Challenges of AI Adoption in the Saudi Arabian Healthcare Sector: A Comprehensive Study

Radwan M. Batyha[1], Ahmed Almaghthawi[2]*, Fahad Alharbi[3], Suhaila Abuowaida[4]
Department of Computer Science, Applied Science Private University, Amman, Jordan[1]
School of Computer and Information Sciences, University of Newcastle, NSW, Australia[2]
Department of Information Technology, College of Computers and Information Technology, Taif University, Saudi Arabia[3]
Department of Data Science and Artificial Intelligence, Faculty of Prince Al-Hussein
Bin Abdallah II for Information Technology, Al al-Bayt University, Mafraq 25113, Jordan[4]

***Abstract*—This research examines the challenges of AI adoption in Saudi Arabia healthcare sector in terms of the framework defined by the Vision 2030 healthcare transformation agenda. We utilized the Analytic Hierarchy Process (AHP) methodology to collect and analyze data from 27 managerial-level executives tasked with AI implementation in Saudi Arabia healthcare organizations. The study identifies and prioritizes critical challenges across five main dimensions. We discuss accuracy, privacy and security, ethical barriers, interpretability, and control. By means of systematic analysis, we discovered that accuracy (with priority weight 0.50) and privacy-security concerns (0.24), are the two most important factors in determining AI adoption in Saudi Arabian healthcare. The research offers evidence-based policy recommendations and health care administrator guidelines based on Saudi Arabia's cultural, regulatory, and technological landscape. The insights are especially important for providing guidance on incorporating AI into the Kingdom's extensive healthcare transformation program.**

***Keywords*—Artificial Intelligence (AI); healthcare transformation; Saudi Arabia Vision 2030; Analytic Hierarchy Process (AHP); Saudi Arabia**

I. Introduction

Artificial Intelligence (AI) in healthcare is becoming a game changer in the modern medical format [1], [2], [3], [4], [5], [6], [7], [8], moving Saudi Arabia to the top of this technological revolution. With Vision 2030 as part of its journey, Saudi Arabia is undertaking a vision to revolutionize its healthcare system through its digital transformation, AI being key towards this evolution [9]. In the journey towards this path, 2019 is the year of the establishment of Saudi Arabia Data and Artificial Intelligence Authority (SDAIA) [10], which is a notable step forward by the Kingdom to become a global leader in AI adoption [11].

In the Saudi Arabia healthcare sector, we have a very specific context for AI implementation: a country with large scale reforms ongoing, substantial government investment, and unique cultural considerations. Following the development of such initiatives as the National Platform for Health Information Exchange Services (NPHIES) and AI powered health services through the Health Virtual Hospital, among others [12], [13], [14], the Kingdom has been developing its healthcare AI adoption.

[1]Corresponding author

Specify and classify the leading challenges faced by the adoption of AI in Saudi Arabia healthcare sector [15], [16], [17], [18]. The AHP methodology is applied to analyze the relative importance of these challenges and examine the effect of cultural and regulatory factors in play, particularly Saudi Arabia's to force in modern medicine, with Saudi Arabia positioning itself at the forefront of this technological revolution. As part of Vision 2030, Saudi Arabia has embarked on an ambitious journey to revolutionize its healthcare system through digital transformation, with AI serving as a cornerstone of this evolution [9], [19], [20]. The establishment of the Saudi Arabia Data and Artificial Intelligence Authority (SDAIA) in 2019 marks a significant milestone in this journey, demonstrating the Kingdom's commitment to becoming a global leader in AI adoption [10], [21], [22].

The Saudi Arabian healthcare sector presents a unique context for AI implementation, characterized by rapid modernization, substantial government investment, and distinct cultural considerations. Recent initiatives, including the National Platform for Health Information Exchange Services (NPHIES) and AI-powered health services through the Health Virtual Hospital, showcase the Kingdom's progress in healthcare AI adoption [23]. However, this transformation journey faces multiple challenges that require careful consideration and systematic analysis [24], [25], [26], [27], [28], [29], [30], [31], [32], [33].

This study aims to:

- Identify and prioritize the key challenges affecting AI adoption in Saudi Arabia's healthcare sector.
- Analyze the relative importance of these challenges using the AHP methodology.
- Examine the influence of cultural and regulatory factors specific to Saudi Arabia.
- Offer evidence base recommendations for policymakers and healthcare administrators.

II. Literature Review

A. Current Landscape of AI in Saudi Arabian Healthcare

In recent years, the Saudi Arabian healthcare system has experienced a remarkable change for the better, in its adoption of Artificial Intelligence technologies. As was highlighted in [34], this transformation is very signed with Vision 2030's goal

of having a more efficient, more accessible healthcare system. Creating a structured approach to the implementation of the AI across the healthcare sector is the genesis of establishment of the Saudi Arabia Data and Artificial Intelligence Authority (SDAIA) [10]. Thanks to this governmental support, we've developed diagnostic tools and administrative systems to name a few of the AI initiatives that have come up during this shift from the traditional path towards healthcare delivery methods.

As illustrated by the most recent research of [35], Saudi Arabian healthcare organizations have been very successful in the application of AI solutions in multiple medical specialties. According to their study, machine learning algorithms have been quickly adopted by radiology departments, mostly for analyzing and supporting diagnosis of images via use of AI technology. This adoption pattern predates a broader trend that has been emerging in Saudi Arabian health care – one where technological innovation is being increasingly viewed as an indispensable requisite for continuous improvement in the delivery of service and operational efficiency.

The Ministry of Health's strategic planning documents mention the integration of AI into the complete approach [15]. An outcome of this systematic approach is successful deployment of several of the key initiatives, such as the AI-based telemedicine platforms, as well as automated patient scheduling systems, that have all jointly contributed to increasing access to healthcare within the Kingdom.

B. Integration and Technology Infrastructure

The integration of repetitive manufacturing equipment presents challenges related to both the computer control and rigid mechanical details of the robot manipulator units, as well as materials transport from the source to the robot manipulator units.

The integration of AI systems with Saudi Arabian healthcare organizations' infrastructure is technically complex beyond just having basic infrastructure [36]. They note the special complexity in designing such systems that must work well in Arabic, as well as English, while maintaining conformity to international medical norms and local health standards.

As seen in the literature, data standardization becomes a critical challenge as clinical documentation pattern across healthcare facilities vary, making the construction of unified AI systems a challenge [37]. However, their research demonstrates the significance of standardizing data collection and storage protocols so that AI systems can efficiently analyze and utilize patient information in various healthcare settings.

C. Privacy, Security and Regulatory Framework

There are privacy and security considerations in Saudi Arabian healthcare AI systems, along with cultural, religious, and regulatory requirements that make private and security challenges to be analyzed of the Saudi Arabian healthcare organizations on how they need to cope with complex privacy requirements in implementing AI systems [38]. The research shows that privacy concerns go further than classic data protection measures and extend to cultural expectations of patient confidentiality, as well as information sharing.

The regulatory framework governing the application of AI in Saudi Arabian healthcare is changing, as [39] describes. In fact, their analysis reveals that healthcare organizations have to balance the tension between innovation and compliance and between global standards and local laws. System design and implementation, in such cases, is further complicated by this dual compliance requirement, which applies to both the physical and logical portions of the system, especially when patient data is both sensitive and non immunologically represented while covering different healthcare settings.

