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From imaging to insights: AI's role in radiology transformation through 2PDT and 4Aim

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Abstract

Artificial intelligence (AI) is progressively integrated into radiologists' processes, improving diagnostic precision, decision-making, and operational efficiency. This systematic literature review (SLR) is a Meta-analysis utilizing the PRISMA framework that investigates the transformative impact of AI in radiology by analyzing studies published from January 2019 to December 2024 across the academic databases of ACM Digital Library, IEEE/IET, Elsevier ScienceDirect, ProQuest, and PubMed. The research employs the People, Process, Data, and Technology (2PDT) framework to classify AI technologies and assess their effects on patient outcomes, radiologists' experiences, and healthcare system performance. The findings indicate the substantial contributions of AI, including enhanced diagnostic accuracy via deep learning models, workflow automation, and facilitation of structured decision-making. AI advancements in identifying diseases, like cancer and tuberculosis screening, correspond with the Quadruple Aim (4Aim) by augmenting patient experience, decreasing costs, improving the work-life of healthcare providers, and promoting population health. This study offers practical insights for practitioners and Information Systems researchers, highlighting new trends, gaps, and recommendations to enhance the integration of AI in radiology practice. Future research must investigate ethical implications, long-term effects, and seamless integration to optimize the capability of AI to transform healthcare delivery.

Keywords: Artificial Intelligence (AI), Radiologist, Role, People, Process, Data, Technology, 2PDT, Quadruple Aim, 4Aim, SLR

Introduction

Artificial intelligence (AI) is revolutionizing the healthcare sector, particularly in radiology, by enhancing diagnostic accuracy, streamlining workflows, and reducing the workload of medical professionals. The integration of AI in medical imaging is expected to transform the field significantly, with the AI in medical imaging market projected to grow at a **Compound Annual Growth Rate (CAGR) of 28.3% from 2025 to 2034,** reaching an estimated **USD 14.46 billion** (Gokhale, 2025). AI integration in healthcare is projected to reduce human workload by 81.5% (World Economic Forum, 2025), highlighting its transformative role in diagnostics. Radiologists play a critical role in diagnosing and treating medical conditions using imaging techniques such as X-rays, computed tomography (CT) scans, magnetic resonance imaging (MRI), ultrasounds, and other imaging modalities. AI tools increasingly support radiologists by analyzing complex image data with high precision and identifying patterns that may not be immediately apparent to the human eye, supporting the radiologists' roles of monitoring and diagnosing disorders (American Board of Medical

Specialties, 2025). This leads to improved diagnostic accuracy, early disease detection, reduced unnecessary tests and treatments, and patient guidance in remedial treatment and care (Hubbard et al., 2024). As the adoption of AI in radiology accelerates, the demand for radiologists continues to grow; according to the U.S. Bureau of Labor Statistics, radiologist employment is projected to increase by 6% between 2023 and 2033, outpacing the average occupational growth rate of 4% (U.S. Bureau of Labor Statistics, 2024). Advancements in AI-driven deep learning (DL) and convolutional neural networks (CNNs) have significantly improved radiology diagnostics, enabling accurate detection of lung nodules and cancers, often rivaling human specialists (Zhao et al., 2024). Beyond imaging, large language models (LLMs) such as ChatGPT are increasingly adopted for automated radiology report generation and structured decision-making. For example, 61.8% of radiologists in India have already integrated LLMs into their workflow (Keshavarz et al., 2024; Sacoransky et al., 2024), highlighting AI's expanding role beyond image analysis. AI is crucial in breast cancer detection, tuberculosis screening, and COVID-19 diagnostics (Ali & Shah, 2022).

There is a need for a structural framework to manage AI adoption and its complexities in radiology effectively. The 2PDT framework, introduced by (Monshizada et al., 2021). It is a holistic, conceptual model for managing Artificial Intelligence (AI) systems and provides a structure for organizations navigating the complexities of AI adoption and management. The framework integrates four key components: People, Process, Technology, and Data. People represent human actors involved in developing, using, and overseeing AI. Process refers to the structured methodologies and workflows guiding AI implementation and operations; Technology encompasses the AI tools, platforms, and systems enabling capabilities. Data highlights the critical role of accurate, reliable, and ethically sourced information as the foundation for AI decision-making.

The 2PDT framework provides a systematic evaluation and control within an Information Systems (IS) focus for classifying our meta-analysis. Furthermore, aligning AI adoption strategies with the Quadruple Aim framework or 4Aim, which emphasizes improving patient experience, enhancing population health, reducing costs, and improving the work-life balance of healthcare providers, is critical for sustainable and ethical AI transformation (Bodenheimer & Sinsky, 2014).

