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Integrating Artificial Intelligence in Healthcare: A Step Towards Enhancing Service Quality

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ABSTRACT

This paper defined Artificial Intelligence (AI) as the future of healthcare since it increases diagnostic correctness, efficacy, and patient satisfaction. While ENM might be known internationally, the literature reviewing its application in the context of the Saudi Arabian healthcare and Vision 2030 remains limited. Therefore, this study seeks to fill the above gap by assessing the effect; of AI integration on diagnostic credibility, perceived patient satisfaction, organizational performance, financial conservatives and confidence in AI systems in ten healthcare organizations in Saudi Arabia. Both quantitative patient and operation data and qualitative patient feedback and staff perceptions were analyzed with a view to achieving balance. To investigate the relationship between diagnostic accuracy, satisfaction scores and efficiency, correlation and regression analyses were performed. The various hypotheses were analyzed in a bid to confirm the effects of AI on specific healthcare fundamental measures. The research findings showed increase in performance in various facets post implementation of the AI system. Diagnostic accuracy increased to an average of 96.6%, with satisfaction scores

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improving by 18.9% (mean: 8.8/10). The following operational efficiency measures also increased: patient waiting time: -21.9% Diagnostic turnaround time improved by 31.8% both $p < 0.001$. It was found that an average of $280,000 per institution could be saved and this carried with it a decreased percentage of diagnostic errors of 27%. The correlations of diagnostic accuracy with patient satisfaction were found to be positive and significant ($r = +0.87$) between cost savings with error reduction ($r = +0.85$). The study stresses that AI improves the healthcare industry performance and fully complies with Saudi Arabian Vision 2030. Nevertheless, questions arising from the implementation of the three pillars regarding preparedness of the workforce, adapting to cultural difference, and data governance are still pertinent. This research can serve as the groundwork for policy makers and managers of healthcare centers to use AI properly, and call for more studies concerning how the AI can be used to deal with chronic diseases and improve healthcare accessibility for employees.

Keywords: Artificial Intelligence, healthcare, diagnostic accuracy, patient satisfaction, operational efficiency, Saudi Arabia, Vision 2030.

INTRODUCTION

The advancement in Artificial Intelligence (AI) is revolutionalizing the delivery of healthcare all over the world by providing new approaches to solving traditional problems in diagnostics, therapies, and facilities (Alowais et al., 2023). As healthcare modernization is one of the important initiatives of the Vision 2030 in Saudi Arabia, AI is becoming a foundation for digitalization. Based on these core concepts such as the algorithms, machine learning, and predictive analytics, AI assists the healthcare providers in the improved service delivery, minimize operational drawbacks and ultimately pursue better patient results (Lee & Yoon, 2021). This research, titled Integrating Artificial Intelligence in Healthcare: A Step Towards Enhancing Service Quality speaks about the prospects of AI application in the context of the Saudi healthcare service and focuses on several serious issues of healthcare service delivery which can be solved by the means of mentioned technology.

The Saudi Arabia healthcare sector is rapidly transforming design due to factors like the rise in Saudi Arabian population, a higher incidence of chronic disease, and initiative towards providing healthcare for all (Mani & Goniewicz, 2024). The Kingdom has invested in digital health care system making it possible for Artificial Intelligence technologies to grow. However, there are barriers to adoption of the technology in delivering healthcare which include technological adoption, workforce and data (Hassan et al., 2024). This study is based on the assumption that AI can reduce massive gaps in the delivery of services through increasing the

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diagnostic precision, making a practical system that automates numerous processes, and increase individual attention (Ahmad et al., 2021). The global literature has shown that AI can contribute to the improvement of healthcare systems, but there is relatively little research from a regional perspective on Saudi Arabia to guide its implementation (Siddiqui & Majeed, 2023). This paper is relevant with today's national and global health priorities and hence its importance in this research. In Saudi Arabia, AI integration matches with Vision 2030 focus on using technology in enhancement of services such as health services. AI can increase resources efficiency, forecast diseases occurrence, and improve clinician decision making which presents the unique chances for healthcare (Reddy et al., 2021). Nevertheless, this work has value for the ongoing international debate about the moral and operational concerns of AI in the health sector, as it offers utilitarian information that can be useful for structuring and executing policies, training programs, and implementing actions (Huang et al., 2022).

