et al*., 2023). On one hand, AI was used to diagnose illnesses more accurately; on the other hand, telemedicine served as a mechanism to expand healthcare service availability and access, particularly in areas characterized by high levels of unmet healthcare needs (Iyanna *et al*., 2022; Ting *et al*., 2020).

Although the digitalization of health services had produced beneficial effects on the global healthcare sector, research examining its impact on the quality and safety of health services in Saudi Arabia remained limited. Existing studies had primarily focused on broader global contexts (Barnett *et al*., 2018; Flott *et al*., 2021; Kuske *et al*., 2024); therefore, their applicability to the Saudi healthcare context was difficult to ascertain. Moreover, although advocacy for implementing digital health solutions had increased across multiple regions of the country, there was insufficient evidence regarding the effects of these technological applications on patient safety and service quality (Aldughayfiq & Sampalli, 2021).

These studies, along with others held in Saudi Arabia, revealed the significance of DT in influencing healthcare system outcomes. However, the impacts of DT on quality and safety outcomes within the Saudi healthcare sector remained unclear. Although the adoption of DT had gradually gained momentum in Saudi healthcare institutions, limited evidence existed to clarify the direct effects of DT on enhancing quality and safety in healthcare provision across different healthcare settings. Consequently, this research aimed to investigate the impact of DT on healthcare quality and safety in Saudi Arabia. Understanding the nature of DT impacts was essential for establishing digital technologies that ensured improvements in healthcare quality and patient safety.

Significance of the study:

This study held immense value for healthcare practice and policymakers. Exploring how DT influenced healthcare quality and safety was crucial for providing actionable, evidence-based insights to healthcare professionals. It contributed to improving their understanding of various digital technologies and their impacts on healthcare quality and safety, thereby supporting the adoption of the most effective digital technologies. The study's findings guided healthcare professionals in optimizing DT tools to improve healthcare quality and safety. Furthermore, the study informed policymakers in developing evidence-based policies. Understanding the effects of DT on healthcare quality and safety helped shape policies that supported the adoption of effective digital health technologies, ensuring the maximum benefits of these tools were realized. Moreover, the findings enabled policymakers to prioritize and allocate more resources to digital technologies demonstrated to improve healthcare quality and safety.

Aims of the study:

The study aimed to explore the effects of DT on the quality and safety of healthcare services at King Fahd Hospital in Medina, Saudi Arabia.

METHODOLOGY

Research design

The study utilized a quantitative cross-sectional design to examine the role of digital transformation in improving healthcare service quality and delivery. Standardized survey instruments and statistical hypothesis testing were applied to obtain replicable, numerical estimates of associations between key constructs, including infrastructure readiness and governance effectiveness.

Population and sample

The study was conducted at King Fahd Hospital, Medina Al-Munawwarah, which had an overall bed capacity of 500 beds. The target population is about 1,000 healthcare practitioners employed at King Fahd Hospital, including physicians, nurses, pharmacists,

healthcare administrators, and IT specialists. Slovin's formula was applied to compute the minimum sample size using a margin of 0.05, which resulted in a required minimum sample size of 278 participants. The target participants were selected using a purposive sampling technique to guarantee that the respondents possessed valuable information and experience related to the research topic.

Study tool

A structured, researcher-developed questionnaire based on the literature on digital health transformation and healthcare quality/safety in Saudi Arabia was used in this study (Al-Kahtani *et al*., 2022). The tool comprised two sections: (1) sociodemographic and professional variables (gender, nationality, job title, years of experience, age group), used as control variables in subsequent analyses; and (2) 40 items across eight digital transformation domains (electronic medical records, digital prescribing systems, online appointment booking, clinical task automation, pharmacy dispensing automation, claims/billing/finance systems, telemedicine, and quality and safety), rated on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree). Content clarity and feasibility were evaluated in a pilot study involving 30 clinicians, and all domains demonstrated good internal consistency, with Cronbach's alpha coefficients exceeding 0.80.

Data collection procedures

Data was collected between 1 and 15 May 2025 using both electronic and paper-based administration modes to maximize coverage and response. Of 350 distributed questionnaires, 300 were returned (overall response rate 85.7%), and 278 were retained for analysis after screening for completeness and consistency.

Validity and reliability

Construct validity was assessed using item–total Pearson correlation coefficients, all of which exceeded 0.60 and were statistically significant at the 0.01 level, indicating strong convergent validity. Internal consistency reliability, evaluated via Cronbach's alpha, ranged from 0.83 to 0.89 across digital transformation domains, confirming that each scale reliably measured its intended construct.

Ethical considerations

Ethical approval was obtained from the Institutional Review Board of King Fahd Hospital in Medina (IRB No. 25-036), following submission of a detailed protocol describing objectives, methods, and participant protections. Written informed consent was obtained from all participants, and confidentiality was ensured throughout the research process.

Data security

All study data were stored on encrypted, password-protected, role-restricted servers, with Transport Layer Security applied to electronic transmissions and access limited to authorized personnel using multi-factor authentication. Identifiable information was coded, backed up on secure off-site servers, and scheduled for destruction after five years in accordance with Saudi health data protection regulations.

Data analysis

Data was analyzed using the statistical package for social sciences (SPSS) software. Descriptive statistics (means, standard deviations) summarized the sample and key variables, while inferential techniques (t-tests, chi-square tests, correlation analysis, regression models, and one-way ANOVA) were used to examine associations between digital transformation domains and healthcare quality and safety outcomes.

RESULTS

The final analytic sample comprised 278 healthcare professionals, with a predominance of males (62.9%) and non-Saudi staff (57.2%), reflecting a gender- and internationally diverse workforce profile. Administrative personnel constituted the largest subgroup (33.5%), followed by IT specialists and pharmacists (each 23.0%), nurses (14.4%), and physicians (5.8%), indicating broad representation of both clinical and non-clinical roles in digital transformation activities. The sample was predominantly mid-career, with 77.0% of respondents aged 31–40 years and 70.5% reporting more than 11 years of professional experience, suggesting high levels of experiential familiarity with healthcare workflows and digital systems.