This study examines the evolving role of radiologists due to AI advancements through the lens of the 2PDT framework and the Quadruple Aim, categorizing AI applications based on their impact on People, Process, Data, and Technology while assessing their contribution to patient experience, population health, cost efficiency, and provider well-being. The following sections outline the conceptual framework and methodology, present the classification of AI technologies in radiology, and discuss key findings, implications, future research directions, and research agenda.

The 2PDT–4Aim Conceptual Framework for AI in Figure 1 represents 2PDT dimensions of People, Process, Data, and Technology implemented through the complexities of AI adoption in radiology. This framework provides a structural approach to integrating artificial intelligence and its consequences, which is aligned with the Quadruple Aim (4Aim), which expands the Triple Aim, where the Triple Aim in healthcare is a framework developed by the Institute for Healthcare Improvement (IHI) in 2008 to optimize healthcare system performance by focusing on improving the patient care experience, improving the health of populations, and reducing the cost of care (Berwick et al., 2008). In 2014, the framework was expanded to the Quadruple Aim by enhancing the work-life of healthcare providers to address healthcare provider burnout and recognize that workforce well-being is essential to achieving better patient care, improved population health, and lower costs (Bodenheimer & Sinsky, 2014).

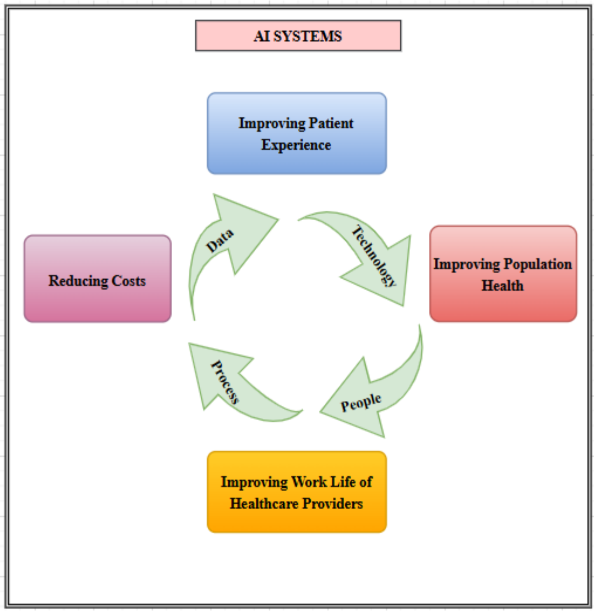

Figure 1. 2PDT– 4Aim Conceptual Framework for AI

The literature review will investigate how the roles of radiologists are evolving due to the advancements in AI through the lens of People, Processes, Data, and Technology (Monshizada et al., 2021) while aligning with the Quadruple Aim framework (Bodenheimer & Sinsky, 2014). This study aims to classify literature in AI and Radiology into 2PDT categories, bound by four Quadruple Aim or 4Aim dimensions. Despite these advancements, AI adoption in radiology presents challenges. Concerns around ethical implications, data reliability, integration into existing healthcare systems, and long-term effects on radiologists' roles remain areas of ongoing research. Additionally, while AI enhances patient outcomes and operational efficiency, its impact on healthcare costs and provider work-life balance has not been thoroughly examined.

To address these gaps, this study conducts a systematic literature review (SLR) and meta-analysis following the PRISMA framework (Page et al., 2021). The research categorizes AI applications in radiology using the People, Process, Data, and Technology (2PDT) framework (Monshizada et al., 2021) while assessing their alignment with the Quadruple Aim, which focuses on improving patient experience, enhancing population health, reducing costs, and improving healthcare providers' work-life balance (Bodenheimer & Sinsky, 2014). This paper proposed the following research questions:

RQ1: What is the classification of Meta-Analysis results using the 2PDT framework to assess their technological and professional roles influence?
RQ2: How have recent AI advancements in radiology augmented the role of radiologists?
RQ3: How does AI influence the Quadruple Aim components to understand its potential for healthcare performance?

We adopted the systematic literature review (SLR) methodology as outlined by (Kitchenham & Charters, 2007), and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines Page et al. (2021). PRISMA aims to guide the quality and clarity of our study and provide comprehensive and reproducible results.