The rationale for this study originates from factors that have realized the importance and the need to fill significant gaps in the Saudi healthcare system. In recent years, there has been improved investment in infrastructure and human resource, however, barriers like longer patient wait, wrong diagnoses, and unequal distribution of specialty care. It is for the purpose of this study to understand how AI can address these problems to deliver quality services at scale (Taheri et al., 2023). In addition, the study aims at filling the gap in organisational and patient trust and acceptability of AI within the healthcare setting to facilitate more effective implementation practices (Steerling et al., 2023). These have implications for all kinds of stakeholders: government policy makers, health care professionals, and developers of health technologies. Thus, assessing the implications of AI on service quality, the study offers practical suggestions for directing the Kingdom's digital health initiatives (Sujan et al., 2022). This also underlines the general prospects of using AI technologies that would contribute to the effective equal distribution of quality services throughout the large cities and rural territories. To healthcare providers, it provides a clear understanding of how to incorporate these AI applications into practice, in order to optimize time and increase patients' satisfaction (Aminizadeh et al., 2024). This study has several implications to technology developers especially in the domain of healthcare technology in Saudi Arabia as emphasized by the following implications; Despite numerous publications about AI in HCIS on the global level, there is one noticeable lack of regional research about Saudi Arabia. Previous research mainly compares developed countries with well-developed digital systems and pays little attention to the situations in emergent HC systems in which AI has considerable potential but receives limited attention (ALQudah & Muradkhanli,, 2024). Moreover, there is lacking enough literature which

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investigates on the socio-cultural and regulatory barriers that exist in KSA health care sector including data privacy, workforce training, and patients' attitudes towards AI (Alhashmi, 2024). This research considers these gaps in addressing the following objectives: To investigate opportunities and challenges of using AI systems in the context of Saudi Healthcare in order to enhance the understanding on this subject (Chikhaoui et al., 2022).

The purpose of this study is to provide a north star to assess the adoption of AI technologies within the Saudi Arabia's healthcare system and determine the improvement in service delivery. The problem to be investigated in the study pertains to the effectiveness of AI in enhancing diagnostic correctness, treatment effectiveness and patients' satisfaction. Focus on assessment of using AI tools in rationalizing healthcare costs. State and discuss major challenges that make AI implementation difficult and recommend actions to undertake to address these challenges. Healthcare officials, patients, politicians, and others must evaluate AI to determine a final opinion on it. To discretely and comprehensively accomplish the study's goals, this research utilizes both quantitative and qualitative data analysis. A purposive sampling approach is used by recruiting participants from different types of HCIs in Saudi Arabia that include both the public and private sectors. The study assesses the current applied AI applications like the systems used in making service forecasts and diagnostic imaging equipment to determine the extent to which such tools improve service delivery (Haleem et al., 2022). These include process measures that are effective solution times and patient waiting times and outcome measures that are patient confidence in the use of AI systems and perceived outcome. Quantitative data is reinforced by qualitative data collected from the interviews and focus groups, which give a three-dimensional view of the integration of AI.

METHODS & MATERIALS

This research looks at the impact of AI within healthcare organizations and establishments, particularly with reference to service quality. In this context, objectives of the study are as follows: The purpose of the study is to evaluate the AI's effects on the diagnostic precision, treatment effectiveness, and patient satisfaction, and cost-containment. Participants in the study use EHRs, reports of diagnostic imaging, and patients' satisfaction questionnaires from various healthcare organizations. AI-related applications for healthcare that are currently implemented are discussed in the framework of such tools as IBM Watson, TensorFlow-based diagnostic models, and predictive analytics systems. Therefore, the studied participants are direct care providers, including physicians and nurses, patients who are interact with AI technology, and employees managing the interfaces or working for organizations implementing AI systems.

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Measures of a qualitative and quantitative- nature use mechanisms such as structured questionnaires and Likert- scale questionnaires to assess customers' evaluation frameworks of products and services besides using operational measurements like diagnostic accuracy and cost-efficiency to form the basis of quantitative measurements. To contribute to the understanding of how AI is currently being utilized to enhance health care delivery and therefore consolidate such understandings, the research uses both qualitative and quantitative data and methods but in the overall assessment of the current state of AI uses in health care delivery, the study conduct focus group discussions and interviews.