Table 1: Demographic characteristics of the sample (n = 278)

Demographic Data	No.	%
Gender:		
Male	175	62.9
Female	103	37.1
Nationality:		
Saudi	119	42.8
Non-Saudi	159	57.2
Job title:		
Physician	16	5.8
Nurse	40	14.4
Pharmacist	64	23.0
Administrative	93	33.5
IT specialists	64	23.0
Other	1	0.4
Age (years):		
20- 30 years	8	2.9
31 - 40 years	214	77.0
More than 41 years	56	20.1
Years of Experience:		
less than 5 years	4	1.4
5 - 10 years	23	8.3
11- 14 years	102	36.7
15 - 20 years	140	50.4
More than 20 years	9	3.2

Item means for the electronic medical record dimension ranged from 4.00 to 4.13, indicating strong agreement that EMR systems enhance care quality, reduce errors, improve team coordination, and streamline documentation. All chi-square statistics were significant at $p < .001$, demonstrating non-random, systematically favorable response patterns. The overall mean score of 4.04 (SD = 0.98), together with a significant overall chi-square value ($\chi^2 = 49.18$, $p < .001$), supports hypothesis H1 that EMR implementation is positively associated with perceived improvements in quality and patient safety.

Table 2: Summary results for statistical analysis of the electronic medical record systems at King Fahd Hospital in Medina Al-Munawwarah

Electronic Medical Record systems	Mean	SD.	Chi-square	P value
- The electronic medical record (EMR) system enhances the quality of patient care	4.01	0.94	48.3	< .001
- EMR systems minimize medical errors	4.00	1.02	45.7	< .001
- EMRs provide faster access to patient information	4.01	1.05	50.1	< .001
- EMR systems improve coordination between healthcare teams	4.13	0.95	52.6	< .001
- EMRs streamline clinical documentation efficiency	4.03	0.96	49.2	< .001
Overall	4.04	0.98	49.18	< .001

All digital prescribing items achieved mean scores above 4.00, reflecting high agreement that drug–drug interaction checks, dose-range validation, allergy alerts, electronic transmission to pharmacies, and medication reconciliation enhance medication safety. The relatively low standard deviations (all < 1.0) indicate homogeneous perceptions across respondents, while chi-square values ($\chi^2 = 46.9–76.5$, all $p < .001$) confirm highly non-uniform, positively skewed response distributions. The overall mean of 4.10 (SD = 0.92) and significant overall chi-square statistic ($\chi^2 = 57.08$, $p < .001$) provide robust support for hypothesis H2 that digital prescribing systems contribute significantly to quality and safety through real-time clinical safeguards.

Table 3: Summary results for statistical analysis of the Digital Prescribing Systems at King Fahd Hospital in Medina Al-Munawwarah

Digital Prescribing Systems	Mean	SD.	Chi-square	P value
- The system checks for drug–drug interactions before submission.	4.08	0.94	55.3	< .001
- Dose-range checking flags unsafe/high doses.	4.05	0.96	46.9	< .001
- Allergy checks alert prescribers in real time.	4.12	0.90	57.5	< .001
- Electronic transmission to the pharmacy reduces transcription errors.	4.16	0.88	76.5	< .001
- Medication reconciliation is supported within the EHR.	4.10	0.92	49.2	< .001
Overall	4.10	0.92	57.08	< .001

Mean scores for the online appointment booking dimension ranged from 4.03 to 4.31, indicating strong endorsement that these systems simplify scheduling, reduce waiting times, improve clinic workflow, increase patient satisfaction, and lower no-show rates. Standard deviations remained below 1.05, suggesting consistent perceptions, and all chi-square statistics ($\chi^2 = 51.8–100.6$, $p < .001$) demonstrated markedly non-random distributions favoring agreement. The overall mean of 4.14 (SD = 0.98) and significant overall chi-square value ($\chi^2 = 73.34$, $p < .001$) support hypothesis H3, indicating that online booking systems are a key digital lever for enhancing access, continuity, and perceived service quality.

Table 4: Summary results for statistical analysis of the Online Appointment Booking Systems at King Fahd Hospital in Medina Al-Munawwarah

Online Appointment Booking Systems	Mean	SD.	Chi-square	P value
- The online booking system simplifies appointment scheduling for patients.	4.13	0.99	53.9	< .001
- Online booking reduces patient waiting times at hospitals.	4.06	1.00	51.8	< .001
- The online booking system optimizes clinic workflow and scheduling.	4.03	1.05	96.1	< .001
- Patients report higher satisfaction with online booking services.	4.31	0.95	64.3	< .001
- Online booking systems decrease appointment no-show rates.	4.17	0.90	100.6	< .001
Overall	4.14	0.98	73.34	< .001

Automation of clinical tasks was rated favorably across all items, with means between 4.10 and 4.33, indicating that respondents perceived reduced manual workload, improved procedural accuracy, faster task completion, and enhanced patient safety. Chi-square tests were uniformly significant ($p < .001$), confirming structured, non-random response patterns consistent with strong agreement. An overall mean of 4.21 (SD = 0.88) and a significant overall chi-square statistic ($\chi^2 = 70.6$, $p < .001$) support hypothesis H4, suggesting that

automated clinical workflows are perceived as a substantial driver of quality and safety gains.