Methodology

This study followed the Preferred Reporting Items for Systematic Literature Reviews and Meta-analysis (PRISMA) guidelines, Page et al. (2021). The article selection criteria for this research are based on the Title/Abstract and are as follows. The search was performed using the needed combination of “Artificial Intelligence,” “Radiologist*” and “Role*.” As Science Direct does not allow wildcards, we have modified our search to “Artificial Intelligence,” “Radiologists,” and “Roles.” As the Artificial Intelligence field has changed expeditiously, this study focuses on the literature published from January 2019 through December 2024, covering a 5-year timeframe. We searched for full-text articles published in peer-reviewed journals and works published in English.

The ensuing databases were included in this study: ACM Digital Library, IEEE/IET Electronic Library, Elsevier Science Direct Journals Complete, ProQuest Research Library, and PubMed/Medicine. Every article was checked to ensure its relevance to artificial intelligence, radiology, and its role. Only full-text, peer-reviewed articles with finished research and available in English were considered for inclusion. Articles such as books, surveys, conference proceedings, narrative and extensive literature reviews, and posters were excluded. Works were unavailable for full-text reviews, education-related studies, or primary research. There is an agreement between the authors in 98% of article selections after screening the titles and abstracts.

Table 1. Summarizes all the inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
• Published between 1/1/2019 and 1/31/2024 • Peer-reviewed • Full-text availability • Focus is Artificial Intelligence, Radiologists, and Roles. • Systematic literature reviews.	• Not published in English • Books, conference proceedings, surveys • Not a Systematic Literature Review • No full-text availability, focused on education.

Figure 2 illustrates the various steps of the evaluation procedure. We first identified all full-text articles that met the essential search criteria. Screening was done in three steps. The first phase involved reviewing all articles for duplicates and removing them. The second phase entailed examining the titles and abstracts and avoiding items not meeting the inclusion criteria. The third phase involves reading the complete content of the articles and removing those that did not meet the inclusion criteria.

Zotero was used to check duplicate articles and identify their database origin. The sole automated tool used was Zotero's citation data generation feature. A spreadsheet was created to include selected article data. To reduce researcher bias, a second and third researcher independently read the article titles and abstracts using the same selection and exclusion procedures, and the findings were then compared.