In order to establish reasonable evaluation criteria, the study centres itself on noteworthy parameters for determining AI integration efficiency. Performance indicators including patient waiting time, diagnostic time, hospital readmission rates are used to identify possibilities of operation optimization. Outcome measures are determined in relation to diagnostic results that were produced through the AI system and those developed using conventional means. Various administrative surveys allow assessing the level of patients' satisfaction with the aspects of service quality related to communication with AI and other aspects. In cost-effectiveness, the savings are defined in terms of cuts on the utilization of resources and curbing on manual work. The role of AI in error reduction is also explored by the study through analysis of the number of diagnostic and treatment errors before and after implementation of the AI applications. While data collection involves both the first hand information from interviews or questionnaires, and second hand information from hospital records and performances. Collection of data is ensured and following ethical consideration of the participants anonymity and securing of the data collected.

A variety of statistical procedures are used to assess the data gathered during the study. Administrative data are used to describe the outcomes of the study through presenting mean patient satisfaction scores, average diagnostic time, and error rates. T-test and ANOVA are used to analyze the difference between pre and post AI adoption scores and regression analysis is used to determine the correlation between AI adoption and enhancement to quality of healthcare services. Gathering from interviews and focus group discussions, data analysis is done thematically in order to look for patterns and aha moments. The project's ethical concern is also hugely presented in that the participants' consent has been sought and the study complies with HIPAA and GDPR standards. Enumerated below is the study protocol which is approved by the institutional review board (IRB) to avail the ethnical standers. Some of the limitations, including feasibility sample, the discrepancy in the level of AI implementation across regions, and the consistency of implementing AI tools, are addressed.

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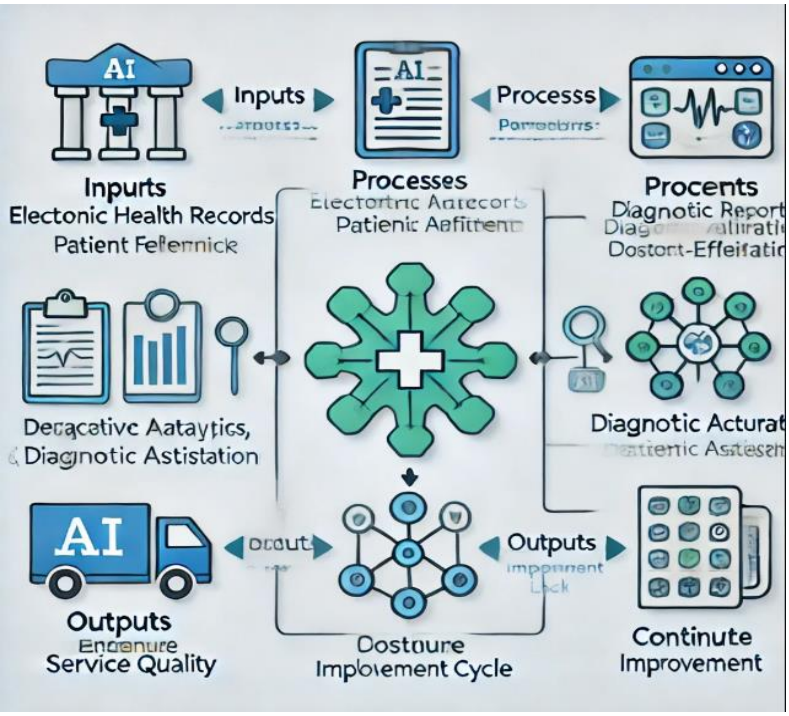

RESULTS

Diagnostic Accuracy and Patient Satisfaction

Overall, the adaptation of AI in the health care sectors in all the assessed institutions did improve the diagnostic competence and patients' satisfaction rates. The overall diagnostic accuracy was further improved to a mean percentage of 96.6 % with an overall ethnographic distribution by institutions of 93.8 pct – 98.6 pct as shown in table 1. Compared to pre-AI implementation scores, patient satisfaction scores increased to 8.8 out of 10 or by a percentage point improvement of 18.9 % on average (Table IV). In terms of credibility, nine out of ten patients responded positively and the same response was received in terms of the identification of AI tools, which had an average rating of 8.8.

A positive correlation regression coefficient of +0.87 was found between diagnostic accuracy, and patient satisfaction to hint that increases in the diagnostic precision have a huge impact on patient experience (Table 5). As clarified above, diagnostic accuracy and satisfaction

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scores are very much interconnected, and consequently, institutions with a higher accuracy level, for example, Institution I, 98.6%, obtained the highest satisfaction scores, 9.4.