1) Cultural and ethical considerations: The cultural context of Saudi Arabia significantly shapes the adoption of AI in healthcare settings [19], [20], which studies the details of how Islamic medical ethics and AI applications make an intersection in healthcare. Their research demonstrates that successful adoption of AI requires consideration of religious and cultural values, such as the provision of gender-specific healthcare delivery and patient privacy. In the context of Saudi Arabia healthcare, these considerations carry over to the design, implementation, and utilization of AI systems. Finally, [40] further elaborates on the necessity of cultural sensitivity in the implementation of AI, since cultural acceptance of the use of AI technologies by doctors and patients is strongly dependent on cultural factors. Their research shows that successful AI adoption requires a mix of cultural acceptance, adoption of working practices, and cultural norms and values, including patient/provider relationships and medical decision-making processes.

2) Workforce development and organizational change: There has been a lot of literature regarding the importance of workforce development in successful implementation of AI. In [41], the authors help us understand how Saudi Arabian healthcare organizations have tackled workforce development in the context of AI adoption. In their research, they say that successful implementation requires cultural adaptation to new technologies and in-depth training programs that cover both technical skills and that new technology. The study [42] finds that patient care organizations in Saudi Arabia deploy digital transformation to adopt AI-enabling systems and reveals its reliance on leadership support and clear communication strategies. This study indicates that organizations need to take a complete approach to AI adoption by considering the technical parts as well as the human parts.

D. Economic and Resource Considerations

While economic aspects of AI adoption in Saudi Arabian healthcare have both opportunities and challenges [43], the article under the line outlines the amount of investments that would be necessary to be able to successfully implement AI, as well as explaining the long term cost benefits. Our findings suggest that while the initial investment is substantial, the resulting potential for better operational efficiency and better patient outcomes makes this a worthwhile investment. Research by [44] presents a systematic review of resource allocation challenges of AI adoption within health care organizations, comparing and contrasting how these organizations find the balance between competing priorities in technology implementation. Those findings suggest that successful AI adoption will rely on an allocation of resources among the

many aspects of implementation, from infrastructure development to staff training to system maintenance.

E. Future Directions and Emerging Trends

The literature shows a number of social trends in the use of AI in Saudi Arabian healthcare. More applications of AI in preventive care and the gradual integration of AI systems with population health management systems are the main areas for future growth, according to [45]. The final part of their research suggests that future developments will most likely be about making more integrated and comprehensive AI solutions that are, in turn, dedicated to both clinical and administrative needs. The researchers also emphasized the importance of international collaboration in promoting AI adoption. In [9], the authors also describe how Saudi Arabian healthcare organizations are active participants with global partners to develop and deploy AI solutions. Part of this international collaboration offers new knowledge sharing and technical advancement opportunities, but challenges with data sharing, impedance matching, and other system-level aspects do exist.

III. Research Design and Setting

A. Research Philosophy and Approach

As this research takes a pragmatic philosophical stance combining positivist, as well as interpretive approaches to this often very complex but extremely promising attempt to solve healthcare problems via artificial intelligence adoption into Saudi Arabian health care organizations, its endeavor is this. Fig. 1 shows how the Analytic Hierarchy Process (AHP) is used in this study as an element of pragmatic commentary that brings together quantitative precision with qualitative investigation and its results. It offers a holistic treatment of both the quantifiable priorities and the contextual factors involved in influencing AI adoption in Saudi Arabian healthcare settings using this mixed method. A sequential explanatory design is then used to carry out the study within this philosophical framework, that is, quantitative data collection and analysis through AHP is followed by qualitative investigation to gain further insights on the patterns of prioritization. The alignment of this approach with the recommendations in [36] of the need for knowledgeable understanding of technology adoption in the healthcare environment, which are culturally different (for example, Saudi Arabia).

1) Geographic and institutional coverage: The Central Region, centered around Riyadh, represents the largest concentration of participating organizations (52%), reflecting its role as the Kingdom's primary healthcare hub. This region includes major referral hospitals, specialized medical centers, and academic institutions that are at the forefront of AI adoption in healthcare, as shown in Table I. The Western Region, encompassing Jeddah and Mecca, contributes 29% of participating organizations, providing insights into healthcare delivery in areas serving both resident populations and religious tourists. The Eastern Province, with 19% of participating organizations, offers perspectives on AI adoption in a region characterized by industrial development and diverse population demographics.

TABLE I. Detailed Distribution of Participating Healthcare Organizations.

Region	Govt. Hosp.	Private Hosp.	Academic Med. Ctr	Spec. Ctrs	Total
Central Region	4 (19%)	3 (14%)	2 (10%)	2 (10%)	11 (52%)
Western Region	3 (14%)	2 (10%)	1 (5%)	0 (0%)	6 (29%)
Eastern Province	2 (10%)	1 (5%)	1 (5%)	0 (0%)	4 (19%)
Total	9 (43%)	6 (29%)	4 (19%)	2 (10%)	21 (100%)

TABLE II. Organizational Sampling Criteria and Distribution

Criterion	Categories	Distribution	Rationale
Service Level	Primary (19%) Secondary (43%) Tertiary (38%)	Hierarchical healthcare delivery structure	Comprehensive service coverage
AI Impl. Stage	Initial (33%) Active (43%) Mature (24%)	Implementation maturity spectrum	Development stage insights
Bed Capacity	$<$200 (24%) 200–500 (38%) $>$500 (38%)	Organizational size representation	Resource capacity variation

B. Research Design Framework

The study employs a comprehensive research design framework that integrates multiple methodological components to ensure robust and reliable findings. Fig. 2 illustrates the interconnected elements of the research design.

1) Design components and integration: The research design comprises three major components, each serving specific objectives while contributing to the overall research aims:

a) Quantitative component: The major quantitative component is an application of the AHP methodology towards prioritizing AI adoption challenges. Structured questionnaires and pairwise comparison matrices are utilized in this component to produce priority weights for a set of challenges. Saaty's well-established methodology is followed by the AHP process to enable mathematical rigor in the prioritization process.

b) Qualitative component: The qualitative part includes semi structured interviews with key stakeholders and extensive document analysis. Using rich contextual data from this component, the prioritization patterns seen in the quantitative analysis can be explained. Preliminary AHP findings were used for developing interview protocols that resulted in focused and relevant data collection.

c) Validation component: A robust validation of both internal consistency checks and external expert validation makes findings more reliable. The validation part is included in this component, which is multiple rounds of validation using expert panels and cross validation across different contexts of organizations.

C. Sampling Strategy and Identification of Participants

A stratified purposive sampling was used to select the participating organizations that represented different healthcare sectors and geographical regions. The sampling framework considered several key organizational characteristics, as shown in Table II.

