Review Article

ARTIFICIAL INTELLIGENCE READINESS AND ITS IMPACT ON CLINICAL DECISION SUPPORT AND OPERATIONAL EFFICIENCY IN DENTAL CARE CENTERS IN SAUDI ARABIA

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ABSTRACT

Dental care centers are increasingly encountering artificial intelligence applications for radiographic interpretation, disease detection, treatment planning, patient communication, clinical documentation, triage, scheduling, and workflow coordination. These technologies may extend professional capabilities by identifying patterns, prioritizing information, and automating selected tasks. Their practical value, however, depends on how effectively they are embedded within clinical and managerial processes. Technology availability alone does not establish readiness for safe or productive use. In Saudi dental care centers, artificial intelligence adoption represents an organizational and healthcare-management challenge as much as a technical development. Clinical value and operational improvement depend on infrastructure, interoperable information systems, reliable data, workforce competence, leadership support, governance arrangements, and adaptable workflows. Centers lacking these conditions may experience fragmented implementation, duplicated work, unclear accountability, or new patient-safety risks. Readiness must therefore be assessed before artificial intelligence is introduced at scale. This article develops a conceptual model explaining how artificial intelligence readiness may influence clinical decision support and operational efficiency in dental care centers in Saudi Arabia. The model treats readiness as a multidimensional organizational capability rather than a binary state of adoption. It links readiness domains with implementation mechanisms, outcome pathways, contextual moderators, and boundary conditions. The conceptual synthesis integrates scholarship on dental artificial intelligence, healthcare artificial intelligence readiness, clinical decision support, operational performance, digital health adoption, organizational change, and Saudi healthcare transformation. It distinguishes readiness inputs from the mechanisms through which artificial intelligence becomes clinically and operationally useful. These mechanisms include workflow integration, data quality, staff competence, managerial support, clinical governance, patient-safety safeguards, and change management. The model also recognizes that public and private dental settings may differ in resources, infrastructure, governance capacity, and patient expectations. The proposed model contributes an integrated explanation of how dental care centers can translate artificial intelligence capability into responsible improvements in decision support and service delivery. It proposes that readiness may strengthen diagnostic assistance, treatment-planning support, workflow coordination, resource utilization, and performance monitoring when enabling conditions are present. It also explains why poorly governed adoption may generate inefficiency, unsafe reliance, resistance, or fragmented care. The model provides a foundation for organizational assessment, implementation planning, and future empirical evaluation in Saudi dental care settings.

Key words: Artificial intelligence readiness, Dental care centers, Clinical decision support, Operational efficiency, Saudi Arabia, Digital dentistry.

Introduction

Artificial intelligence is increasingly applied in dentistry to radiographic interpretation, disease detection, treatment planning, documentation, triage, patient communication, and digitally supported clinical workflows. These applications may augment clinicians by recognizing patterns, organizing diagnostic information, and supporting more consistent decisions [1]. Nevertheless, dental artificial intelligence presents technical, professional, ethical, and implementation challenges [2] that must be addressed before benefits can be translated into routine care. Its adoption therefore requires attention to both algorithmic capability and the organizational environment in which the technology is used.

Dental artificial intelligence has been examined across oral radiology, cariology, periodontology, orthodontics, prosthodontics, endodontics, oral pathology, and related specialties. The reviewed evidence demonstrates considerable breadth in potential applications, but variations in datasets, methods, validation practices, and performance outcomes limit assumptions that every available system is equally suitable for clinical adoption [2, 3]. A dental care center may possess access to an artificial intelligence product without having the data, infrastructure, governance, or workforce capabilities required to use it responsibly. Readiness is consequently distinct from simple exposure to or interest in artificial intelligence.

The development of digital dentistry has increased the connectivity of imaging systems, electronic records, chairside technologies, laboratory processes, and treatment-planning platforms. Artificial intelligence may enhance this environment by supporting information exchange, individualized planning, and more timely clinical decisions when it is integrated with existing digital processes [4, 5]. However, disconnected applications may produce additional screens, duplicate documentation, conflicting recommendations, or interruptions to established workflows. The organizational capacity to integrate technologies is therefore central to their clinical usefulness.

Artificial intelligence should also be understood as a cross-specialty capability rather than a single diagnostic application. Its functions can include image segmentation, classification, prediction, risk assessment, prosthetic design, orthodontic analysis, treatment monitoring, and decision support across multiple areas of dental practice [6]. This breadth creates opportunities for coordinated clinical and operational improvement, but it also increases requirements for governance, interoperability, professional oversight, and role clarity. An integrated readiness model is needed to explain how these requirements interact within dental care centers.

Saudi Arabia's healthcare transformation has increased attention to digital maturity, information exchange, analytics, workforce capability, patient experience, and technology-enabled quality improvement. Evidence from Saudi healthcare organizations indicates that digital capability can vary across governance, interoperability, workforce preparedness, analytical capacity, and implementation maturity [7]. These differences are relevant to dental care centers because they can moderate whether artificial intelligence strengthens clinical decisions and operational performance. This article therefore develops a conceptual model linking artificial intelligence readiness with clinical decision support and operational efficiency through organizational, technological, data, workforce, managerial, governance, and contextual mechanisms.