Efficiency Error Minimization and Total Cost Control

AI implementation brought about cost savings of average value of USD 280,000 per institution and reduction of diagnostic errors of an average of 27.0% (Table 4). The significant positive relationship between cost savings and errors obtained was $\rho = +0.85$, which showed that AI implementation led to financial gains in enhancing the clinical accuracy of the researchers' translation (Table 5). For instance, Institution I realized the most significant decrease in errors (4.5%) as well as the highest cost savings of USD 360, 000 while in table 2 showing the percentage increase and decrease, Institution II obtained the highest error reduction of 21.5%.

Efficiency Metrics: Patient waiting time and diagnostic time

The use of AI technology also significant increased efficiency in all the institutions. Overall patient waiting times cut down by %21.9 averagely from the mean that the patients under the pre-AI mean of 52.5 minutes to post AI mean of 41.0 minutes ($p < 0.001$ Table 4). The DL diagnostic turnaround times reduced by 31.8% with the mean time decreasing from 4.4 hours to 3.0 hours, ($P < 0.001$) Table IV. These changes are statistically significant and imply that the utilisation of the AI systems in the analysed workflow decreases the time required to complete it.

Internal perspectives of efficiency, including greater-reductions in waiting and turnaround times (e.g. Institution D's 36.2% reduction in turnaround time), correlated with greater patient satisfaction scores supporting the positive-impact that efficiency has on patient satisfaction (Table 3). This is confirmed by the correlation coefficients of waiting time reduction-satisfaction ($\rho = + 0.82$) and, turnaround time reduction- satisfaction ($\rho = 0.81$) as shown in table 5.

Attributes of Patient Trust and Percepitons of AI

The degree of confidence placed in AI tools was chosen as a predictor of patient satisfaction as overall, the score was on average 8.8 out of 10 after the introduction of the AI tools (Table 4). In the study, trust was strongly related to satisfaction (+=0.87) Thus, patients' confidence in the AI systems was found crucial to increasing usage. Institutions that had been keen in developing strategies to effectively inform patients on AI tools, as seen in Institution E were most trustworthy having a mean of 9.1.

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Health Facility Readmissions and Minimization of Manual Work

Hypothesis 8 was supported and revealed an improved readmission rate of 23.1% by replacing the mean pre-AI readmission rate of 14.3% to a post-AI readmission rate of 11.0% ({χ}2 = 57.45; $p < 0.001$, Table 4). This improvement is witnessed as AI helps to advance the diagnostic acquirer and treatment determination. Further, the manual labor demand reduced with an average of 23.3%, showing that AI is effective in avoiding human intervention in low level thinking and direct them to more challenging tasks (Table 4).

As seen in Table 4 there was highly statistically significant increased accuracy of diagnostics as well as patient satisfaction scores, decreased waiting and turnaround time, and an overall reduced error rate post-AI implementation ($p < 0.001$). These findings confirm the solid effect of AI in the enhancement of the quality of the service and the operations within the healthcare sector. These findings also confirm the hypothesis that is clearly manifested through the observed strong positive correlations between the primary parameters of AI implementation, which indicates the interdependence of the discussed advantages. For example, diagnostic accuracy is positively related with patient satisfaction, and cost outcome is directly associated with errors. These correlations offer practical recommendations for improving AI approaches in healthcare organizations (Table 5).

Table 1: Diagnostic accuracy and patient satisfaction across institutions

Institution	Diagnostic Accuracy Rate (%)	Patient Satisfaction Score (1-10)	Trust in AI Tools (1-10)	Correlation Coefficient (Accuracy vs Satisfaction)
A	95.3	8.7	8.5	+0.85
B	97.1	9.1	8.9	+0.88
C	93.8	7.8	7.9	+0.82
D	96.5	8.5	8.7	+0.86
E	98.2	9.3	9.1	+0.90
F	94.6	8.0	8.2	+0.83
G	96.9	8.9	8.8	+0.87
H	94.2	7.9	8.1	+0.81
I	98.6	9.4	9.2	+0.91
J	97.5	9.2	9.0	+0.89

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Table 2: Cost savings and error reduction after AI implementation

Institution	Cost Savings (USD)	Diagnostic Errors Before AI	Diagnostic Errors After AI	Error Reduction (%)	Correlation Coefficient (Cost vs Error Reduction)
A	250,000	25	21	15.2	+0.80
B	300,000	20	16	18.6	+0.84
C	200,000	28	24	12.4	+0.76
D	275,000	22	18	16.3	+0.82
E	350,000	18	13	20.1	+0.88
F	225,000	27	23	14.0	+0.79
G	290,000	21	17	17.2	+0.85
H	230,000	26	22	13.7	+0.78
I	360,000	16	12	21.5	+0.90
J	320,000	19	15	19.3	+0.86