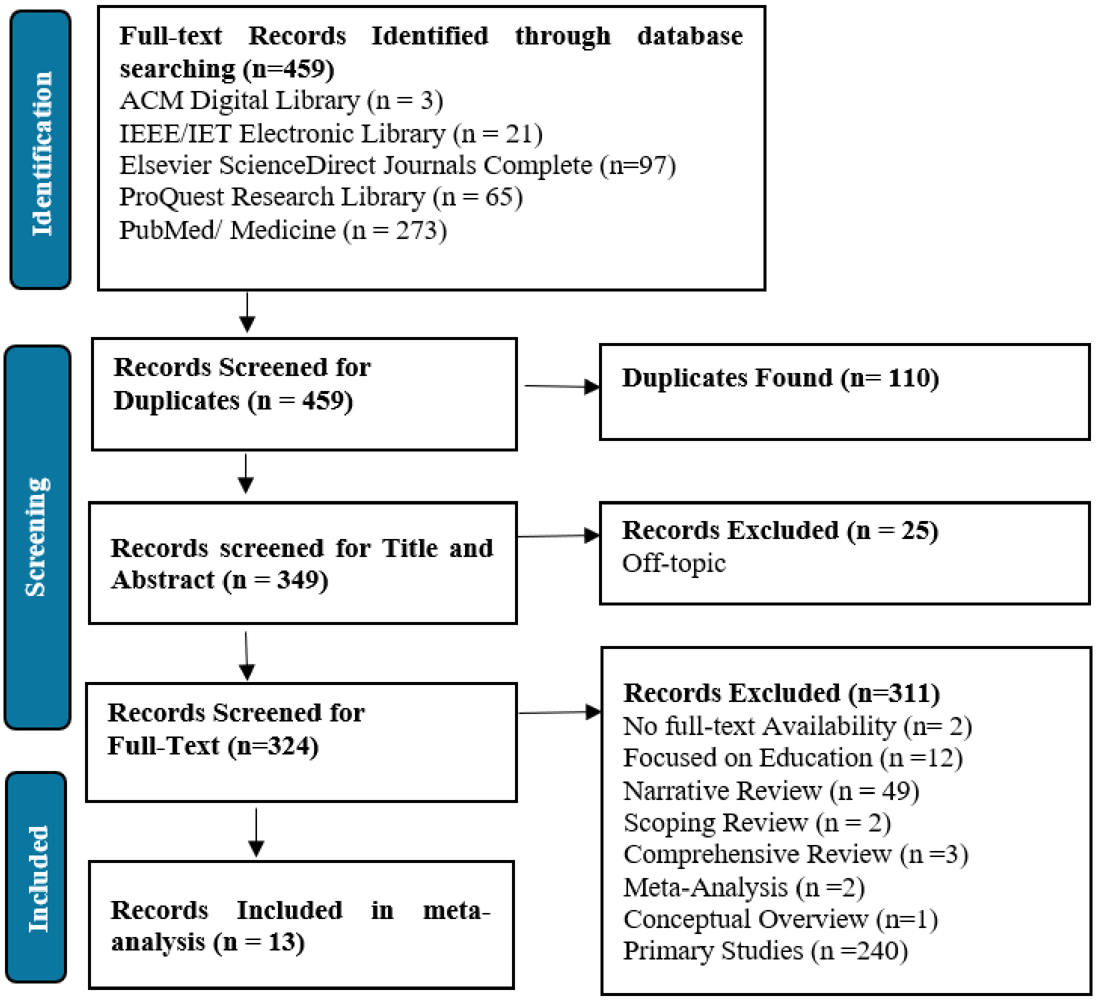

Figure 2. PRISMA Flowchart

Figure 2 represents the initial search, which yielded 459 results, including 3 from the ACM Digital Library, 21 from the IEEE/IET Electronic Library, 97 from Elsevier ScienceDirect Journals Complete, 65 from the ProQuest Research Library, and 273 from PubMed/Medicine. We identified 110 duplicate records and eliminated them from the results. After screening titles and abstracts, 25 records were excluded because they were irrelevant to AI, radiology, and role, leaving only 324. The remaining 324 records were screened again using full-text criteria. Among these, 311 records are excluded for several reasons, such as no full-text availability (n = 2), focus on education (n = 12), narrative reviews (n = 49), scoping review (n = 2), a nd comprehensive reviews (n = 3), metaanalysis that is not systematic (n = 2), conceptual overview (n=1) and primary studies (n = 240). Ultimately, the final review includes 13 Systematic literature review articles.

Results

To get more clarity and depth of this systematic literature review, a group of visualizations was designed to communicate the timeline, key trends, patterns, and gaps in the current literature search.

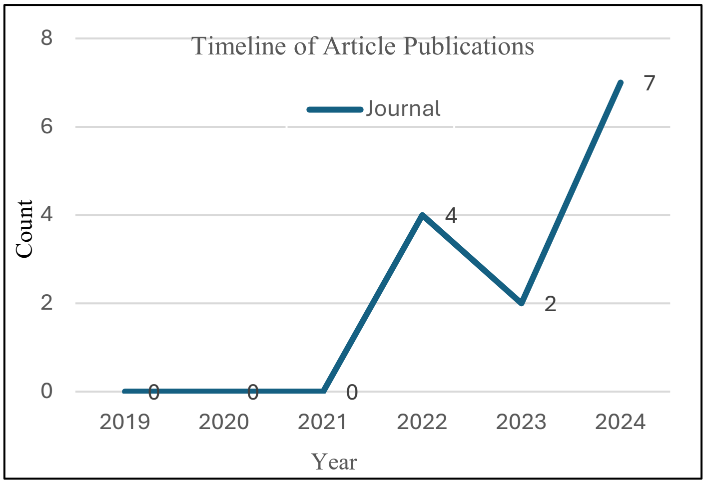

Figure 2. Timeline of Article Publications

Figure 3 displays the articles published over five years (2019-2024) in our literature review. The x-axis indicates the year, and the y-axis shows the number of articles per year. The observations include zero articles from 2019 to 2021, four articles in 2022, which have decreased to two in 2023, and significantly, there is a rise to seven in 2024. This general change indicates a variation in the number of articles published over the three years. After a decrease in 2023, the number of articles saw a steep increase in 2024, suggesting an increase in research.