Artificial intelligence readiness in dental care centers

Artificial intelligence readiness in dental care centers can be defined as the organizational capacity to evaluate, adopt, integrate, govern, and sustain artificial intelligence-enabled tools within clinical and operational workflows. Healthcare organizations require more than positive attitudes toward innovation because readiness involves decision structures, resource allocation, implementation capability, clinical participation, and institutional support [8]. General organizational research similarly identifies strategy, knowledge, resources, culture, and data as interacting components of artificial intelligence readiness [9]. In dental care centers, these elements determine whether artificial intelligence can move from experimental availability to controlled and meaningful use.

The readiness construct includes technological infrastructure, human expertise, financial resources, organizational routines, and managerial capabilities [10]. Artificial intelligence capability is strengthened when technical resources, skilled personnel, and intangible organizational assets are coordinated rather than acquired independently [11]. A center with advanced imaging equipment may remain unprepared when its records are fragmented, staff lack training, or leadership has not defined implementation goals. Readiness must therefore be assessed as an integrated capability configuration rather than as a checklist of purchased technologies.

Technological and data readiness concern the availability, reliability, interoperability, security, and maintainability of systems required to support artificial intelligence. Health-system deployment of predictive models depends on computational architecture, data pipelines, model integration, maintenance responsibilities, and clearly assigned operational ownership [12]. Within dental care centers, these requirements extend to radiographic systems, electronic dental records, laboratory interfaces, scheduling platforms, cybersecurity controls, and procedures for monitoring model performance. Data must also be sufficiently complete, representative, standardized, and clinically interpretable for the intended use.

Workforce and managerial readiness determine whether artificial intelligence is accepted, understood, and used consistently within daily practice [13]. Healthcare professionals may require structured education to understand system capabilities, recognize limitations, interpret outputs, and maintain responsibility for patient care [14]. Managers must align investment decisions with clinical priorities, establish change-management processes, protect patient privacy, and involve dentists and support staff in workflow redesign [13]. **Figure 1** illustrates the AI readiness domains required for dental care centers in Saudi Arabia.

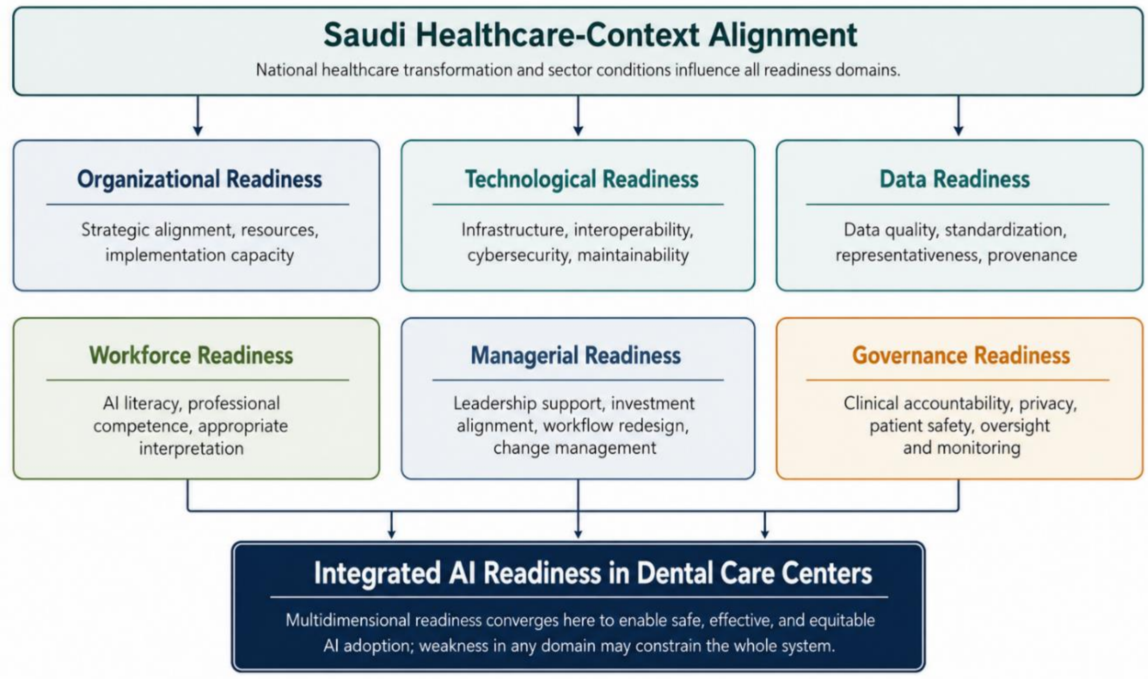

Figure 1. AI Readiness Domains for Dental Care Centers in Saudi Arabia

Alt-text: A layered conceptual diagram showing AI readiness for Saudi dental care centers as a combination of organizational, technological, data, workforce, managerial, governance, and contextual readiness domains.

Clinical decision support in dental practice

Clinical decision support represents the first major outcome domain of artificial intelligence readiness. Deep-learning systems have demonstrated the capacity to assist with dental-caries detection and diagnosis using radiographic information [15]. Comparable approaches have been developed to support the radiographic identification of periodontal bone loss, illustrating how artificial intelligence can extend structured assessment beyond a single oral disease [16]. These capabilities are most useful when their outputs are presented as clinically interpretable assistance rather than autonomous conclusions.

Decision-support performance must be evaluated in relation to disease presentation, imaging quality, patient characteristics, and intended clinical use. Research on caries detection has shown that algorithmic performance may differ according to the radiographic extension and visibility of lesions [17]. Consequently, a system validated for one diagnostic threshold, image source, or patient population should not automatically be assumed to perform equivalently in another environment. Data readiness and local validation are therefore mechanisms connecting organizational readiness with reliable clinical support.