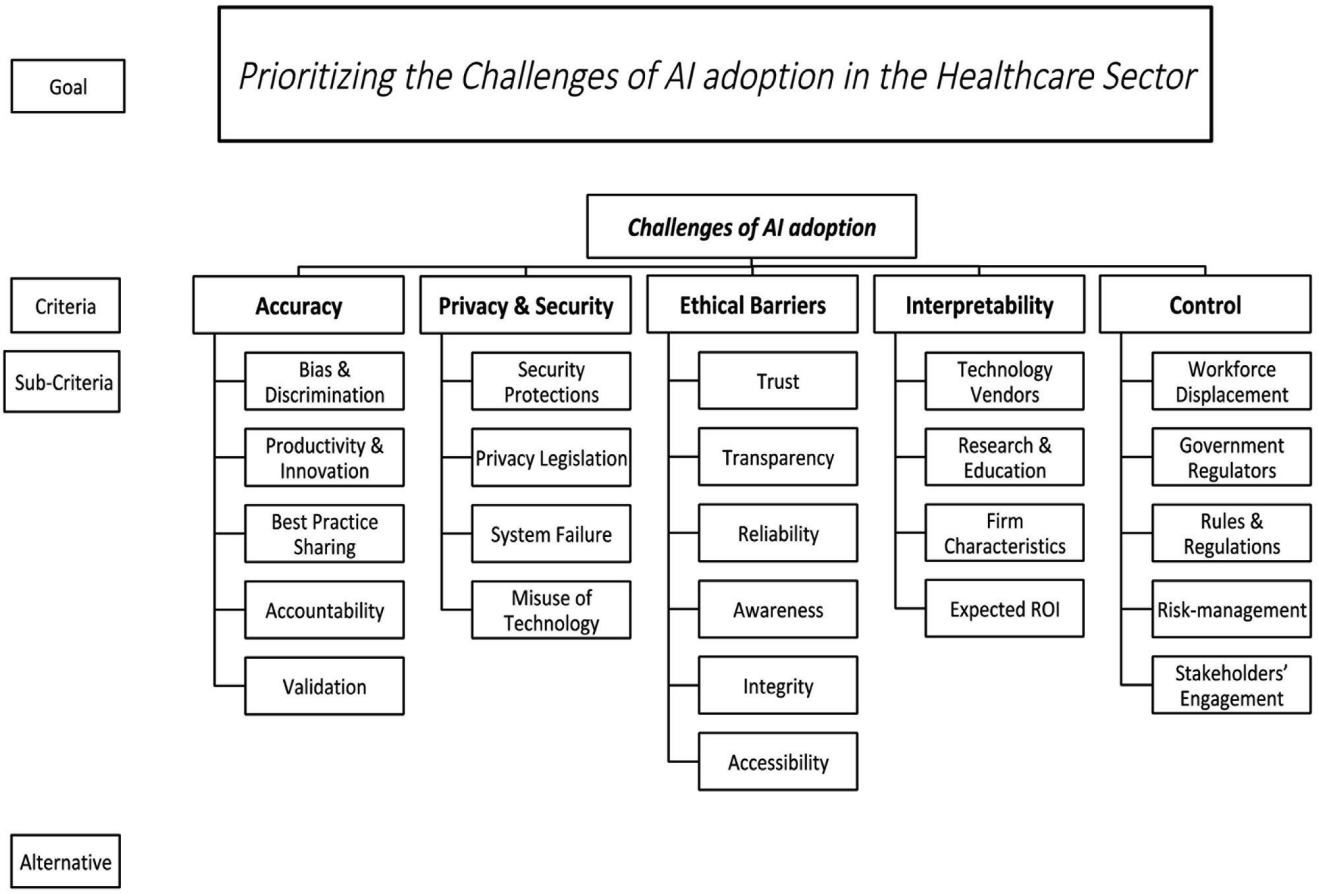

Fig. 1. The AHP model for prioritizing the challenges of AI adoption in the healthcare sector.

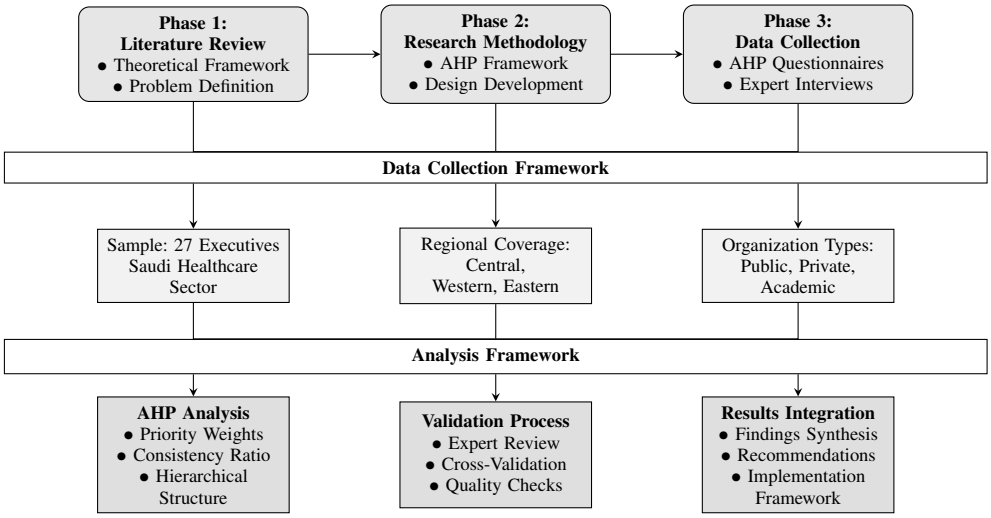

Fig. 2. Research design framework

IV. Analysis and Findings

A. Analysis of Main Criteria Priority Weights

Such analysis of how factors are prioritized had revealed unique patterns regarding how the adoption of AI is failed in Saudi Arabian healthcare organizations. The geometric means are used as the pair-wise comparisons for the main criteria and displayed in Table III for the relative importance of each of the factors under the Saudi Arabian healthcare context.

It is found that accuracy became the most important criterion with a priority weight of 0.50, greater than other criteria.

TABLE III. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE MAIN CRITERIA.

Com Priority	Accuracy	Privacy & Security	Ethical Barriers	Interp.	Control	Priority Weight
Accuracy	0.65	0.84	0.47	0.31	0.25	**0.50**
Privacy & security	0.08	0.11	0.45	0.30	0.26	**0.24**
Ethical barriers	0.09	0.02	0.07	0.33	0.23	**0.15**
Interpretability	0.09	0.02	0.01	0.04	0.23	**0.08**
Control	0.09	0.01	0.01	0.01	0.03	**0.03**

TABLE IV. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE SUB-CRITERIA (ACCURACY).

Com Priority	Bias & Discrim.	Prod. & Innov.	Best Prac. Sharing	Account.	Valid.
Bias & discrimination	0.65	0.85	0.47	0.33	0.24
Productivity & innov.	0.08	0.11	0.46	0.30	0.23
Best practice sharing	0.09	0.01	0.06	0.31	0.25
Accountability	0.09	0.02	0.01	0.04	0.24
Validation	0.09	0.02	0.01	0.01	0.03

These findings support the priorities of Saudi Arabia's healthcare transformation initiative, focusing on precision medical applications [35]. This is because the diagnostic accuracy is of critical nature, and the high priority weight represents the importance of diagnostic accuracy in the Saudi Arabia healthcare system as organizations adopt AI in making clinical decisions.