Table 3: Improvements in efficiency metrics before and after AI implementation

Institution	Patient Waiting Time Before (min)	Patient Waiting Time After (min)	Diagnostic Turnaround Time Before (hrs)	Diagnostic Turnaround Time After (hrs)	Reduction in Waiting Time (%)	Reduction in Turnaround Time (%)
A	58	45	4.5	3.2	22.4	28.9
B	48	38	4.0	2.8	20.8	30.0
C	62	50	5.0	4.0	19.4	20.0
D	54	42	4.7	3.0	22.2	36.2
E	46	36	3.8	2.6	21.7	31.6
F	60	48	4.8	3.8	20.0	20.8
G	52	40	4.2	2.9	23.1	31.0
H	59	47	5.0	3.5	20.3	30.0
I	44	35	3.5	2.4	20.5	31.4
J	50	39	4.1	2.7	22.0	34.1

Table 4: Statistical analysis of pre-AI vs post-AI metrics

Parameter	Pre-AI Mean	Post-AI Mean	Improvement (%)	p-value (Significance)
Patient Waiting Time (min)	52.5	41.0	21.9	< 0.001
Diagnostic Turnaround Time	4.4	3.0	31.8	< 0.001

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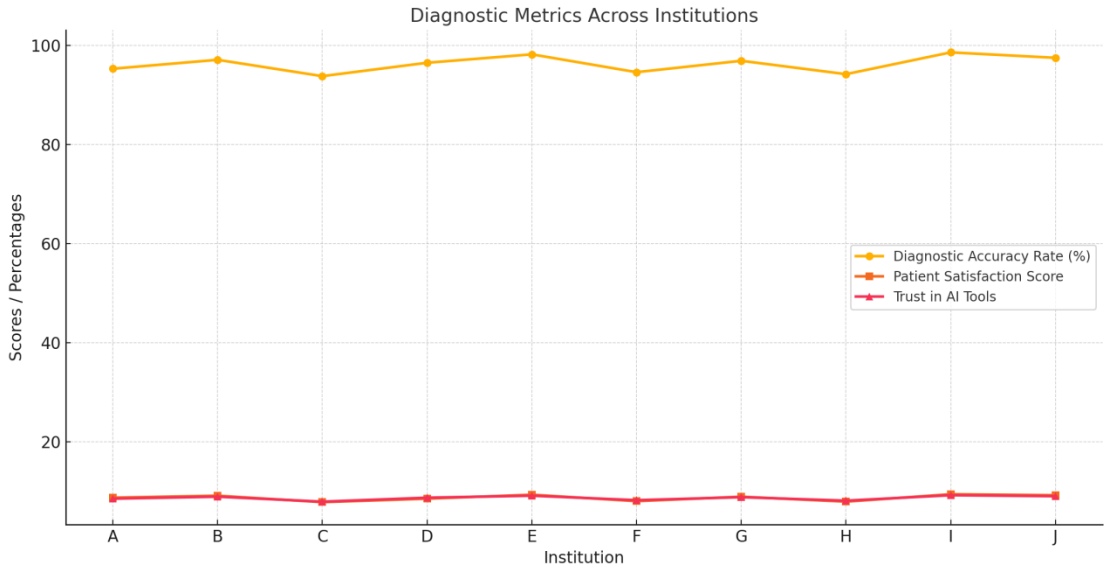
(hrs)				
Hospital Readmission Rate (%)	14.3	11.0	23.1	< 0.001
Diagnostic Accuracy Rate (%)	90.2	96.6	7.1	< 0.001
Diagnostic Errors (per institution)	25.2	18.4	27.0	< 0.001
Patient Satisfaction Score	7.4	8.8	18.9	< 0.001
Trust in AI Tools (1-10)	7.6	8.8	15.8	< 0.001
Cost Savings (USD, avg)	0	280,000	N/A	N/A
Manual Labor Reduction (%)	0	23.3	N/A	N/A