Artificial intelligence can influence not only detection performance but also how clinicians interpret information and reach decisions. Randomized evaluation of artificial intelligence-assisted caries detection indicates that decision-support tools can affect clinicians' diagnostic performance in practical assessment settings [18]. This finding reinforces the importance of interface design, trust calibration, professional judgement, and clear responsibility for final decisions. Artificial intelligence should support dentists by drawing attention to relevant findings while preserving clinician authority and accountability.

Clinical decision support may also improve the speed and consistency of panoramic-image interpretation when classification tools are accurate, usable, and properly integrated. Deep-learning methods for tooth classification have demonstrated potential to reduce interpretation time and support clinical decision processes while maintaining high classification performance [19]. Such gains remain conditional on image quality, system reliability, clinician competence, and patient-safety monitoring. **Table 1** summarises AI readiness requirements for clinical decision support in dental care centers.

Table 1. AI Readiness Requirements for Clinical Decision Support in Dental Care Centers: Data Quality, Diagnostic Integration, Treatment Planning Support, Clinical Governance, Staff Competence, Patient Safety, and Decision Accountability

AI readiness requirement	Operational definition in dental care centers	Contribution to clinical decision support	Main implementation risk	Required safeguard or management response
Data quality	Complete, accurate,	Supports reliable	Biased, incomplete,	Data-quality audits,

	standardized, representative, and clinically interpretable imaging and patient data	detection, classification, prediction, and risk assessment	mislabeled, or poor-quality data may produce unreliable outputs	validation protocols, provenance controls, and correction procedures
Diagnostic integration	Connection of AI outputs with radiographic systems, electronic dental records, and clinical examination processes	Places relevant recommendations within the clinician's normal decision pathway	Stand-alone applications may interrupt workflow or create duplicate interpretation tasks	Interface testing, interoperability standards, workflow mapping, and clinician-led integration
Treatment-planning support	Use of AI-generated information to inform, rather than determine, individualized treatment options	May improve information synthesis, consistency, and recognition of clinically relevant patterns	Automated recommendations may be accepted without sufficient contextual assessment	Mandatory clinician review, documentation of rationale, and escalation procedures
Clinical governance	Defined oversight structures for approval, use, monitoring, incident management, and system retirement	Establishes accountability for the clinical use of AI-supported recommendations	Unclear ownership may delay responses to errors or performance deterioration	Multidisciplinary governance committee, assigned clinical owner, and formal reporting pathways
Staff competence	Ability of dentists and support personnel to interpret outputs, recognize limitations, and respond appropriately	Enables calibrated use of AI information alongside professional judgement	Overreliance, underuse, or inconsistent interpretation may compromise care	Role-specific education, competency assessment, simulation, and continuing professional development
Patient safety	Processes for detecting errors, monitoring adverse effects, managing uncertainty, and protecting vulnerable patients	Ensures that decision support improves care without introducing unacceptable clinical risk	False reassurance, missed disease, inappropriate escalation, or inequitable performance	Prospective risk assessment, human oversight, incident review, subgroup monitoring, and fail-safe procedures
Decision accountability	Explicit assignment of responsibility for final diagnosis, treatment selection, referral, and documentation	Preserves professional responsibility and supports transparent clinical reasoning	Responsibility may become diffused between clinicians, managers, and technology vendors	Clear accountability policies, audit trails, informed consent processes, and documented clinician decisions

Operational efficiency in dental care delivery

Operational efficiency is the second major outcome domain through which artificial intelligence readiness may create value in dental care centers. Healthcare artificial intelligence can support administrative automation, clinical coordination, patient engagement, and the prioritization of information-intensive tasks [20]. In dental settings, these capabilities may contribute to appointment scheduling, patient-flow management, documentation, triage, inventory forecasting, chair utilization, and performance analytics. Efficiency should nevertheless be defined as improved use of time and resources without compromising clinical quality, access, safety, or patient experience.

Operational gains depend on whether artificial intelligence is incorporated into usable clinical decision-support and information-management processes. Clinical decision-support systems produce benefits when recommendations are timely, relevant, understandable, appropriately evaluated, and embedded within the user's workflow [21]. A scheduling algorithm that operates separately from patient records, staffing information, and treatment-duration data may add coordination work rather than reduce it. Workflow integration therefore mediates the relationship between technological readiness and operational performance.

Efficiency must also be evaluated through a patient-safety and lifecycle-management perspective. Responsible clinical machine-learning deployment requires context-specific validation, documentation, monitoring, and mechanisms for responding to performance deterioration or unintended harm [22]. Dental care centers should therefore monitor whether automation changes waiting times, missed appointments, chair turnover, documentation burden, referral delays, diagnostic error, or inequitable access. Faster processing is not an adequate efficiency outcome when it shifts hidden work to clinicians or increases clinical risk.

The economic contribution of artificial intelligence is similarly conditional rather than automatic. Dental evidence indicates that cost-effectiveness can depend on diagnostic performance, disease prevalence, downstream treatment choices, and the consequences of false-positive and false-negative findings [23]. Implementation research from clinical imaging environments further shows that credible evidence, professional trust, local champions, and deliberate workflow adaptation influence whether artificial intelligence becomes operationally useful [24]. Poorly integrated systems may therefore increase inefficiency through duplicated tasks, resistance, interruptions, maintenance demands, and unclear escalation procedures.