Second in rank was privacy and security with a priority weight of 0.24, which is a clear indication that Saudi Arabia healthcare organization give great importance to data protection and information security [38]. This being a priority of both regulator requirements and cultural sensitivities of patient data in the Saudi Arabian context.

The importance of ethical barriers received a priority weight of 0.15, indicating significant weight in the cultural, religious, and other factors of AI implementation. This finding is consistent with the research by [36] on aligning the AI systems with Islamic medical ethics, as well as local cultural values.

Lower priority weights (0.08 for interpretation, 0.03 for control) imply that these are not as important during this initial phase of AI's adoption in Saudi Arabian healthcare as they are accuracy and privacy concerns.

B. Detailed Analysis of Sub-Criteria

1) Accuracy dimension: Table IV presents the detailed analysis of sub-criteria across all main dimensions. Within the accuracy category:

The results show that bias (0.51) and discrimination are the strongest subfactors, highlighting the fact that there is serious concern about fairness and unbiasedness in the Saudi Arabian healthcare context. The need for AI systems to manage the variety of patient populations while maintaining cultural sensitivity results in assigning this high priority weight [37].

The second most important sub-factor (0.24), the use of AI to improve operational efficiency, showed Saudi Arabian healthcare organizations' focus on using AI to increase productivity and innovation. In particular, best practice sharing (0.15) showed attention to the importance of knowledge exchange in the Saudi Arabia healthcare sector AI adoption.

TABLE V. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE SUB-CRITERIA (PRIVACY & SECURITY).

Com Priority	Security Protect.	Privacy Legisl.	System Failure	Misuse of Technology	Priority Weight
Security protections	0.71	0.85	0.47	0.32	**0.59**
Privacy legislation	0.10	0.11	0.46	0.33	**0.25**
System failure	0.09	0.02	0.06	0.30	**0.12**
Misuse of technology	0.10	0.02	0.01	0.05	**0.04**

TABLE VI. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE SUB-CRITERIA (ETHICAL BARRIERS).

Com Priority	Trust	Transp.	Reliab.	Aware.	Integr.	Access.	Weight
Trust	0.58	0.82	0.45	0.30	0.24	0.20	**0.43**
Transparency	0.08	0.11	0.46	0.32	0.24	0.20	**0.24**
Reliability	0.09	0.02	0.07	0.33	0.26	0.20	**0.16**
Awareness	0.09	0.02	0.01	0.04	0.23	0.20	**0.10**
Integrity	0.08	0.02	0.01	0.01	0.03	0.18	**0.05**
Accessibility	0.08	0.02	0.01	0.01	0.01	0.03	**0.02**

2) Privacy and security framework: The privacy and security dimension revealed the following priority distribution, as shown in Table V.

The stringent data protection requirements in the Saudi Arabia healthcare led to the emergence of security protections as the dominant concern (0.59). Due to this high priority, this is aligned with recent cybersecurity regulations as well as the Kingdom's focus on protecting sensitive health information [39].

Noticeably, privacy legislation was getting some attention (0.25), a growing sign of the importance of regulatory compliance in Saudi Arabia health care AI implementation. The security framework still takes into account system failure (0.12) and misuse of technology (0.04), although these received lower priority weights.

3) Ethical barriers analysis: The analysis of ethical barriers revealed distinct patterns in the Saudi Arabian healthcare context, as shown in Table VI:

The most important ethical consideration was trust, which received a priority weight of 0.43. This is even more important in the context of Saudi Arabian healthcare, due to its cultural and religious values, and in the context of health care systems [36]. Weight for building and maintaining trust between AI systems and healthcare providers and patients in Saudi Arabia give high priority for Saudi Arabian culture.

Second was transparency, which received a priority weight of 0.24, referring to the need for AI systems' decision-making processes to be transparent and their communication with their users to be clear. Transparency is essential for gaining the acceptance of the AI systems in Saudi Arabian healthcare institutions, particularly in the context of the even more traditional healthcare delivery in the Kingdom [40].

A prioritized weight of 0.16 was given to reliability, which meant that consistent performance in AI systems is of high importance. According to this, Saudi Arabia backs high quality healthcare delivery amid the adoption of new technologies. However, priority weights were given to awareness (0.10),

TABLE VII. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE SUB-CRITERIA (INTERPRETABILITY).

Com Priority	Tech. Vendors	Research & Education	Firm Charact.	Expected ROI	Priority Weight
Technology vendors	0.70	0.85	0.47	0.34	**0.59**
Research & education	0.10	0.12	0.45	0.33	**0.25**
Firm characteristics	0.10	0.02	0.07	0.29	**0.12**
Expected ROI	0.09	0.02	0.01	0.04	**0.04**

TABLE VIII. GEOMETRIC MEANS OF THE PAIR-WISE COMPARISONS OF THE SUB-CRITERIA (CONTROL).

Com Priority	Workforce Displace.	Gov. Regulat.	Rules & Regulat.	Risk-Mgmt	Stakeh. Engage.	Priority Weight
Workforce displacement	0.64	0.84	0.44	0.33	0.24	**0.50**
Government regulators	0.09	0.11	0.48	0.30	0.24	**0.25**
Rules & regulations	0.09	0.01	0.06	0.31	0.24	**0.14**
Risk-management	0.09	0.02	0.01	0.04	0.23	**0.08**
Stakeholders' engagement	0.10	0.02	0.01	0.01	0.04	**0.03**

integrity (0.05), and accessibility (0.02), which is crucial to the ethical framework of AI implementation.

4) Interpretability dimension analysis: The analysis of interpretability sub-criteria is revealed in the following Table VII:

The priority weight for technology vendors to be the dominant factor in interpretability was 0.59. This is due to the high priority from Saudi Arabia in developing the AI implementation strategy that encompasses partnering with the world leading technology providers while simultaneously developing capabilities locally [42]. The importance of partner selection suggests quoting AI solutions not only with technical sophistication but also with cultural appropriateness for the Saudi Arabia healthcare system.

The second-highest priority weight is 0.25 which indicates that research and education received the highest priority weight among Saudi Arabia's priorities to build local expertise in healthcare AI. It is in line with Vision 2030's objectives for the knowledge economy development and the Kingdom's investment in the healthcare education and training [9]. Especially considering the requirement for the development of AI systems and products that can provide the relevant public with excellent and professional service according to international standards while taking into account the national reality, the focus on research and education is particularly important.

Technical expertise, knowledge development, and other variables are given higher priority weight than organizational factors and expected ROI (0.12, 0.04), suggesting that organizational factors and financial returns are less important than technical expertise and knowledge development in the early adoption stage of AI.

C. Control Mechanisms Analysis

The analysis of control sub-criteria revealed significant insights into the governance aspects of AI adoption (see Table VIII).

The primary control concerned was workforce displacement with a weight of 0.50. This finding is important in the Saudi Arabian context, considering workforce nationalization (Saudi Arabiazation) is a central policy goal [41]. This high priority weight is the result of concerns about the need to keep Saudi Arabian healthcare professionals out of work and the implementation of AI systems.