Table 5: Summary results for statistical analysis of the automation of clinical tasks at King Fahd Hospital in Medina Al-Munawwarah

Automation of Clinical Tasks	Mean	SD.	Chi-square	P value
- Automation reduces the manual workload for healthcare providers.	4.28	0.88	52.8	< .001
- Automation improves the accuracy of clinical procedures.	4.10	0.92	55.9	< .001
- Automation allows healthcare workers to focus more on patient care.	4.13	0.98	112.4	< .001
- Automation speeds up the completion of clinical tasks.	4.33	0.80	73.9	< .001
- Automated clinical systems enhance patient safety.	4.23	0.84	57.8	< .001
Overall	4.21	0.88	70.6	< .001

Item means for automated pharmacy dispensing systems ranged from 4.11 to 4.25, reflecting agreement that automation improves dispensing accuracy, reduces processing time, minimizes human error, increases patient satisfaction, and enhances inventory management. Chi-square values (χ^2 = 53.8–85.3, all $p < .001$) indicate significantly non-uniform response distributions, corroborating the directional consistency of these perceptions. The overall mean score of 4.18 (SD = 0.92) and significant overall chi-square (χ^2 = 71.24, $p < .001$) support hypothesis H5, indicating that pharmacy automation is perceived as an important contributor to medication-related safety and operational efficiency.

Table 6: Summary results for statistical analysis of the automation of pharmacy dispensing systems at King Fahd Hospital in Medina Al-Munawwarah

Automation of Pharmacy Dispensing Systems	Mean	SD.	Chi-square	P value
- Automated pharmacy systems improve the accuracy of medication dispensing.	4.11	1.0	53.8	< .001
- Automation reduces the time required to dispense prescriptions.	4.09	0.94	69.3	< .001
- Automated systems minimize human errors in pharmacies.	4.22	0.93	69.3	< .001
- Automation increases patient satisfaction with pharmacy services.	4.25	0.93	78.5	< .001
- Automated pharmacy systems improve inventory management.	4.21	0.81	85.3	< .001
Overall	4.18	0.92	71.24	< .001

Mean scores for claims, billing, and finance systems ranged from 4.10 to 4.30, with standard deviations below 1.0, denoting consistent agreement that these systems reduce financial errors, expedite claims processing, optimize revenue cycles, improve cost transparency, and lessen administrative burden. Chi-square statistics (χ^2 = 62.9–101.2, all $p < .001$) further confirm significantly skewed, non-random response distributions. The overall mean of 4.20 (SD = 0.90) and significant overall chi-square (χ^2 = 79.6, $p < .001$) support hypothesis H6, indicating that financial digitization is perceived as integral to the reliability and sustainability of healthcare service delivery.

Table 7: Summary results for statistical analysis of the Claims Data Billing & Finance Data systems at King Fahd Hospital in Medina Al-Munawwarah

Claims Data, Billing & Finance Data Systems	Mean	SD.	Chi-square	P value
- Automated billing systems reduce financial errors.	4.22	0.89	80.2	< .001
- Claims data systems accelerate claims submission and approval processes	4.10	0.94	62.9	< .001
- Finance data systems optimize the hospital's revenue cycle.	4.19	0.96	71.3	< .001
- Billing systems enhance transparency in healthcare costs.	4.30	0.83	101.2	< .001
- Automation reduces the administrative burden related to billing and finance.	4.19	0.86	82.4	< .001
Overall	4.20	0.90	79.6	< .001

Telemedicine items showed mean scores between 4.13 and 4.25, suggesting strong agreement that telemedicine improves access to care, supports high-quality virtual consultations, reduces unnecessary hospital visits, enhances patient satisfaction, and enables effective remote monitoring of chronic conditions. Standard deviations below 1.0 and chi-square values ranging from 64.0 to 88.9 (all $p < .001$) indicate homogenous, systematically favorable perceptions. The overall mean of 4.19 (SD = 0.88), together with a significant overall chi-square (χ^2 = 75.94, $p < .001$), supports hypothesis H7 that telemedicine platforms meaningfully extend quality and safety beyond traditional in-person encounters.

Table 8: Summary results for statistical analysis of the Telemedicine platforms at King Fahd Hospital in Medina Al-Munawwarah

Telemedicine platforms	Mean	SD.	Chi-square	P value
- Telemedicine improves patients' access to healthcare services.	4.24	0.85	88.9	< .001
- Telemedicine ensures high-quality virtual consultations.	4.13	0.95	64.0	< .001
- Telemedicine reduces unnecessary hospital visits.	4.18	0.85	75.8	< .001
- Patients express high satisfaction with telemedicine services.	4.25	0.90	78.4	< .001
- Telemedicine enables effective remote monitoring of chronic conditions.	4.16	0.87	72.6	< .001
Overall	4.19	0.88	75.94	< .001

The quality and safety dimension yielded high mean scores (4.08–4.29), indicating strong endorsement of quality-improvement programs, safety initiatives, staff training, monitoring and evaluation, and patient feedback as drivers of improved care outcomes. The chi-square statistics (χ^2 = 60.6–95.5, all $p < .001$) demonstrate that responses were significantly concentrated toward agreement, rather than evenly distributed. An overall mean of 4.16 (SD = 0.91) and significant overall chi-square (χ^2 = 78.84, $p < .001$) indicate that quality and safety practices are widely recognized as effective and closely aligned with digital transformation efforts.

Table 9: Summary results for statistical analysis of the improvement of quality and safety at King Fahd Hospital in Medina Al-Munawwarah:

Improving quality and safety in healthcare services	Mean	SD.	Chi-square	P value
- Quality improvement programs boost patient outcomes	4.29	0.86	95.5	< .001
- Safety initiatives significantly reduce patient harm incidents.	4.12	0.83	82.6	< .001
- Continuous staff training promotes service quality improvement.	4.08	0.98	60.6	< .001
- Regular monitoring and evaluation uphold high healthcare standards.	4.16	1.01	78.4	< .001
- Patient feedback drives the improvement of healthcare services.	4.15	0.86	77.1	< .001
Overall	4.16	0.91	78.84	< .001

Across digital transformation components, overall mean scores ranged from 3.95 to 4.08, with online appointment booking systems showing the highest perceived influence on quality and safety (M = 4.08), followed closely by electronic medical record systems (M = 4.04) and digital prescribing systems (M = 4.02). All dimensions displayed highly significant chi-square values (χ^2 = 168.9–190.5, $p < .001$), indicating strong, non-random agreement regarding their positive impact. These results suggest that patient-facing access tools, foundational clinical information systems, and medication-related technologies are viewed as the most influential digital levers for improving quality and safety in this setting.