Organizational, technological, and workforce readiness drivers

Organizational readiness provides the strategic and structural foundation for artificial intelligence adoption. Technical accuracy alone does not guarantee clinical impact because systems must also undergo appropriate validation, regulatory assessment, workflow integration, and professional acceptance [25]. Public healthcare experience shows that artificial intelligence implementation can be constrained by interconnected challenges involving institutional coordination, data access, specialist skills, procurement, and regulatory uncertainty [26]. Dental care center leaders must consequently align artificial intelligence initiatives with clinical priorities, quality objectives, investment capacity, and measurable service needs.

Leadership commitment must be translated into practical change-management processes rather than symbolic endorsement. Research on intelligent technologies in healthcare demonstrates that implementation can alter professional roles, task allocation, communication routines, and relationships between staff and technology [27]. Dental care centers should involve dentists, hygienists, assistants, radiographers, administrators, information-technology personnel, and quality teams in workflow mapping and redesign. Early participation can reveal implementation risks that may not be visible to vendors or senior managers.

Workforce readiness includes knowledge, digital competence, clinical confidence, appropriate skepticism, and the ability to recognize when an artificial intelligence output should be questioned. Clinician surveys indicate that familiarity with artificial intelligence, perceived usefulness, educational exposure, and expectations about professional roles can shape acceptance [28]. Evidence from medical education also suggests that limited formal preparation may coexist with strong demand for artificial intelligence training [29]. Dental organizations should therefore provide role-specific education covering system purpose, limitations, uncertainty, privacy, bias, safety, and escalation responsibilities.

Professional judgement remains central even when artificial intelligence systems achieve high technical performance. Human–artificial intelligence complementarity offers a more appropriate model than autonomous substitution because clinicians contribute contextual reasoning, communication, ethical responsibility, and patient-specific interpretation [30]. Workforce readiness should therefore be assessed by the quality of collaboration between professionals and systems rather than by the degree of automation alone. Trust should be calibrated through evidence, experience, transparency, monitoring, and accountability.

Saudi dental care context and implementation barriers

Artificial intelligence readiness in Saudi dental care centers is shaped by the broader transformation of healthcare delivery, digital infrastructure, quality management, and patient services. Saudi dentists have reported both growing use of digital technologies and practical challenges involving cost, training, technical support, and accessibility [31]. These conditions may differ across public institutions, private chains, specialist centers, teaching facilities, and smaller independent clinics. A context-sensitive readiness assessment should therefore avoid assuming uniform infrastructure or managerial capacity across the dental sector.

Workforce development is a particularly important contextual condition. National evidence from Saudi dental education indicates variability in digital dentistry curriculum coverage, faculty expertise, training opportunities, and access to relevant technologies [32]. Dentists' knowledge, perceptions, and attitudes toward artificial intelligence and robotics also influence whether new tools are approached with informed confidence, excessive optimism, or resistance [33]. Continuing professional development should therefore connect technical education with clinical governance, patient communication, and responsible implementation.

Readiness may also vary across career stages, regions, institutions, and professional training environments. Evidence concerning artificial intelligence readiness among Saudi healthcare students suggests that exposure, educational opportunity, and digital competence can influence preparedness to work with artificial intelligence-enabled systems [34]. Dental care centers may consequently need differentiated training pathways for experienced clinicians, recent graduates, managers, support staff, and technical specialists. Workforce planning should also address the availability of interdisciplinary expertise in dental informatics, cybersecurity, data governance, clinical engineering, and quality improvement.

Patient-centered readiness requires attention to accessibility, cultural expectations, trust, privacy, communication, and differences in care needs. Saudi dental research concerning artificial intelligence and robotics in the care of persons with disabilities highlights the importance of considering inclusive implementation rather than evaluating adoption only through general efficiency indicators [35]. Dental organizations should examine whether artificial intelligence systems perform appropriately across patient groups and whether digitally mediated processes create new barriers. **Table 2** compares readiness drivers, implementation barriers, and operational-efficiency pathways for AI adoption in Saudi dental care centers.

Table 2. Readiness Drivers, Implementation Barriers, and Operational-Efficiency Pathways for AI Adoption in Saudi Dental Care Centers: Organizational Capability, Technology Infrastructure, Workforce Skills, Workflow Integration, Regulatory Alignment, and Performance Outcomes