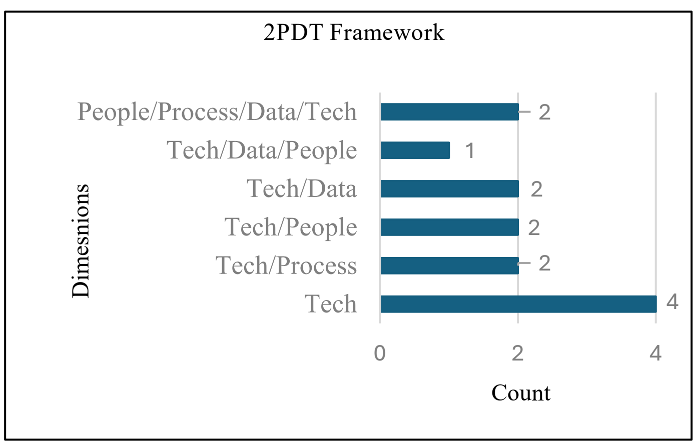

Figure 4. Distribution of Articles by 2PDT Framework

For a better understanding of the distribution of articles based on the 2PDT framework, see Figure 4 highlighting a higher number of articles are based on Technology (Tech in Figure 4) (n = 4) and an equal number of articles in the combination of People, Process, Data, Technology (n = 2), Technology, Data (n = 2), Technology, Process (n = 2), Technology, People (n = 2) and Technology, Data, People (n = 1).

LEGEND: Improving Population Health (IPH), Improving Patient Experience (IPE), Reducing Costs (RC), and Improving Work Life for Healthcare Providers (IWHP).

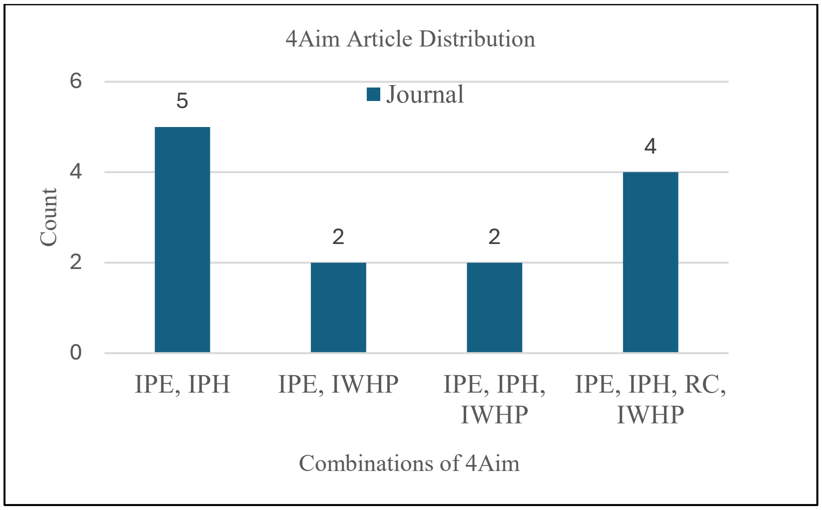

Figure 5. Distribution of Articles by 4Aim

Figure 5 represents the article distribution of 4Aim. The x-axis includes the different combinations of 4Aim, i.e., (IPE, IPH = 5), (IPE, IWHP = 2), (IPE, IPH, IWHP = 2), (IPE, IPH, RC, IWHP = 4). The y-axis counts the number of articles that represent the 4Aim.

Figure 6. Top 50 Abstract Terms

Figure 6 illustrates a word cloud of the top 50 terms generated from the reviewed abstracts, highlighting the fifty most frequently occurring terms. The relative size of each term reflects its frequency within the collection, providing a visual summary of dominant research themes. Terms such as "cancer," "artificial intelligence," "radiologists," "diagnostic," and "imaging" emerge as central themes, suggesting an emphasis on the integration of AI technologies into radiology practice. The prominence of terms such as "radiomics," "detection," "performance," and "accuracy" indicates interest in evaluating AI-driven methodologies for augmenting radiologist roles and enhancing clinical outcomes. This visualization serves as an initial thematic mapping of the abstract data. The research questions are answered by analyzing Table 2, which provides various roles of technologies in radiology by aligning them with 2PDT and 4Aim.