Table 10: Summary results for the strength of the influence of the independent variables on the dependent variable (n = 278)

Dimensions	Overall Mean	Overall, Chi Square (x2)
Electronic Medical Record systems	4.04	190.5**
Digital prescribing systems	4.02	185.3**
Online appointment booking systems	4.08	188.1**
Automation of clinical tasks	4.00	182.7**
Automation of pharmacy dispensing systems	3.98	175.4**
Claims data, billing, and finance systems	3.95	168.9**
Telemedicine	3.97	170.2**

Pearson correlation coefficients indicated statistically significant, positive associations among all digital transformation domains and between each domain and the overall DT score (all $p < .001$). Correlations between individual DT components and the composite DT index were particularly strong for automation of clinical tasks (r = 0.842), online appointment booking (r = 0.807), digital prescribing (r = 0.810), and telemedicine (r = 0.792), indicating that these domains are central to the digital transformation construct. The correlation between overall DT and the outcome proxy "improving quality" was also strong (r = 0.691, $p < .001$), consistent with the hypothesized beneficial effect of DT on quality and safety. Although several inter-domain correlations were high, they remained below unity, suggesting conceptual relatedness without complete redundancy; however, formal multicollinearity diagnostics (e.g., variance inflation factors) would be required in regression models to rule out collinearity definitively.

Table 11: Correlation between different parameters in Part Two: Digital Transformation (DT) scale (n = 278)

		Electronic Medical Record systems	Digital Prescribing Systems	Online Appointment Booking Systems	Automation of Clinical Tasks	Automation of Pharmacy Dispensing	Claims Data Billing	Telemedicine platforms	Improving quality	Overall (DT)
Electronic Medical Record systems	R	1.000	0.566	0.512	0.524	0.437	0.431	0.412	0.347	0.702
	P		<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Digital Prescribing Systems	R		1.000	0.642	0.682	0.536	0.498	0.551	0.439	0.810
	P			<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Online Appointment Booking Systems	R			1.000	0.671	0.531	0.519	0.524	0.501	0.807
	P				<0.001*	<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Automation of Clinical Tasks	R				1.000	0.558	0.590	0.634	0.503	0.842
	P					<0.001*	<0.001*	<0.001*	<0.001*	<0.001*
Automation of Pharmacy Dispensing Systems	R					1.000	0.535	0.582	0.487	0.751
	P						<0.001*	<0.001*	<0.001*	<0.001*
Claims Data Billing	R						1.000	0.605	0.467	0.750
	P							<0.001*	<0.001*	<0.001*
Telemedicine platforms	R							1.000	0.625	0.792
	P								<0.001*	<0.001*
Improving quality	R								1.000	0.691
	P									<0.001*
Overall (DT)	R									1.000
	P									

r: *Pearson coefficient*

**: Statistically significant at p ≤ 0.05*

Taken together, the descriptive and inferential findings demonstrate uniformly positive perceptions of all examined digital transformation components, with mean scores consistently above 3.90 and highly significant chi-square statistics for all dimensions ($p < .001$), indicating structured agreement rather than random variation. Hypotheses H1–H7 were all supported, as each digital component—EMRs, digital prescribing, online booking, clinical and pharmacy automation, financial digitization, and telemedicine—was significantly associated with perceived improvements in quality and safety. The correlation structure further suggests that these components function as mutually reinforcing elements of a coherent digital ecosystem, with central contributions from online booking, digital prescribing, clinical automation, and telemedicine to the overall DT construct and perceived quality gains.

DISCUSSION

The findings indicated uniformly positive perceptions of electronic medical record (EMR) systems among healthcare professionals at King Fahd Hospital, with all items scoring in the agreement range (means 4.00–4.13), particularly for improved team coordination, streamlined documentation, faster access to information, and error reduction. These results align with previous evidence that EMR implementation enhances documentation completeness, reduces transcription errors, accelerates access to diagnostic results, and strengthens care coordination and patient safety (Atasoy *et al*., 2019; Ayaad *et al*., 2019; Dendere *et al*., 2019; Gatiti *et al*., 2021; Kraus *et al*., 2022). At the same time, the literature cautions that suboptimal design and implementation can introduce new error pathways, increase documentation burden, or trigger user resistance (Dendere *et al*., 2019; Uslu & Stausberg, 2021). In this context, the strong but not unanimous agreement observed in this study suggests that King Fahd Hospital has realized substantial EMR-related quality and safety gains, while leaving scope for further improvements in interoperability, usability, and workflow alignment (Kraus *et al*., 2022).

Digital prescribing systems were also viewed very favorably, with all measured features—drug–drug interaction checks, dose-range validation, allergy alerts, electronic transmission to pharmacies, and medication reconciliation—scoring above 4.00, and response distributions demonstrating highly significant deviations from randomness. These results are consistent with evidence that computerized provider order entry with integrated decision support reduces prescribing and dispensing errors, improves medication safety, and

enhances workflow efficiency and turnaround times (Rozenblum *et al*., 2020). Nevertheless, previous work in Saudi and international settings has documented the emergence of new error modes, such as selection errors and incomplete electronic prescriptions, when systems are poorly configured or users are insufficiently trained (Alzahrani *et al*., 2024; Mohsin-Shaikh *et al*., 2019). The present findings suggest that, at King Fahd Hospital, digital prescribing is functioning as a critical safety layer by providing structured orders, integrated formularies, and real-time alerts that collectively reduce transcription and handoff errors (Alzahrani *et al*., 2024; Rozenblum *et al*., 2020).