Readiness dimension	Main readiness drivers	Common implementation barriers	Operational-efficiency pathway	Suggested performance indicators
Organizational capability	Strategic alignment, leadership commitment, innovation culture, financial planning, quality-improvement orientation	Fragmented ownership, unclear objectives, limited investment, weak change management	Coordinates implementation priorities and reduces duplication across clinical and administrative units	Implementation milestones, budget adherence, staff participation, project completion, service-level improvement
Technology infrastructure	Reliable networks, integrated imaging systems, electronic dental records, secure computing, vendor support	Legacy systems, downtime, incompatible platforms, limited technical support	Enables timely data exchange, automated task execution, and coordinated clinical operations	System availability, integration failures, processing time, support-response time, user-reported interruptions
Data readiness	Standardized records, complete datasets, data provenance, quality controls, interoperability	Missing data, inconsistent coding, fragmented records, limited representativeness	Improves the reliability of analytics, scheduling, prediction, and decision-support outputs	Data completeness, coding consistency, error rates, rejected records, model-performance stability
Workforce skills	Digital competence, clinical AI literacy, interdisciplinary teamwork, continuing education	Limited training, resistance, overreliance, uncertainty about professional roles	Reduces interpretation errors, workarounds, and implementation delays	Training completion, competency scores, adoption rates, override patterns, user-confidence measures
Managerial readiness	Clinical–administrative coordination, procurement oversight, workflow redesign, resource allocation	Short-term procurement focus, inadequate consultation, weak accountability	Aligns artificial intelligence with staffing, chair capacity, patient demand, and service priorities	Chair utilization, staff productivity, waiting time, appointment capacity, workflow-cycle time
Workflow integration	User-centered interfaces, mapped care pathways, automated information transfer, escalation procedures	Duplicate entry, alert burden, disconnected applications, poorly designed handoffs	Reduces administrative burden and improves patient-flow coordination	Documentation time, duplicate tasks, referral delays, handoff errors, appointment throughput
Governance and regulatory alignment	Privacy controls, cybersecurity, clinical accountability, incident reporting, compliance review	Unclear responsibility, privacy concerns, regulatory uncertainty, weak auditability	Reduces disruption from safety incidents, legal uncertainty, and unplanned system suspension	Privacy incidents, audit completion, adverse-event reporting, corrective-action time, policy compliance
Patient-centered implementation	Clear communication, accessibility, informed consent, culturally appropriate processes, equity monitoring	Low trust, digital exclusion, inaccessible interfaces, unclear use of patient data	Supports engagement, attendance, continuity, and appropriate use of digital services	Patient satisfaction, no-show rates, complaint patterns, accessibility measures, subgroup outcome differences
Continuous performance monitoring	Operational dashboards, clinical audits, model surveillance, feedback loops	Limited baseline data, poorly selected metrics, failure to act on findings	Identifies inefficiencies and enables iterative process improvement	Waiting time, cost per visit, diagnostic turnaround, rework, safety incidents, model drift

Proposed AI readiness impact model

The proposed model defines artificial intelligence readiness as a higher-order organizational construct composed of organizational, technological, data, workforce, managerial, and governance readiness. Governance is not treated as an external compliance activity but as an internal capability connecting technical oversight, clinical responsibility, ethical review, and regulatory alignment [36]. The domains are mutually reinforcing because weaknesses in one area can constrain otherwise strong capabilities in another. For example, high-quality data may not improve care when workflow integration or professional accountability is absent.

The model proposes that readiness domains influence outcomes through identifiable mediating mechanisms. Data quality, system interoperability, workflow integration, staff competence, clinical governance, patient-safety safeguards, and change management translate organizational capacity into practical use. Privacy-preserving approaches such as federated learning may support collaboration across institutions when sensitive health information cannot appropriately be centralized [37]. Such technologies do not remove the need for data standards, security controls, validation, or institutional agreements.

Clinical decision support is the first outcome pathway in the model. Reliable information, usable interfaces, clinician competence, and clear escalation processes may improve diagnostic assistance, treatment-planning support, risk assessment, monitoring, and referral decisions. Explainability should not be treated as a substitute for clinical validation, safety evidence, or accountable professional review [38]. Responsible implementation also requires fairness, transparency, privacy protection, human oversight, and mechanisms for challenging inappropriate outputs [39].

Operational efficiency is the second outcome pathway and includes patient flow, appointment coordination, resource utilization, documentation, chair-time management, quality monitoring, and performance analytics. The model proposes that operational improvements emerge when artificial intelligence is integrated with care processes and supported by governance throughout the system lifecycle [40]. Dental-specific ethical guidance further indicates that privacy, fairness, transparency, patient safety, and professional responsibility must be incorporated into implementation design [41]. Efficiency is therefore constrained when automation transfers workload, increases cognitive burden, fragments information, or weakens accountability.

The model includes the Saudi dental care and healthcare-transformation context as a moderating band that can strengthen or weaken readiness-to-outcome relationships. Relevant contextual conditions include regulation, infrastructure, digital health policy, workforce capacity, patient expectations, organizational type, procurement arrangements, and public–private differences. Bias, consent, privacy, and accountability function as boundary conditions because unresolved ethical problems can prevent technically capable systems from producing acceptable clinical or operational outcomes [42]. **Figure 2** visualises the proposed AI readiness impact model for Saudi dental care centers.