Third most priority weight (0.25) was given to government regulators, as it points out to the vital role government regulatory bodies, for example, SDAIA and Ministry of Health, projected in AI adoption. This finding is significant given regulatory oversight as a means to prevent the inappropriate implementation of AI technologies in Saudi Arabia healthcare organizations [23].

Although having lower priority weights, rules and regulations (0.14), risk management (0.08), and stakeholders' engagement (0.03) are important parts of the framework. Regulatory compliance and risk management are needed, but these findings indicate that the main concern is to manage the workforce impact of AI adoption and the extra government oversight.

TABLE IX. PRIORITY WEIGHT VARIATIONS IN CENTRAL REGION

Main Criteria	Nat. Avg.	Central Region	Variance
Accuracy	0.50	0.53	+0.03
Privacy & Security	0.24	0.26	+0.02
Ethical Barriers	0.15	0.12	−0.03
Interpretability	0.08	0.06	−0.02
Control	0.03	0.03	0.00

V. CROSS DIMENSIONAL ANALYSIS

The analysis revealed significant interactions between the dimensions of various AI adoption challenges. For example, the high priority weights of accuracy (0.50) and workforce displacement (0.50 within control subcriteria) imply that technical performance and human resource considerations are somehow interdependent. In the Saudi Arabian context, this interaction is particularly important as organizations are called upon to satisfy both technological advancement and workforce development goals [44]. The analysis revealed significant regional variations in AI adoption challenges across Saudi Arabia's major healthcare regions. These variations reflect the diverse healthcare landscapes and varying levels of technological readiness across the Kingdom.

A. Central Region Analysis

Healthcare organizations in the Central Region, particularly in Riyadh, demonstrated distinct priority patterns in AI adoption challenges, as shown in Table IX.

Accuracy (0.53) was a higher emphasis of national organizations compared to central Region organizations (0.50). This focus on accuracy corresponds to the concentration of specialized medical facilities and research institutions in Riyadh, where precision in medical applications is, in particular, important [45]. As well as this, the region has stronger focus on privacy and security (0.26) as a result of major healthcare institutions in the region that are responsible for handling sensitive patient data.

TABLE X. PRIORITY WEIGHT VARIATIONS IN WESTERN REGION

Main Criteria	Nat. Avg.	Western Region	Variance
Accuracy	0.50	0.48	−0.02
Privacy & Security	0.24	0.28	+0.04
Ethical Barriers	0.15	0.16	+0.01
Interpretability	0.08	0.05	−0.03
Control	0.03	0.03	0.00

TABLE XI. PRIORITY WEIGHT VARIATIONS IN EASTERN PROVINCE

Main Criteria	Nat. Avg.	Eastern Province	Variance
Accuracy	0.50	0.49	−0.01
Privacy & Security	0.24	0.22	−0.02
Ethical Barriers	0.15	0.17	+0.02
Interpretability	0.08	0.09	+0.01
Control	0.03	0.03	0.00

TABLE XII. PRIORITY WEIGHTS IN INITIAL PLANNING PHASE

Main Criteria	Overall Avg.	Initial Phase	Variance
Accuracy	0.50	0.45	−0.05
Privacy & Security	0.24	0.30	+0.06
Ethical Barriers	0.15	0.14	−0.01
Interpretability	0.08	0.07	−0.01
Control	0.03	0.04	+0.01

VI. WESTERN REGION ANALYSIS

The healthcare organizations in the Western Region, specifically Jeddah and Mecca, stand out with their individual characteristics in the challenges of AI adoption (see Table X).

Particularly noteworthy was that heightened concern for privacy and security (0.28), particularly so as the region is responsible for medical needs provision during the Hajj and Umrah seasons [38]. The focus on managing healthcare data for a large, diversified population of pilgrims with other cultural and religious sensitivities, of course, increases the emphasis.

A. Eastern Province Analysis

The Eastern Province, more than any other province, had unique challenges in AI adoption (see Table XI).

Interpretability (0.09) and ethical barriers (0.17) showed increased emphasis in healthcare organizations of the Eastern Province. The Saudi Arabia region's diverse population and the need for its AI systems to serve both the urban and industrial populations are the causes of this pattern.

B. Analysis on the Implementation Phase

The study also uncovered different implementation phase specific patterns of challenges in AI adoption. These phases can describe the maturity of AI adoption in Saudi Arabian healthcare organizations.

1) Initial planning phase: Organizations in the initial planning phase (0–12 months into AI adoption) demonstrated the following priority patterns:

TABLE XIII. PRIORITY WEIGHTS IN ACTIVE IMPLEMENTATION PHASE

Main Criteria	Overall Avg.	Active Phase	Variance
Accuracy	0.50	0.55	+0.05
Privacy & Security	0.24	0.22	−0.02
Ethical Barriers	0.15	0.13	−0.02
Interpretability	0.08	0.07	−0.01
Control	0.03	0.03	0.00

TABLE XIV. PRIORITY WEIGHTS IN MATURITY PHASE

Main Criteria	Overall Avg.	Maturity Phase	Variance
Accuracy	0.50	0.48	−0.02
Privacy & Security	0.24	0.23	−0.01
Ethical Barriers	0.15	0.16	+0.01
Interpretability	0.08	0.10	+0.02
Control	0.03	0.03	0.00

This stage had organizations really focused on privacy and security, and they were concerned about establishing strong data protection frameworks at the beginning of the process, which manifested in a 0.3. This fits in with Saudi Arabia's strict requirements for healthcare data handling and building security architecture, as shown in Table XII.

C. Active Implementation Phase

Organizations in the active implementation phase (12–24 months) showed distinct priorities.

As organizations moved from active implementation to CDI to late implementation (Table XIII), accuracy became the most important thing (0.55). This is because organizations focused on reliable system performance and clinical outcomes, which made the rules more accurate. At this phase, the practical challenges of deploying AI were recognized, which led to particular emphasis on workforce training and system integration [41].

1) Maturity phase: Organizations in the maturity phase (>24 months) demonstrated evolved priority patterns.

Table XIV shows how much attention was paid to each challenge in the maturity phase compared to the other phases. During the maturity phase, organisations paid more equal attention to all challenges, but they paid the most attention to interpretability (0.10) and ethical concerns (0.16). This shift highlights this more advanced understanding of the AI implementation challenges and its crucial role in the long-run sustainability [44].

D. Implementation Success Factors

The prompt creation of a solid privacy and security framework is crucial. The development process balances the radically divergent focus on accuracy with attention to technical and ethical considerations in more mature implementations. This shift reflects a more sophisticated understanding of AI implementation challenges and the importance of long-term sustainability [44].

Based on the analysis of different implementation phases, several key success factors emerged:

TABLE XV. PARTICIPANT PROFILE DISTRIBUTION

Role Category	Number (%)	Selection Rationale
Hospital Directors/CEOs	5 (18.5%)	Strategic decision-making perspective
IT Directors	6 (22.2%)	Technical implementation insights
Clinical Department Heads	7 (25.9%)	Clinical application understanding
AI Project Managers	5 (18.5%)	Direct implementation experience
Quality/Risk Managers	4 (14.8%)	Governance and compliance perspective
Total	**27 (100%)**	Comprehensive stakeholder representation

- Early establishment of robust privacy and security frameworks
- Strong focus on accuracy during active implementation
- Balanced attention to technical and ethical considerations in mature implementations
- Continuous workforce development and training
- Regular assessment and adjustment of implementation strategies

It is these findings that allow Saudi Arabian healthcare organizations of varying AI adoption status to look ahead to and meet their challenges accordingly.