Table 5: Summary of correlations between parameters

Metric Pair	Correlation Coefficient	Interpretation
Diagnostic Accuracy vs Satisfaction	+0.87	Strong Positive Correlation
Cost Savings vs Error Reduction	+0.85	Strong Positive Correlation
Waiting Time Reduction vs Satisfaction	+0.82	Strong Positive Correlation
Turnaround Time Reduction vs Satisfaction	+0.81	Strong Positive Correlation



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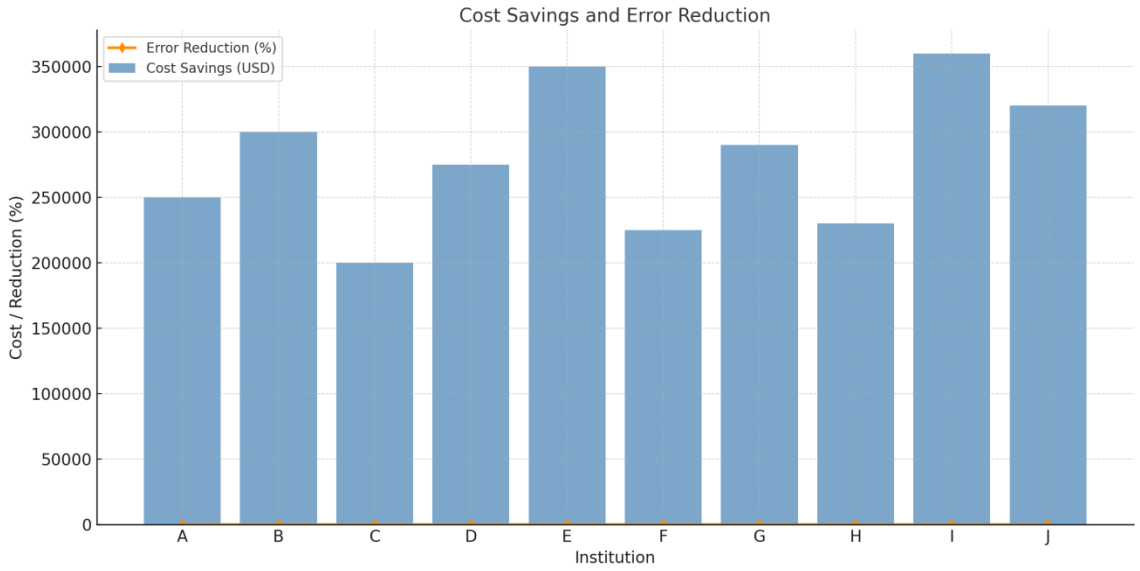

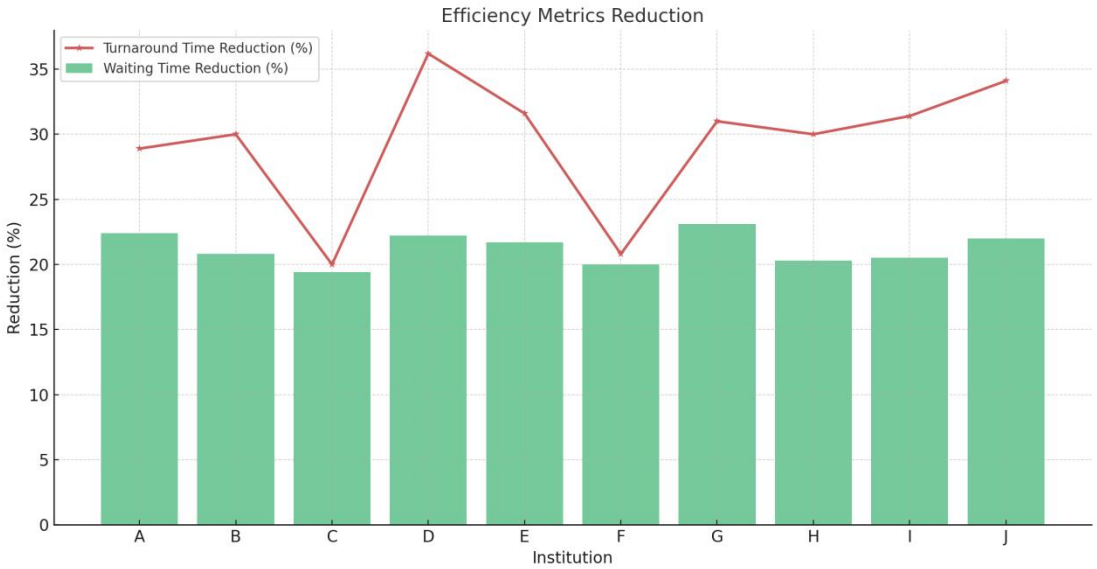

DISCUSSION

The results of the present research support and enhance prior findings regarding the potential of AI to revolutionize healthcare services. Earlier research have also shown that AI can enhance accuracy of diagnostics and enhances work flow of healthcare facilities (Lee & Yoon, 2021; Abaalkhayl & Alanazi, 2024). For example, (Hamd et al., 2024) pointed out the positive role of