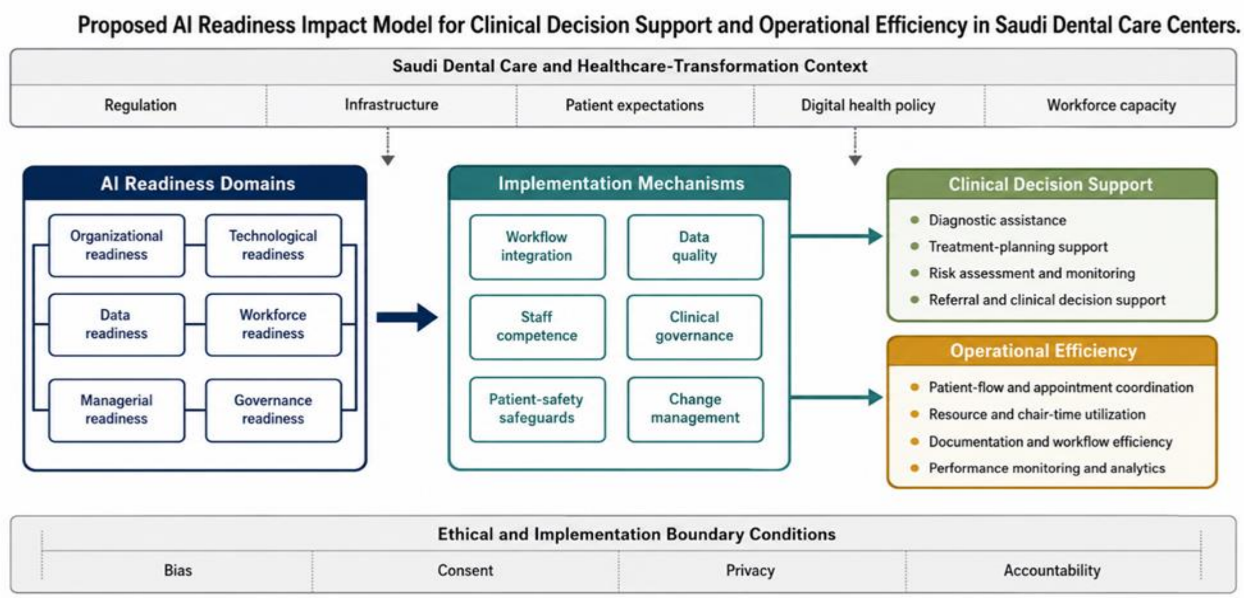

Figure 2. Proposed AI Readiness Impact Model for Clinical Decision Support and Operational Efficiency in Saudi Dental Care Centers

Alt-text: A conceptual model showing AI readiness domains feeding into mediating mechanisms such as workflow integration, data quality, staff competence, and governance, which then influence clinical decision support and operational efficiency in Saudi dental care centers.

Practical implications and future research

Dental care center managers should conduct structured readiness assessments before procurement or large-scale deployment. These assessments should examine clinical need, data availability, infrastructure, workflow fit, staff competence, governance capacity, patient-safety risk, privacy protection, and measurable service outcomes. Dental ethics research indicates that practical guidance is needed to translate high-level principles into routine implementation and evaluation processes [43].

Multidisciplinary governance groups should include clinical, managerial, information-technology, quality, legal, privacy, and patient-representation perspectives.

Implementation should begin with clearly bounded use cases, defined baseline measures, clinician-led workflow design, and controlled pilot evaluation. The distribution of dental artificial intelligence applications remains uneven across specialties and functions, supporting the need to evaluate readiness beyond established imaging tasks [44]. Future systems should also be assessed as integrated components of personalized clinical and operational workflows rather than isolated algorithms [45]. Procurement criteria should therefore address interoperability, validation evidence, usability, auditability, cybersecurity, vendor accountability, update management, and post-deployment monitoring.

Future research should empirically test the proposed model in Saudi public and private dental care centers. Surveys, longitudinal case studies, implementation evaluations, and comparative analyses should examine relationships among readiness domains, mediating mechanisms, clinical decision-support outcomes, operational indicators, patient safety, and organizational context. Data scale, population risk, uncertainty, and local cost structures should be investigated because they may influence both clinical and economic value [46]. Research should also determine whether readiness requirements differ by specialty, center size, ownership model, region, patient population, and level of digital maturity.

Conclusion

This article presents a conceptual model explaining how artificial intelligence readiness may influence clinical decision support and operational efficiency in dental care centers in Saudi Arabia. The model connects readiness domains with implementation mechanisms, outcome pathways, contextual moderators, and boundary conditions. It positions readiness as the organizational foundation through which artificial intelligence may become clinically useful and operationally sustainable.

Artificial intelligence readiness is not a single technology condition. It is a multidimensional organizational capability involving infrastructure, data, workforce competence, managerial commitment, governance, cybersecurity, privacy, and workflow redesign. These capabilities must be coordinated because isolated strengths cannot compensate reliably for critical weaknesses elsewhere in the implementation system.

Clinical decision support requires valid models, appropriate data, usable interfaces, clinician oversight, patient-safety safeguards, and integration with professional judgement. Operational efficiency similarly depends on process redesign, interoperability, staff acceptance, monitoring, and accountable management. Artificial intelligence may increase burden or risk when these enabling conditions are absent.

Saudi dental care centers can use readiness assessment as a practical basis for responsible digital transformation. By aligning artificial intelligence initiatives with clinical priorities, workforce development, governance requirements, and measurable operational needs, centers may improve care quality and organizational performance. The proposed model offers a foundation for implementation planning and empirical evaluation across diverse Saudi dental care environments.