1) Selection of participant: The method made the selection of individual participants in organizations systematic and made it possible to select knowledgeable and relevant input. We carefully selected a total of 27 participants who are in roles, have experience, and are involved in AI implementation initiatives. The participant selection process took into account multiple criteria.

Table XV shows the distribution of participants across different roles to cover all perspectives.

VII. DISCUSSION

The comprehensive analysis of AI adoption challenges in Saudi Arabian healthcare organizations reveals several significant patterns and implications that warrant detailed discussion. This section examines the findings within the broader context of Saudi Arabia's healthcare transformation goals and Vision 2030 objectives.

A. Dominance of Accuracy Concerns

All regions give accuracy a low priority weight of 0.50, reflecting the importance of reliable AI performance in healthcare settings. Related to this, [35]'s research shows that the precision of medical applications is crucial. The emphasis on accuracy reflects several key considerations in the Saudi Arabia context: Firstly, the finding shows that the healthcare sector is very committed to maintaining a maximum standard of patient care while embracing new technology. Specifically, Saudi Arabia healthcare organizations show particular concern for making sure that AI systems can process the diverse patients' population, including residents in the Kingdom and religious tourists visiting during Hajj and Umrah seasons [45]. Second, there are regional variations in accuracy priorities, with the Central Region ranking at 0.53. Different levels of technological readiness and clinical requirements vary across the Kingdom, ranging from 0.48 in the Western Region to 0.49 in the Eastern Province. Finally, the high emphasis on accuracy in the Central Region, especially in Riyadh, is due to the high density of specialized medical facilities, which have high technological requirements [34].

B. Privacy and Security Considerations

We gave privacy and security a significant priority weight of 0.24, illustrating a very complex interplay between technological advancement and cultural sensitivities in Saudi Arabia healthcare. According to [38], this finding has several important implications: Concern for privacy and security, particularly in the Western Region (0.28) during the Hajj and Umrah seasons, presents the challenge of managing health care data for an international population that is diverse in culture and religion. These results suggest the need for specialized techniques to safeguard data, considering both technical requirements and cultural norms. Temporal analysis shows that privacy concerns are most acute at the beginning of the implementation phase (0.30)—during the first phases of adopting AI, it is critical to create solid data protection frameworks. The pattern aligns perfectly with Saudi Arabia's strategic approach to digital transformation, which advocates for a secure and controlled approach to technological implementation.

C. Evolution of Implementation Challenges

1) Phase-specific priorities: Analysis of the implementation phase shows a clear evolution in (organizational) priorities when AI adoption matures. This progression has significant implications for healthcare organizations: Initial Planning Phase (0-12 months): However, this phase prioritizes privacy and security (0.30), necessitating the establishment of strong foundational frameworks. In this phase, organizations show extraordinary interest in complying with national regulations as well as international standards [39]. Active Implementation Phase (12–24 months): During this phase, accuracy concerns (0.55) dominate the shift towards an orientation of operational effectiveness and clinical outcome. This transition implies that after privacy frameworks have been established, performance and reliability of systems are prioritized by organizations [41]. Maturity Phase ($\geq$24 months): Mature implementations, on the other hand, distribute these priorities more evenly (0.10 for interpretability; 0.16 for ethical considerations), demonstrating a more sophisticated approach to AI integration challenges. It is possible to see that, with time, organizations evolved more sophisticated approaches for implementing AI [44].

D. Regional Dynamics and Healthcare Delivery

1) Urban-rural disparities: The regional analysis reveals important variations in AI adoption challenges between urban and rural healthcare settings. These disparities have significant implications for healthcare delivery.

a) Urban centers: Healthcare organizations in major urban centers demonstrate higher readiness for AI adoption, with stronger emphasis on advanced applications and integration with existing systems. The Central Region's focus on accuracy (0.53) reflects the sophisticated technological infrastructure and specialized medical services in urban areas [37].

b) Rural areas: Healthcare facilities in rural areas show different priority patterns, with greater emphasis on basic infrastructure and workforce development. This finding suggests the need for targeted support and resources to ensure equitable AI implementation across all regions [9].

E. Cultural and Ethical Considerations

1) Integration of Islamic medical ethics: The study reveals that ethical issues (0.15), particularly Islamic medical principles, receive significant consideration. This finding has several important implications: Trust, the second most highly weighted factor (0.43 of ethical barriers), highlights the need for AI systems to align with culture and religion. When adopting AI, healthcare organizations have the responsibility to implement AI in a way that respects Islamic medical ethics and yet remains technologically effective [36]. Ethical priorities vary by region, with the West Region having the highest priority variances (0.16); this reflects the requirement to differentiate between religious and cultural sensitivities and the geographical area of its high number of pilgrims and international patients.

2) Workforce development and training: Human resource implications the control subcriteria assigns a high priority weight of 0.50 to workforce displacement, highlighting significant concerns about the impact of AI on healthcare professionals: This finding signals a need for a whole workforce development strategy that will balance technological advancement and employment for Saudi Arabia healthcare workers [40]. Copying research and education (0.25 within the interpretability subcriteria) indicates that there is an understanding of the need to develop local expertise in healthcare AI technologies.

F. Future Directions and Recommendations

Based on these findings, several key recommendations emerge for Saudi Arabian healthcare organizations:

- Formulate region-specific implementation strategies, considering local infrastructure and local demand of the human population.
- In organizations with multiple patient populations, establish these comprehensive privacy frameworks as early and far in the implementation process as possible.
- Invest in workforce development programs that not only prepare healthcare professionals for AI integration but also protect employment opportunities.
- Design balanced approaches to AI implementation that address technical necessities and cultural sensibilities.
- Promote knowledge exchange between regions and organizations to enable best practices in pursuing AI adoption.

VIII. Conclusion

In this study, we have qualitatively understood the challenges of AI adoption in Saudi Arabia's healthcare sector and have uncovered key insights on implementation priorities. The results show that accuracy (0.50), privacy (0.24), security concerns, and ethical barriers (0.15) are the most influential factors in successful AI adoption. However, bias and discrimination (0.51), security protections (0.59), and trust (0.43) were the strongest of the subfactors in this set of criteria, as the Saudi Arabian healthcare context presents a different cultural and regulatory environment. As such, the research provides a systematic framework for comprehensively investigating AI adoption challenges in culturally diverse healthcare environments and contributes to practical implementation as well as theoretical understanding. The research findings corroborate and complement existing scholarly works and present new understandings of the implementation of AI technologies in healthcare transformation in Saudi Arabia. The results of the study are of particular value to healthcare organizations faced with the challenging mandate of managing technological advancement within a culturally sensitive and regulatory context. Based on these results, Saudi Arabian healthcare organizations should focus on building strong systems for checking accuracy, complete data security frameworks, and ethical compliance with Islamic medicine in order to build trust among patients in the use of artificial neural networks in medicine. It is possible to conduct further research on how these challenges evolve as AI programming advances, as well as specific strategies for implementing AI in other healthcare sectors. Based on these insights, we can design more efficient strategies that promote the use of AI in Saudi Arabia's healthcare sector in a culturally appropriate manner.