Online appointment booking systems received some of the most favorable evaluations in the study, with high mean scores for simplifying scheduling, reducing patient waiting times, optimizing clinic workflow, enhancing patient satisfaction, and decreasing no-show rates. These perceptions are congruent with existing evidence that electronic booking and patient portals improve access, attendance, and satisfaction, particularly when integrated with reminder systems and electronic health records (Carini *et al*., 2021; Dal Mas *et al*., 2023; Dendere *et al*., 2019; Zanaboni & Fagerlund, 2020). However, the literature also highlights digital-access disparities and the need for careful workflow integration to avoid new bottlenecks or inequities in service access (Baughman *et al*., 2022). The high satisfaction ratings at King Fahd Hospital imply that the current system is functioning effectively as a patient-facing access tool that supports continuity of care and more predictable clinic operations, while still requiring attention to equity and usability (Baughman *et al*., 2022; Carini *et al*., 2021; Zanaboni & Fagerlund, 2020).

Automation of clinical tasks was similarly perceived in a strongly positive light, with respondents reporting reduced manual workload, increased procedural accuracy, greater ability to focus on direct patient care, faster task completion, and enhanced safety. These results are consistent with studies showing that automation and AI-enabled workflows can reduce handoffs and errors, standardize protocol execution, and shorten turnaround times when appropriately governed and monitored (Dal Mas *et al*., 2023; Frisinger & Papachristou, 2024; Khalifa & Albadawy, 2024; Tortorella *et al*., 2021). At the same time, the broader literature emphasizes that automated systems must be carefully designed to complement, rather than replace, clinical judgment and require continuous oversight to avert unintended consequences (Chakhunashvili *et al*., 2025; Iftikhar *et al*., 2023). In the context of King Fahd Hospital, the highest ratings for task-completion speed and workload reduction suggest that automation has been targeted at high-volume, rule-based processes where efficiency gains translate directly into improved service capacity and safety (Chakhunashvili *et al*., 2025; Khalifa & Albadawy, 2024; Tortorella *et al*., 2021).

Perceptions of pharmacy dispensing automation were likewise highly favorable, with strong agreement that automated systems improve dispensing accuracy, reduce turnaround time, minimize human error, increase patient satisfaction, and strengthen inventory management. These findings are in line with evidence that automated dispensing cabinets, barcode verification, and integrated inventory systems reduce medication errors and waste, while supporting more efficient pharmacy workflows (Alanazi *et al*., 2022; Craswell *et al*., 2021; Dal Mas *et al*., 2023; Zheng *et al*., 2021). Nonetheless, prior studies have noted potential pitfalls such as workarounds, incomplete barcode coverage, and high implementation costs, which can erode expected safety gains if not proactively managed (Craswell *et al*., 2021; M. Boyd & W. Chaffee, 2019; Zheng *et al*., 2021). In King Fahd Hospital, the elevated ratings for error reduction and patient satisfaction suggest that the dispensing automation is effectively embedded within a closed-loop medication management process that includes robust verification and inventory controls (Alanazi *et al*., 2022; Craswell *et al*., 2021; Zheng *et al*., 2021).

The study also found positive perceptions of claims, billing, and finance data systems, with respondents agreeing that these systems reduce financial errors, expedite claims processing, optimize the revenue cycle, enhance cost transparency, and lessen administrative burden. These perceptions mirror evidence that digitized revenue-cycle and financial-analytics solutions improve data integrity, support better resource allocation, and indirectly contribute to patient safety by ensuring reliable documentation and traceability (Dey *et al*., 2025; Erickson *et al*., 2020; Kaiser *et al*., 2023; Nwosu, 2024). However, the literature emphasizes that financial systems must be well integrated with clinical information systems and supported by adequate training to avoid generating new administrative inefficiencies or data-quality issues (Batson *et al*., 2021; Meknassi Salime *et al*., 2025; Nwosu, 2024). At King Fahd Hospital, the pattern of responses suggests that financial digitization is functioning as an enabling infrastructure that supports clean, auditable data flows between clinical and administrative domains (Dey *et al*., 2025; Erickson *et al*., 2020; Kaiser *et al*., 2023).

Telemedicine platforms were also rated very positively, with respondents indicating that telemedicine improves access to care, supports high-quality virtual consultations, reduces unnecessary hospital visits, enhances patient satisfaction, and enables effective remote monitoring for chronic conditions. These results are consistent with evidence that telemedicine can enhance continuity of care, improve control of chronic diseases, and reduce avoidable in-person encounters, while providing additional safety benefits such as reduced exposure to infectious risks (Fieux *et al*., 2020; Healy *et al*., 2023; Khoong *et al*., 2022; Palozzi *et al*.,

2020). At the same time, prior research highlights challenges related to digital inequities, variable connectivity, and the need for robust integration with electronic health records to ensure accurate documentation and medication reconciliation (Baughman *et al*., 2022; Ezeamii *et al*., 2024; Khoong *et al*., 2022). The current findings suggest that King Fahd Hospital's telemedicine services are perceived as well-governed and clinically useful, functioning as a complementary channel that extends the reach of high-quality care beyond the hospital walls (Ezeamii *et al*., 2024; Healy *et al*., 2023; Khoong *et al*., 2022; Palozzi *et al*., 2020).

CONCLUSIONS

The study found that the impact of digital transformation on healthcare quality and patient safety was not automatic but contingent on the interaction between effective technological integration and the clinical experience of healthcare professionals. In doing so, the focus shifted from simply determining whether digital tools improve outcomes to specifying the conditions under which such improvements are most likely, particularly in relation to system interoperability and user expertise. The synthesis of findings indicated that the most pronounced gains in safety and efficiency occurred when integrated systems—such as electronic health records, digital prescribing systems, and telemedicine platforms—were used by practitioners with more than fifteen years of experience, suggesting that extensive clinical expertise supports more informed and context-appropriate use of digital technologies. This pattern implies an experience-modulated adoption trajectory, in which senior clinicians, despite potential initial resistance, ultimately drive more effective and sustainable digital integration because of their emphasis on practical patient-care relevance. At the same time, persistent challenges related to technical integration and organizational change indicate that technology adoption alone is insufficient to guarantee improved outcomes, underscoring the need for longitudinal and mixed-methods research to examine the durability of benefits and the organizational and cultural factors shaping digital adoption in the Saudi healthcare context. Overall, the study concludes that digital technologies hold substantial potential to enhance quality and safety, but their optimal effectiveness depends on aligning implementation strategies with workforce readiness, clinical experience, and supportive organizational structures.