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References

1. Kokurkhaeva AA, Balakerimov ID, Tsoroeva MR, Abdulvagidova KS, Gapuraeva RA, Selimova AG, et al. Role of artificial intelligence in lung cancer screening: reducing false positive results and improving diagnostic efficiency. J Biochem Technol. 2025;16(3):109-16. doi:10.51847/VZLsfFao5v
2. Schwendicke F, Samek W, Krois J. Artificial intelligence in dentistry: chances and challenges. J Dent Res. 2020;99(7):769-74. doi:10.1177/0022034520915714
3. Khanagar SB, Al-Ehaideb A, Maganur PC, Vishwanathaiah S, Patil S, Baeshen HA, et al. Developments, application, and performance of artificial intelligence in dentistry-A systematic review. J Dent Sci. 2021;16(1):508-22. doi:10.1016/j.jds.2020.06.019
4. Chen YW, Stanley K, Att W. Artificial intelligence in dentistry: current applications and future perspectives. Quintessence Int. 2020;51(3):248-57. doi:10.3290/j.qi.a43952
5. Krasnoshchekova AR, Kalenkina AA, Kozlenko AA, Gagieva KK, Eldarova KI, Ulkhaev YK, et al. Diagnosis of neonatal brain pathologies: analysis of the effectiveness of deep learning algorithms and expert evaluation. J Biochem Technol. 2025;16(4):1-9. doi:10.51847/ubDcGLiTuc
6. Shan T, Tay FR, Gu L. Application of artificial intelligence in dentistry. J Dent Res. 2021;100(3):232-44. doi:10.1177/0022034520969115
7. Al-Kahtani N, Alrawiai S, Al-Zahrani BM, Abumadini RA, Aljaffary A, Hariri B, et al. Digital health transformation in Saudi Arabia: a cross-sectional analysis using Healthcare Information and Management Systems Society's digital health indicators. Digit Health.

2022;8:20552076221117742. doi:10.1177/20552076221117742
8. Alami H, Lehoux P, Denis JL, Motulsky A, Petitgand C, Savoldelli M, et al. Organizational readiness for artificial intelligence in health care: insights for decision-making and practice. J Health Organ Manag. 2021;35(1):106-14. doi:10.1108/JHOM-03-2020-0074
9. Jöhnk J, Weißert M, Wyrtki K. Ready or not, AI comes- An interview study of organizational AI readiness factors. Bus Inf Syst Eng. 2021;63(1):5-20. doi:10.1007/s12599-020-00676-7
10. Mucaj O, Krasniqi M, Qendro A. Technological innovation in dental and ocular industries: economic impacts and future prospects. J Adv Pharm Educ Res. 2025;15(1):49-53. doi:10.51847/ytKUn7R31S
11. Mikalef P, Gupta M. Artificial intelligence capability: conceptualization, measurement calibration, and empirical study on its impact on organizational creativity and firm performance. Inf Manag. 2021;58(3):103434. doi:10.1016/j.im.2021.103434
12. Kashyap S, Morse KE, Patel B, Shah NH. A survey of extant organizational and computational setups for deploying predictive models in health systems. J Am Med Inform Assoc. 2021;28(11):2445-50. doi:10.1093/jamia/ocab154
13. Ramy HMM. AI-enabled human resource practices and quality of work life: evidence from the Saudi telecommunications sector. J Organ Behav Res. 2025;10(4):14-27. doi:10.51847/J4pmwUH6Jf
14. Abuzaid MM, Elshami W, McFadden S. Integration of artificial intelligence into nursing practice. Health Technol (Berl). 2022;12(6):1109-15. doi:10.1007/s12553-022-00697-0
15. Lee JH, Kim DH, Jeong SN, Choi SH. Detection and diagnosis of dental caries using a deep learning-based convolutional neural network algorithm. J Dent. 2018;77:106-11. doi:10.1016/j.jdent.2018.07.015
16. Krois J, Ekert T, Meinhold L, Golla T, Kharbot B, Wittemeier A, et al. Deep learning for the radiographic detection of periodontal bone loss. Sci Rep. 2019;9(1):8495. doi:10.1038/s41598-019-44839-3
17. Cantu AG, Gehrung S, Krois J, Chaurasia A, Rossi JG, Gaudin R, et al. Detecting caries lesions of different radiographic extension on bitewings using deep learning. J Dent. 2020;100:103425. doi:10.1016/j.jdent.2020.103425
18. Mertens S, Krois J, Cantu AG, Arsiwala LT, Schwendicke F. Artificial intelligence for caries detection: randomized trial. J Dent. 2021;115:103849. doi:10.1016/j.jdent.2021.103849
19. Yilmaz S, Tasyurek M, Amuk M, Celik M, Canger EM. Developing deep learning methods for classification of teeth in dental panoramic radiography. Oral Surg Oral Med Oral Pathol Oral Radiol. 2024;138(1):118-27. doi:10.1016/j.oooo.2023.02.021
20. Davenport T, Kalakota R. The potential for artificial intelligence in healthcare. Future Healthc J. 2019;6(2):94-8. doi:10.7861/futurehosp.6-2-94
21. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med. 2020;3(1):17. doi:10.1038/s41746-020-0221-y
22. Wiens J, Saria S, Sendak M, Ghassemi M, Liu VX, Doshi-Velez F, et al. Do no harm: a roadmap for responsible machine learning for health care. Nat Med. 2019;25(9):1337-40. doi:10.1038/s41591-019-0548-6
23. Schwendicke F, Rossi JG, Göstemeyer G, Elhennawy K, Cantu AG, Gaudin R, et al. Cost-effectiveness of artificial intelligence for proximal caries detection. J Dent Res. 2021;100(4):369-76. doi:10.1177/0022034520972335
24. Strohm L, Hehakaya C, Ranschaert ER, Boon WPC, Moors EHM. Implementation of artificial intelligence applications in radiology: hindering and facilitating factors. Eur Radiol. 2020;30(10):5525-32. doi:10.1007/s00330-020-06946-y
25. Kelly CJ, Karthikesalingam A, Suleyman M, Corrado G, King D. Key challenges for delivering clinical impact with artificial intelligence. BMC Med. 2019;17(1):195. doi:10.1186/s12916-019-1426-2
26. Sun TQ, Medaglia R. Mapping the challenges of artificial intelligence in the public sector: evidence from public healthcare. Gov Inf Q. 2019;36(2):368-83. doi:10.1016/j.giq.2018.09.008
27. Cresswell K, Cunningham-Burley S, Sheikh A. Health care robotics: qualitative exploration of key challenges and future directions. J Med Internet Res. 2018;20(7):e10410. doi:10.2196/10410
28. Scheetz J, Rothschild P, McGuinness M, Hadoux X, Soyer HP, Janda M, et al. A survey of clinicians on the use of artificial intelligence in ophthalmology, dermatology, radiology and radiation oncology. Sci Rep. 2021;11(1):5193. doi:10.1038/s41598-021-84698-5
29. Sit C, Srinivasan R, Amlani A, Muthuswamy K, Azam A, Monzon L, et al. Attitudes and perceptions of UK medical students towards artificial intelligence and radiology: a multicentre survey. Insights Imaging. 2020;11(1):14. doi:10.1186/s13244-019-0830-7
30. Topol EJ. High-performance medicine: the convergence of human and artificial intelligence. Nat Med. 2019;25(1):44-56. doi:10.1038/s41591-018-0300-7
31. Radwan HA, Alsharif AT, Alsharif MT, Aloufi MR, Alshammari BS. Digital technologies in dentistry in Saudi Arabia: perceptions, practices and challenges. Digit Health. 2023;9:20552076231197095. doi:10.1177/20552076231197095
32. Alfallaj HA, Afrashtehfar KI, Asiri AK, Almasoud FS, Alnaqa GH, Al-Angari NS. The status of digital dental technology implementation in the Saudi dental schools' curriculum: a national cross-sectional survey for healthcare digitization. Int J Environ Res Public Health. 2023;20(1):321. doi:10.3390/ijerph20010321
33. Abouzeid HL, Chaturvedi S, Abdelaziz KM, Alzahrani FA, AlQarni AA, Alqahtani NM. Role of robotics and