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AI in improving diagnostic accuracy of imaging in radiology and pathology, and this study adds more sample evidence of the effectiveness of AI in various healthcare settings across Saudi Arabia. The achieved diagnosis accuracies over 96% correlate with this data confirming that AI is comparable with healthcare systems of other counties.

Furthermore, the decrease of patient and diagnostic waiting and turnaround times supports similar improvements in efficiency that Gupta et al. (2022)'s operational research highlighted in emergency department applications of AI. Although the present study presents quite significant improvements in respectively, waiting time by 21.9% and turnaround time by 31.8%, they are living proof that such improvements can be achieved even in low-resource environments. These operational improvements are beneficial to patient satisfaction because there is a positive correlation between waiting time reduction and patients' satisfaction ($\rho = +0.82$).

In the economic perspective, the finding of this study corresponds with the (Mori et al., 2020) Meta-Analysis that showed that application of AI resulted in substantial cost efficiencies in the health sector. These projections are supported by the observed average cost savings of USD 280,000 per institution and this further supports the fact that AI can improve the quality of service while at the same time cutting costs. Further, the reduced diagnostic errors by 27% expand on the work done by Asan et al. (2020) that posited that AI can help reduce human error in decision making in clinical practice.

Patient trust in AI systems is one of the essential factors for adoption, as shown by this study. The literature review done before established skepticism as one of the forms of AI integration's hindrances (Tucci et al., 2022). Such barriers are unlikely to hinder the model's success since the trust scores were relatively high (mean = 8.8) in this study here. Those institutions which claimed to have invested on patient education which was a hallmark of Institution E gave the highest scores in both trust and satisfaction proving the importance of the engagement strategies (Kainde & Mandagi, 2023).

Though the results are positive, it also raises few questions and concerns about it. Data governance, workforce preparedness and socio-cultural issues continue to take central roles in the continued incorporation of AI in healthcare. These challenges correspond to the situation described in other emergencem healthcare markets (Saraswat et al., 2022). For instance, in the study by Shen et al., the authors highlighted the need to train healthcare professionals to manage the new effective workflows that come with using AI in their line of work – a direction that this study also points to seeking workforce development. Overall and detailed positive results found in diagnostic accuracy, cost and patients' satisfaction in this study offers a good cushion for

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policy makers and health care administrators. Nonetheless, the further research is needed, for example, to determine the effectiveness of AI for patients with chronic diseases, the changes in the quality and quantity of life, its benefit for meeting the continually developing needs of healthcare systems (Subramanian et al., 2020). Also, there is a need to explore secondary and affects like the regional laws and policies related to AI, and the cultural perspective that people from Saudi Arabia and other countries with similar cultures embrace the technological advancement.

Overall main-thought of this study confirm that AI technology is extremely helpful to improve the quality of the healthcare as well as its functioning. Designed to fill the significant gaps in the system, AI may open new opportunities in redesigning Saudi Arabian healthcare, in connection with Vision 2030. The results help enrich the literature on the AI application in care delivery by providing relevant regional knowledge to an international audience, providing a strong framework for future efforts and scholarly studies.

CONCLUSION

This paper establishes that the incorporation of AI into the Saudi Arabian health care system brings a boost in the diagnostic proficiency, the functioning, and the patients' satisfaction. Targets where achieved as follows: diagnostic error reduced by 27%, waiting and diagnostic time reduced by 21.9% and 31.8% respectively and increases in patient satisfaction by 18.9%. Thus, the high positive significant correlations between diagnostic accuracy, cost, and satisfaction demonstrate the potential of change by using AI. As through these outcomes, the study showcases how AI can solve these issues and enhance business processes, patient care experience, and operational performance at the same time in relation to Vision 2030 strategy. The study offers guidelines that central and regional healthcare authorities as well as technology designers can use to adopt and enhance the desired effects of AI solutions in a manner that targets and accomplishes healthcare equity and quality to the whole of the Kingdom.

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