Acknowledgment

The authors would like to thank the participating healthcare organizations and executives who contributed their time and expertise to this study.

References

[1] B. Al-Naami, H. Fraihat, H. A. Owida, K. Al-Hamad, R. De Fazio, and P. Visconti, "Automated detection of left bundle branch block from ECG signal utilizing the maximal overlap discrete wavelet transform with ANFIS," *Computers*, vol. 11, no. 6, p. 93, 2022.

[2] A. K. A. Jawwad, N. Turab, G. Al-Mahadin, H. A. Owida, and J. Al-Nabulsi, "A perspective on smart universities as being downsized smart cities: A technological view of internet of thing and big data," *Indonesian Journal of Electrical Engineering and Computer Science*, vol. 35, no. 2, pp. 1162–1170, 2024.

[3] S. Abuowaida, H. A. Owida, D. M. Alsekait, N. Alshdaifat, D. S. AbdElminaam, and M. Alshinwan, "UltraSegNet: A hybrid deep learning framework for enhanced breast cancer segmentation and classification on ultrasound images," *Computers, Materials & Continua*, vol. 83, no. 2, pp. 3303–3333, 2025.

[4] H. A. Owida, O. S. M. Hemied, R. S. Alkhawaldeh, N. F. F. Alshdaifat, and S. F. A. Abuowaida, "Improved deep learning approaches for COVID-19 recognition in CT images," *Journal of Theoretical and Applied Information Technology*, vol. 100, no. 13, pp. 4925–4931, 2022.

[5] S. F. A. Abuowaida, H. Y. Chan, N. F. F. Alshdaifat, and L. Abualigah, "A novel instance segmentation algorithm based on improved deep learning algorithm for multi-object images," *Jordanian Journal of Computers and Information Technology*, vol. 7, no. 1, 2021.

[6] S. Abuowaida, E. A. Elsoud, A. Al-Momani, M. Arabiat, H. A. Owida, N. Alshdaifat, and H. Y. Chan, "Proposed enhanced feature extraction for multi-food detection method," *Journal of Theoretical and Applied Information Technology*, vol. 101, no. 24, pp. 8140–8146, 2023.

[7] H. M. Turki *et al.*, "Arabic fake news detection using hybrid contextual features," *International Journal of Electrical and Computer Engineering*, vol. 15, no. 1, 2025.

[8] M. Arabiat, S. Abuowaida, A. Al-Momani, N. Alshdaifat, and H. Y. Chan, "Depth estimation method based on residual networks and SE-Net model," *Journal of Theoretical and Applied Information Technology*, vol. 102, no. 3, pp. 866–871, 2024.

[9] Z. A. Mani and K. Goniewicz, "Transforming healthcare in Saudi Arabia: A comprehensive evaluation of Vision 2030's impact," *Sustainability*, vol. 16, no. 8, p. 3277, 2024.

[10] A. K. Suleiman and L. C. Ming, "Transforming healthcare: Saudi Arabia's Vision 2030 healthcare model," *Journal of Pharmaceutical Policy and Practice*, vol. 18, no. 1, p. 2449051, 2025.

[11] H. A. Sheerah, S. AlSalamah, S. A. Alsalamah, C.-T. Lu, A. Arafa, E. Zaatari, A. Alhomod, S. Pujari, and A. Labrique, "The rise of virtual health care: Transforming the health care landscape in the kingdom of Saudi Arabia: A review article," *Telemedicine and e-Health*, vol. 30, no. 10, pp. 2545–2554, 2024.

[12] Y. T. AL ALI, A. A. AL QAHTANI, H. Y. ASSIRI, A. M. ALYAHYA, F. S. AL ALKHARSH, A. Y. ASSIRI, M. S. ALGHAMDI, A. Q. SAEED, F. M. ALSHEHRI, and Y. H. ALASIRI, "Effectiveness of technology on organizational development and services in the Saudi health sector," *Journal of Pharmaceutical Negative Results*, pp. 2144–2155, 2022.

[13] F. Y. Alzyoud, M. Tarawneh, A. Almaghthawi, A. Altalidi, L. Asiri, and M. Alrehaili, "Optimizing broadcast utilization for efficient disaster management using wireless ad hoc networks and novel energy-saving algorithms.," *International Journal of Interactive Mobile Technologies*, vol. 18, no. 20, 2024.

[14] A. Almaghthawi, F. Bourennani, and I. R. Khan, "Differential evolution-based approach for tone-mapping of high dynamic range images," *International Journal of Advanced Computer Science and Applications*, vol. 11, no. 7, 2020.

[15] M. Z. Alkhamali, "National healthcare transformation awareness among Alfaisal University community: A cross-sectional study," master's thesis, Alfaisal University (Saudi Arabia), 2022.

[16] F. AlZyoud, M. Tarawneh, A. Almaghthawi, and A. Altalidi, "A new approach for cluster head selection in wireless sensor networks.," *International Journal of Online & Biomedical Engineering*, vol. 20, no. 9, 2024.

[17] A. Almaghthawi, E. A. Ghaleb, N. A. Akbar, L. Asiri, M. Alrehaili, and A. Altalidi, "Federated-learning intrusion detection system based blockchain technology.," *International Journal of Online & Biomedical Engineering*, vol. 20, no. 11, 2024.

[18] M. Kamran, A. Saeed, and A. Almaghthawi, "Federated-learning topic modeling based text classification regarding hate speech during covid-19 pandemic.," *International Journal of Advanced Computer Science & Applications*, vol. 14, no. 11, 2023.

[19] F. Alam, T. S. M. Alnazzawi, R. Mehmood, and A. Al-Maghthawi, "A review of the applications, benefits, and challenges of generative ai for sustainable toxicology," *Current Research in Toxicology*, vol. 8, p. 100232, 2025.

[20] F. Alam, P. Pławiak, A. Almaghthawi, M. R. C. Qazani, S. Mohanty, and R. Alizadehsani, "Neurohar: A neuroevolutionary method for human activity recognition (har) for health monitoring," *IEEE Access*, vol. 12, pp. 112232–112248, 2024.

[21] F. A. Rao, A. Muneer, A. Almaghthawi, A. Alghamdi, S. M. Fati, and E. A. A. Ghaleb, "Bmsp-ml: big mart sales prediction using different machine learning techniques," *IAES International Journal of Artificial Intelligence*, vol. 12, no. 2, p. 874, 2023.

[22] T. Alam, R. Gupta, N. N. Ahamed, A. Ullah, and A. Almaghthwi, "Towards sustainable iot-based smart mobility systems in smart cities," *GeoJournal*, vol. 89, no. 6, p. 235, 2024.

[23] A. A. Alasiri and V. Mohammed, "Healthcare transformation in Saudi Arabia: an overview since the launch of Vision 2030," *Health Services Insights*, vol. 15, p. 11786329221121214, 2022.