artificial intelligence in oral health and preventive dentistry-Knowledge, perception and attitude of dentists. Oral Health Prev Dent. 2021;19(1):353-63. doi:10.3290/j.ohpd.b1693873
34. Al Shahrani A, Alhumaidan N, AlHindawi Z, Althobaiti A, Aloufi K, Almughamisi R, et al. Readiness to embrace artificial intelligence among medical students in Saudi Arabia: a national survey. Healthcare (Basel). 2024;12(24):2504. doi:10.3390/healthcare12242504
35. Barnawi NA, AlAmmar FA, Aldabeis SA, Alahmar SM, Alharthi AA, Abolfotouh MA. Dentists' perception and use of AI and robotics in the care of persons with disabilities. Sci Rep. 2025;15(1):27551. doi:10.1038/s41598-025-10988-x
36. Reddy S, Allan S, Coghlan S, Cooper P. A governance model for the application of AI in health care. J Am Med Inform Assoc. 2020;27(3):491-7. doi:10.1093/jamia/ocz192
37. Rieke N, Hancox J, Li W, Milletari F, Roth HR, Albarqouni S, et al. The future of digital health with federated learning. NPJ Digit Med. 2020;3(1):119. doi:10.1038/s41746-020-00323-1
38. Ghassemi M, Oakden-Rayner L, Beam AL. The false hope of current approaches to explainable artificial intelligence in health care. Lancet Digit Health. 2021;3(11):e745-e750. doi:10.1016/S2589-7500(21)00208-9
39. Siala H, Wang Y. SHIFTing artificial intelligence to be responsible in healthcare: a systematic review. Soc Sci Med. 2022;296:114782. doi:10.1016/j.socscimed.2022.114782
40. Morley J, Machado CCV, Burr C, Cowls J, Joshi I, Taddeo M, et al. The ethics of AI in health care: a mapping review. Soc Sci Med. 2020;260:113172. doi:10.1016/j.socscimed.2020.113172
41. Rokhshad R, Ducret M, Chaurasia A, Karteva T, Radenkovic M, Roganovic J, et al. Ethical considerations on artificial intelligence in dentistry: a framework and checklist. J Dent. 2023;135:104593. doi:10.1016/j.jdent.2023.104593
42. Char DS, Shah NH, Magnus D. Implementing machine learning in health care-Addressing ethical challenges. N Engl J Med. 2018;378(11):981-3. doi:10.1056/NEJMp1714229
43. Mörch CM, Atsu S, Cai W, Li X, Madathil SA, Liu X, et al. Artificial intelligence and ethics in dentistry: a scoping review. J Dent Res. 2021;100(13):1452-60. doi:10.1177/00220345211013808
44. Thurzo A, Urbanová W, Novák B, Czako L, Siebert T, Stano P, et al. Where is the artificial intelligence applied in dentistry? Systematic review and literature analysis. Healthcare (Basel). 2022;10(7):1269. doi:10.3390/healthcare10071269
45. Carrillo-Perez F, Pecho OE, Morales JC, Paravina RD, Della Bona A, Ghinea R, et al. Applications of artificial intelligence in dentistry: a comprehensive review. J Esthet Restor Dent. 2022;34(1):259-80. doi:10.1111/jerd.12844
46. Schwendicke F, Cejudo Grano de Oro J, Garcia Cantu A, Meyer-Lueckel H, Chaurasia A, Krois J. Artificial intelligence for caries detection: value of data and information. J Dent Res. 2022;101(11):1350-6. doi:10.1177/00220345221113756