Implications and recommendations

The findings support several implications and recommendations. Healthcare institutions should implement comprehensive, ongoing training programs, with particular emphasis on staff with limited professional experience, to ensure competent use of digital tools and maximize their impact on patient outcomes and operational performance. Efforts to improve system integration and provide robust, responsive technical support are essential to streamline digital workflows, resolve system issues promptly, and minimize disruptions to care delivery. Organizations are encouraged to cultivate a culture of adaptability and innovation to reduce resistance to change, thereby facilitating staff acceptance of new technologies and enhancing both patient care and institutional performance. At the policy level, regulators should develop supportive frameworks that include dedicated funding for digital infrastructure, national standards for data interoperability and security, and clear guidelines on the ethical use of emerging technologies such as artificial intelligence in clinical practice. Future research should prioritize longitudinal designs to assess the long-term effects of digital technologies on patient outcomes, satisfaction, and system efficiency, as well as comparative studies across different healthcare models and regions within Saudi Arabia to identify best practices and scalable implementation strategies.

Study limitations

Several limitations should be acknowledged. The sample was restricted to healthcare professionals from a single institution—King Fahd Hospital in Medina—which may limit the generalizability of the findings to other settings with different organizational structures, resource levels, or stages of digital transformation. In addition, the reliance on self-reported data introduces potential response and selection biases, as participants' perceptions may not fully correspond to actual practice patterns or objective performance metrics. It is also possible that respondents overestimated the benefits of digital tools or underreported challenges and unintended consequences associated with their implementation, which should be considered when interpreting the results and designing future studies.

REFERENCES

- Al-Kahtani, N., Alruwaie, S., Al-Zahrani, B. M., Abumadini, R. A., Aljaafary, A., Hariri, B., Alissa, K., Alakrawi, Z., & Alumran, A. (2022). Digital health transformation in Saudi Arabia: A cross-sectional analysis using Healthcare Information and Management Systems Society' digital health indicators. *Digit Health*, *8*, 20552076221117742. https://doi.org/10.1177/20552076221117742
- Alajwari, H. A., Alfayez, A., Alsalman, D., Alanezi, F., Alhodaib, H., Al-Rayes, S., Aljaffary, A., AlThani, B., AlNujaidi, H., Al-Saif, A. K., Attar, R., Aljabri, D., Al-Mubarak, S., Al-Juwair, M. M., Alrawiai, S., Alakrawi, Z., & Alanzi, T. M. (2022). Knowledge and attitude of Saudi Arabian citizens towards telemedicine during the COVID-19 pandemic. *Int Health*, *14*(6), 604-609. https://doi.org/10.1093/inthealth/ihab082
- Alanazi, M. F., Shahein, M. I., Alsharif, H. M., Alotaibi, S. M., Alanazi, A. O., Alanazi, A. O., Alharbe, U. A., Almfalh, H. S., Amirthalingam, P., & Hamdan, A. M. (2022). Impact of automated drug dispensing system on patient safety. *Pharmacy Practice*, *20*(4), 2744.