[24] O. Alidmat *et al.*, "Simulation of crowd evacuation in asymmetrical exit layout based on improved dynamic parameters model," *IEEE Access*, vol. 13, pp. 7512–7525, 2025.

[25] A. Ehsan, Z. Iqbal, S. Abuowaida, M. Aljaidi, H. U. Zia, N. Alshdaifat, and N. K. Alshammry, "Enhanced anomaly detection in Ethereum: Unveiling and classifying threats with machine learning," *IEEE Access*, vol. 12, pp. 176440–176456, 2024.

[26] M. Iqtait, J. Ababneh, M. Rasmi, A. Abu-Jassar, and S. Abuowaida, "Enhancing facial feature detection: Hybrid active shape and active appearance model (HASAAM)," *IEEE Access*, vol. 12, pp. 189590–189610, 2024.

[27] M. Baniata, S. Abuowaida, M. Aljaidi, M. Kharabsheh, A. Alsarhan, and A. A. Alsuwaylimi, "A multi-modal attention-guided network for Alzheimer's disease classification using deep learning," *Engineering, Technology & Applied Science Research*, vol. 15, no. 5, pp. 27150–27158, 2025.

[28] H. A. Owida, J. Al-Nabulsi, N. A. Hawamdeh, S. Abuowaida, Z. Salah, and E. A. Elsoud, "Deep learning-based kidney disease classification using ResNet50: Enhancing diagnostic accuracy," in *Proc. 2024 Second Jordanian International Biomedical Engineering Conference (JIBEC)*, pp. 126–129, 2024.

[29] A. Aburomman *et al.*, "Automated detection of Alzheimer's disease using EfficientNet-B3 architecture with transfer learning," in *Proc. 25th International Arab Conference on Information Technology (ACIT)*, pp. 1–6, 2024.

[30] M. M. Malkawi *et al.*, "Enhancing autism spectrum disorder detection: A novel ensemble learning framework with multi-model integration," in *Proc. 1st International Conference on Computational Intelligence Approaches and Applications (ICCIAA)*, pp. 1–6, 2025.

[31] S. Abuowaida *et al.*, "Hybrid ensemble architecture for brain tumor segmentation using EfficientNetB4-MobileNetV3 with multi-path decoders," *Data and Metadata*, vol. 4, p. 374, 2025.

[32] Z. Salah, H. Abu Owida, E. Abu Elsoud, E. Alhenawi, S. Abuowaida, and N. Alshdaifat, "An effective ensemble approach for preventing and detecting phishing attacks in textual form," *Future Internet*, vol. 16, no. 11, p. 414, 2024.

[33] H. A. Owida, M. R. Hassan, A. M. Ali, F. Alnaimat, A. Al Sharah, S. Abuowaida, and N. Alshdaifat, "The performance of artificial intelligence in prostate magnetic resonance imaging screening," *International Journal of Electrical and Computer Engineering*, vol. 14, no. 2, 2024.

[34] K. A. Al-Dosari, S. M. A. Al Qahtani, A. M. Al Shammari, B. A. R. Al Shehri, Y. S. A. Algarny, and A. S. A. Algarny, "Digital transformation of the health sector through the requirements of Vision 2030," *Journal of Survey in Fisheries Sciences*, vol. 10, no. 5, pp. 53–61, 2023.

[35] M. A. M. Alyami, N. S. A. Atti, F. M. M. Masmali, M. H. Oraibi, M. A. Alruwaili, Z. M. A. Mahdi, T. M. N. Hafdi, E. M. A. Sahly, M. A. M. Rajhy, M. H. Alonazi, *et al.*, "The role of artificial intelligence in transforming healthcare leadership: A systematic review of current trends and future directions," *Journal of Namibian Studies: History Politics Culture*, vol. 31, pp. 86–106, 2022.

[36] R. Kumar, A. Singh, A. S. A. Kassar, M. I. Humaida, S. Joshi, and M. Sharma, "Leveraging artificial intelligence to achieve sustainable public healthcare services in Saudi Arabia: A systematic literature review of critical success factors," *Computer Modeling in Engineering & Sciences*, vol. 142, no. 2, p. 2, 2025.

[37] S. A. Alghamdi and Y. Alashban, "Medical science students' attitudes and perceptions of artificial intelligence in healthcare: A national study conducted in Saudi Arabia," *Journal of Radiation Research and Applied Sciences*, vol. 17, no. 1, p. 100815, 2024.

[38] A. H. Alfahad, Y. S. Alabbas, H. S. M. ALabbas, T. H. Abukhashbah, A. A. Alabdali, Q. M. H. Alfatieh, E. A. Bashawri, H. T. H. Hadidi, R. M. A. Junaid, and K. M. A. Alhazmi, "Evaluating the impact of Saudi Vision 2030 on healthcare investment: A comprehensive review of progress and future directions," *Journal of Ecohumanism*, vol. 3, no. 8, pp. 870–880, 2024.

[39] O. M. E. Ramadan, M. M. Alruwaili, A. N. Alruwaili, M. G. Elsehrawy, and S. Alanazi, "Facilitators and barriers to AI adoption in nursing practice: a qualitative study of registered nurses' perspectives," *BMC Nursing*, vol. 23, no. 1, p. 891, 2024.

[40] A. Alshahrani, D. Stewart, and K. MacLure, "A systematic review of the adoption and acceptance of ehealth in Saudi Arabia: Views of multiple

stakeholders," *International Journal of Medical Informatics*, vol. 128, pp. 7–17, 2019.

[41] A. Al Shahrani, N. Alhumaidan, Z. AlHindawi, A. Althobaiti, K. Aloufi, R. Almughamisi, and A. Aldalbahi, "Readiness to embrace artificial intelligence among medical students in Saudi Arabia: A national survey," in *Healthcare*, vol. 12, p. 2504, MDPI, 2024.

[42] H. A. Sheerah, S. AlSalamah, S. A. Alsalamah, C.-T. Lu, A. Arafa, E. Zaatari, A. Alhomod, S. Pujari, and A. Labrique, "The rise of virtual health care: Transforming the health care landscape in the kingdom of Saudi Arabia: A review article," *Telemedicine and e-Health*, vol. 30, no. 10, pp. 2545–2554, 2024.

[43] Saudi Vision 2030, "Vision 2030: Healthcare transformation program," *Strategic Document, Kingdom of Saudi Arabia*, 2021.

[44] A. M. Muafa and S. H. Al-Obadi, "The impact of artificial intelligence applications on the digital transformation of healthcare delivery in Riyadh, Saudi Arabia (opportunities and challenges in alignment with Vision 2030)," *Academic Journal of Research and Scientific Publishing*, vol. 5, no. 59, 2024.

[45] N. Aljerian, M. Arafat, A. Aldhubib, I. Almohaimeed, A. Alsultan, A. Alhosaini, A. Aloqayli, B. AlRabiah, S. AlBanyan, L. Ashry, *et al.*, "Artificial intelligence in health care and its application in Saudi Arabia," *International Journal of Innovative Research in Medical Science (IJIRMS)*, vol. 7, no. 11, 2022.