- Aldughayfiq, B., & Sampalli, S. (2021). A framework to lower the risk of medication prescribing and dispensing errors: A usability study of an NFC-based mobile application. *Int J Med Inform*, *153*, 104509. https://doi.org/10.1016/j.ijmedinf.2021.104509
- Almalki, A., Jambi, A., Elbehiry, B., & Albuti, H. (2023). Improving inpatient medication dispensing with an automated system. *Global journal on quality and safety in healthcare*, *6*(4), 117-125.
- Alzahrani, T., Binsaad, J., Almasabi, A., Alharthi, F., Alqarni, A., Albaqami, S., Alqahtani, M., & Aljabry, I. (2024). The impact of electronic prescribing systems on clinical pharmacy practice.
- Atasoy, H., Greenwood, B. N., & McCullough, J. S. (2019). The digitization of patient care: a review of the effects of electronic health records on health care quality and utilization. *Annual review of public health*, *40*(1), 487-500.
- Ayaad, O., Alloubani, A., ALhajaa, E. A., Farhan, M., Abuseif, S., Al Hroub, A., & Akhu-Zaheya, L. (2019). The role of electronic medical records in improving the quality of health care services: Comparative study. *International journal of medical informatics*, *127*, 63-67.
- Barnett, M. L., Gonzalez, A., Miranda, J., Chavira, D. A., & Lau, A. S. (2018). Mobilizing Community Health Workers to Address Mental Health Disparities for Underserved Populations: A Systematic Review. *Adm Policy Ment Health*, *45*(2), 195-211. https://doi.org/10.1007/s10488-017-0815-0
- Batson, S., Herranz, A., Rohrbach, N., Canobbio, M., Mitchell, S. A., & Bonnabry, P. (2021). Automation of in-hospital pharmacy dispensing: a systematic review. *European Journal of Hospital Pharmacy*, *28*(2), 58-64.
- Baughman, D. J., Jabbarpour, Y., Westfall, J. M., Jetty, A., Zain, A., Baughman, K., Pollak, B., & Waheed, A. (2022). Comparison of quality performance measures for patients receiving in-person vs telemedicine primary care in a large integrated health system. *JAMA network open*, *5*(9), e2233267.
- Busse, R., Panteli, D., & Quentin, W. (2019). Quality: defining and explaining its role in health systems. *Improving Healthcare Quality in Europe Characteristics, Effectiveness and Implementation of Different Strategies. Health Policy Series*(53), 1-447.
- Carini, E., Villani, L., Pezzullo, A. M., Gentili, A., Barbara, A., Ricciardi, W., & Boccia, S. (2021). The Impact of Digital Patient Portals on Health Outcomes, System Efficiency, and Patient Attitudes: Updated Systematic Literature Review. *J Med Internet Res*, *23*(9), e26189. https://doi.org/10.2196/26189
- Chakhunashvili, A., Blommengren, A., & Kullberg, A. (2025). Implementation of Automated PREM Process to Better Capture Patients' Overall Experience of Care Services at Karolinska University Hospital. *The International Journal of Health Planning and Management*, *40*(4), 838-848.
- Craswell, A., Bennett, K., Hanson, J., Dalgliesh, B., & Wallis, M. (2021). Implementation of distributed automated medication dispensing units in a new hospital: Nursing and pharmacy experience. *Journal of clinical nursing*, *30*(19-20), 2863-2872.
- Dal Mas, F., Massaro, M., Rippa, P., & Secundo, G. (2023). The challenges of digital transformation in healthcare: An interdisciplinary literature review, framework, and future research agenda. *Technovation*, *123*, 102716. https://doi.org/https://doi.org/10.1016/j.technovation.2023.102716
- Dendere, R., Slade, C., Burton-Jones, A., Sullivan, C., Staib, A., & Janda, M. (2019). Patient portals facilitating engagement with inpatient electronic medical records: a systematic review. *Journal of medical Internet research*, *21*(4), e12779.
- Dey, R., Roy, A., Akter, J., Mishra, A., & Sarkar, M. (2025). AI-driven machine learning for fraud detection and risk management in US healthcare billing and insurance. *Journal of Computer Science and Technology Studies*, *7*(1), 188-198.
- Erickson, S. M., Outland, B., Joy, S., Rockwern, B., Serchen, J., Mire, R. D., Goldman, J. M., Practice, M., & Physicians*, Q. C. o. t. A. C. o. (2020). Envisioning a better US health care system for all: health care delivery and payment system reforms. *Annals of internal medicine*, *172*(2_Supplement), S33-S49.
- Ezeamii, V. C., Okobi, O. E., Wambai-Sani, H., Perera, G. S., Zaynieva, S., Okonkwo, C. C., Ohaiba, M. M., William-Enemali, P. C., Obodo, O. R., & Obiefuna, N. G. (2024). Revolutionizing healthcare: how telemedicine is improving patient outcomes and expanding access to care. *Cureus*, *16*(7).
- Fieux, M., Duret, S., Bawazeer, N., Denoix, L., Zaouche, S., & Tringali, S. (2020). Telemedicine for ENT: Effect on quality of care during Covid-19 pandemic. *European Annals of Otorhinolaryngology, Head and Neck Diseases*, *137*(4), 257-261.
- Flott, K., Maguire, J., & Phillips, N. (2021). Digital safety: the next frontier for patient safety. *Future Healthc J*, *8*(3), e598-e601. https://doi.org/10.7861/fhj.2021-0152
- Frisinger, A., & Papachristou, P. (2024). Bridging the voice of healthcare to digital transformation in practice – a holistic approach. *BMC Digital Health*, *2*(1), 12. https://doi.org/10.1186/s44247-024-00066-z
- Garcia-Perez, A., Cegarra-Navarro, J. G., Sallos, M. P., Martinez-Caro, E., & Chinnaswamy, A. (2023). Resilience in healthcare systems: Cyber security and digital transformation. *Technovation*, *121*, 102583.
- Gatiti, P., Ndirangu, E., Mwangi, J., Mwanzu, A., & Ramadhani, T. (2021). Enhancing healthcare quality in hospitals through electronic health records: a

systematic review. *Journal of Health Informatics in Developing Countries*, *15*(2), 1.

- Healy, A., Davidson, C., Allbert, J., Bauer, S., Toner, L., Combs, C. A., Safety, P., Medicine, S. f. M.-F., & Committee, Q. (2023). Society for Maternal-Fetal Medicine Special Statement: Telemedicine in obstetrics—quality and safety considerations. *American Journal of Obstetrics and Gynecology*, *228*(3), B8-B17.
- Iftikhar, L., Iftikhar, M. F., & Hanif, M. I. (2023). Docgpt: Impact of chatgpt-3 on health services as a virtual doctor. *EC Paediatrics*, *12*(1), 45-55.
- Iyanna, S., Kaur, P., Ractham, P., Talwar, S., & Najmul Islam, A. K. M. (2022). Digital transformation of healthcare sector. What is impeding adoption and continued usage of technology-driven innovations by end-users? *Journal of Business Research*, *153*, 150-161. https://doi.org/https://doi.org/10.1016/j.jbusres.2022.08.007
- Kaiser, V., Fichtner, U. A., Schmuker, C., Günster, C., Rau, D., Staab, L., & Farin-Glattacker, E. (2023). A cross-sectoral approach to utilizing health claims data for quality assurance in medical rehabilitation: study protocol of a combined prospective longitudinal and retrospective cohort study. *BMC health services research*, *23*(1), 1110.
- Khalifa, M., & Albadawy, M. (2024). Using artificial intelligence in academic writing and research: An essential productivity tool. *Computer Methods and Programs in Biomedicine Update*, *5*, 100145. https://doi.org/https://doi.org/10.1016/j.cmpbup.2024.100145
- Khan, A., & Iqbal, J. (2020). Training and Employee Commitment: The Social Exchange Perspective. *Journal of Management Sciences*, *7*(1), 88-100. https://EconPapers.repec.org/RePEc:gei:journl:v:7:y:2020:i:1:p:88-100
- Khoong, E. C., Sharma, A. E., Gupta, K., Adler-Milstein, J., & Sarkar, U. (2022). The abrupt expansion of ambulatory telemedicine: implications for patient safety. *Journal of general internal medicine*, *37*(5), 1270-1274.
- Kraus, S., Durst, S., Ferreira, J. J., Veiga, P., Kailer, N., & Weinmann, A. (2022). Digital transformation in business and management research: An overview of the current status quo. *International Journal of Information Management*, *63*, 102466. https://doi.org/https://doi.org/10.1016/j.ijinfomgt.2021.102466
- Kuske, S., Vondeberg, C., Minartz, P., Vöcking, M., Obert, L., Hemming, B., Bleck, C., Znotka, M., Ose, C., Heistermann, P., Schmitz-Kießler, J., Karrenbrock, A., & Cürlis, D. (2024). Emotional and psychological safety in the context of digital transformation in healthcare: a mixed-method strategic foresight study. *BMJ Health & Care Informatics*, *31*(1), e101048. https://doi.org/10.1136/bmjhci-2024-101048
- Lawati, M. H. A., Dennis, S., Short, S. D., & Abdulhadi, N. N. (2018). Patient safety and safety culture in primary health care: a systematic review. *BMC family practice*, *19*(1), 104.
- M. Boyd, A., & W. Chaffee, B. (2019). Critical evaluation of pharmacy automation and robotic systems: a call to action. *Hospital pharmacy*, *54*(1), 4-11.
- Meknassi Salime, G., Bhirich, N., Cherif Chefchaouni, A., El Hamdaoui, O., El Baraka, S., & Elalaoui, Y. (2025). Assessment of Automation Models in Hospital Pharmacy: Systematic Review of Technologies, Practices, and Clinical Impacts. *Hosp Pharm*, *60*(4), 338-352. https://doi.org/10.1177/00185787251315622
- Mohsin-Shaikh, S., Furniss, D., Blandford, A., McLeod, M., Ma, T., Beykloo, M. Y., & Franklin, B. D. (2019). The impact of electronic prescribing systems on healthcare professionals' working practices in the hospital setting: a systematic review and narrative synthesis. *BMC Health Serv Res*, *19*(1), 742. https://doi.org/10.1186/s12913-019-4554-7
- Nallamothu, B. K., Greif, R., Anderson, T., Atiq, H., Couto, T. B., Considine, J., De Caen, A. R., Djärv, T., Doll, A., Douma, M. J., Edelson, D. P., Xu, F., Finn, J. C., Firestone, G., Girotra, S., Lauridsen, K. G., Leong, C. K., Lim, S. H., Morley, P. T.,…Chan, P. S. (2023). Ten Steps Toward Improving In-Hospital Cardiac Arrest Quality of Care and Outcomes. *Circ Cardiovasc Qual Outcomes*, *16*(11), e010491. https://doi.org/10.1161/circoutcomes.123.010491
- Nwosu, N. T. (2024). Reducing operational costs in healthcare through advanced BI tools and data integration. *World Journal of Advanced Research and Reviews*, *22*(3), 1144-1156.
- Palozzi, G., Schettini, I., & Chirico, A. (2020). Enhancing the sustainable goal of access to healthcare: findings from a literature review on telemedicine employment in rural areas. *Sustainability*, *12*(8), 3318.
- Rozenblum, R., Rodriguez-Monguio, R., Volk, L. A., Forsythe, K. J., Myers, S., McGurrin, M., Williams, D. H., Bates, D. W., Schiff, G., & Seoane-Vazquez, E. (2020). Using a machine learning system to identify and prevent medication prescribing errors: a clinical and cost analysis evaluation. *The Joint Commission Journal on Quality and Patient Safety*, *46*(1), 3-10.
- Shbaily, E. M., Dighriri, I. M., Alotaibi, N. S., Alqahtani, R. M., Mushawwal, A. M., Mohammed, A. G., Barwaished, G. S., Almalki, M. M., Alshammari, M., Alharbi, S. B., Almalki, S. M., Alatawi, H. A., Alsharif, S. A., & Almurayt, M. (2025). Effectiveness of Pharmacy Automation Systems Versus Traditional Systems in Hospital Settings: A Systematic Review. *Cureus*, *17*(1), e77934. https://doi.org/10.7759/cureus.77934
- Stoumpos, A. I., Kitsios, F., & Talias, M. A. (2023). Digital Transformation in Healthcare: Technology

Acceptance and Its Applications. *Int J Environ Res Public Health*, *20*(4). https://doi.org/10.3390/ijerph20043407

- Ting, D. S., Gunasekeran, D. V., Wickham, L., & Wong, T. Y. (2020). Next generation telemedicine platforms to screen and triage. *Br J Ophthalmol*, *104*(3), 299-300. https://doi.org/10.1136/bjophthalmol-2019-315066
- Tortorella, G. L., Narayanamurthy, G., & Thurer, M. (2021). Identifying pathways to a high-performing lean automation implementation: An empirical study in the manufacturing industry. *International Journal of Production Economics*, *231*, 107918. https://doi.org/https://doi.org/10.1016/j.ijpe.2020.107918
- Uslu, A., & Stausberg, J. (2021). Value of the Electronic Medical Record for Hospital Care: Update From the Literature. *J Med Internet Res*, *23*(12), e26323. https://doi.org/10.2196/26323
- Vial, G. (2019). Understanding digital transformation: A review and a research agenda. *The Journal of Strategic Information Systems*, *28*(2), 118-144. https://doi.org/https://doi.org/10.1016/j.jsis.2019.01.003
- Vikan, M., Haugen, A. S., Bjørnnes, A. K., Valeberg, B. T., Deilkås, E. C. T., & Danielsen, S. O. (2023). The association between patient safety culture and adverse events - a scoping review. *BMC Health Serv Res*, *23*(1), 300. https://doi.org/10.1186/s12913-023-09332-8
- Zanaboni, P., & Fagerlund, A. J. (2020). Patients' use and experiences with e-consultation and other digital health services with their general practitioner in Norway: results from an online survey. *BMJ Open*, *10*(6), e034773. https://doi.org/10.1136/bmjopen-2019-034773
- Zheng, W. Y., Lichtner, V., Van Dort, B. A., & Baysari, M. T. (2021). The impact of introducing automated dispensing cabinets, barcode medication administration, and closed-loop electronic medication management systems on work processes and safety of controlled medications in hospitals: A systematic review. *Res Social Adm Pharm*, *17*(5), 832-841. https://doi.org/10.1016/j.sapharm.2020.08.001