Table 2. Classification of Articles

Author [Ref]	Role of Technology in Radiology	2PDT	4Aim
(Ali & Shah, 2022)	Generative Adversarial Networks (GANs) for data synthesis and augmentation in AI for COVID-19 lung imaging	2PDT	IPE, IPH, RC, IWHP
(Antolin et al., 2024)	Deep Radiomics and Handcrafted Radiomics help in the detection of breast cancer.	$D_a/P_e/T_e$	IPH, IPE
(Hansun et al., 2023)	Machine Learning, Deep Learning in the detection of tuberculosis TB) using chest radiography (chest x-ray [CXR])	T_e	IPH, IPE
(Hubbard et al., 2024)	AI techniques for Specimen Mammography Interpretation (SMI) standardize practices and improve diagnostic accuracy in margin analysis	T_e/P_r	IPH, IPE
(Indrani et al., 2022)	AI models - Detecting prostate cancer on imaging (MRI, ultrasound), decision-making, and workflow efficiency.	T_e	IPE, IPH, RC, IWHP
(Keshavarz et al., 2024)	LLM-based Chatbot, ChatGPT – Usage of ChatGPT in diagnosis and clinical decision support.	T_e	IWHP, IPE
(Madani et al., 2022)	DL-based computer-aided detection (CAD) Systems improve the early detection and treatment of different types of cancer, especially breast cancer.	$T_e/P_r/D_a$	IPE, IPH, IWHP
(Omega Boro et al., 2023)	AI-based Deep Learning algorithms assist in breast cancer detection and improve diagnostic accuracy.	T_e/P_e	IPH, IPE
(Quirk et al., 2024)	Lung cancer screening and diagnosis using LUNG-RADS	2PDT	IPE, IPH, RC, IWHP
(Sacoransky et al., 2024)	LLM-based Chatbot ChatGPT assists in report generation	T_e	IWHP, IPE
(Sidibe et al., 2022)	Demonstrates how AI enhances the effectiveness of advanced MRI (Magnetic Resonance Imaging) techniques.	D_a/T_e	IPH, IPE
(Tieu et al., 2024)	Deep learning models – Identification of Bone fractures	T_e/P_r	IPE, IPH, IWHP
(Zhao et al., 2024)	Convolutional Neural Networks (CNN) - diagnose the presence of meniscal tears with high sensitivity and specificity.	D_a/T_e	IPE, IPH, RC, IWHP
People (P_e), Process (P_r), Data (D_a), Technology (T_e), 2PDT (People, Process, Data, Technology), Improving Population Health (IPH), Improving Patient Experience (IPE), Reducing Costs (RC) and Improving Work life for Healthcare Providers (IWHP).			

Our first research question, What is the classification of Meta-Analysis results using the 2PDT framework to assess their technological and professional roles influence?, is answered by Table 2, which provides a structured classification of AI applications in radiology, mapping them to the 2PDT framework (People, Process, Data, and Technology) and the Quadruple Aim (Improving Population Health, Improving Patient Experience, Reducing Costs, and Enhancing Work-Life Balance for Healthcare Providers). This classification highlights the predominant role of AI-driven technologies in advancing radiology, particularly in diagnostic accuracy, workflow automation, and clinical decision support. Table 2 presents a comprehensive analysis of AI's role in radiology. The key findings from Table 2 from the 2PDT perspective answer Research Question 2: How have recent AI advancements in radiology augmented the role of radiologists? Technology-driven innovation, workflow efficiency, Clinical Decision Support, and Generative AI are advancements. Technology-Driven Innovation: Most of the studies emphasize AI's technological advancements, particularly in deep learning (DL), machine learning (ML), and convolutional neural networks (CNNs) for diagnosing conditions such as tuberculosis, lung cancer, and bone fractures (Antolin et al., 2024; Hansun et al., 2023; Quirk et al., 2024; Tieu et al., 2024) . Workflow Efficiency & Clinical Decision Support: AI-based deep learning (DL) algorithms significantly reduce radiologists' workload in early disease detection, improving treatment outcomes and lowering mortality rates. Computer-aided detection (CAD) systems are widely used in breast cancer screening and tumor identification, assisting radiologists in making faster, more accurate diagnoses(Antolin et al., 2024; Omega Boro et al., 2023). Generative AI in Radiology: Generative Adversarial Networks (GANs) are applied for data augmentation in medical imaging, particularly in COVID-19 lung imaging, improving diagnostic accuracy with enhanced datasets (Ali & Shah, 2022). Additionally, large language models (LLMs) like ChatGPT are increasingly used for automated radiology report generation, demonstrating their potential to streamline documentation and reporting workflows (Keshavarz et al., 2024; Sacoransky et al., 2024).

The key findings from Table 2 from the perspective of impact on the Quadruple Aim answer Research Question 3: How does AI influence the Quadruple Aim Components to understand its potential for healthcare performance? The most frequently addressed objectives within the Quadruple Aim are Improving Patient Experience (IPE) and Enhancing Population Health (IPH), highlighting AI's effectiveness in reducing diagnostic errors and improving clinical efficiency. However, there appears to be a research gap in cost-reduction strategies (RC) and healthcare provider work-life balance (IWHP). While AI reduces workload, few studies assess its long-term effects on radiologists' cognitive load, burnout prevention, or economic impact on radiology departments.

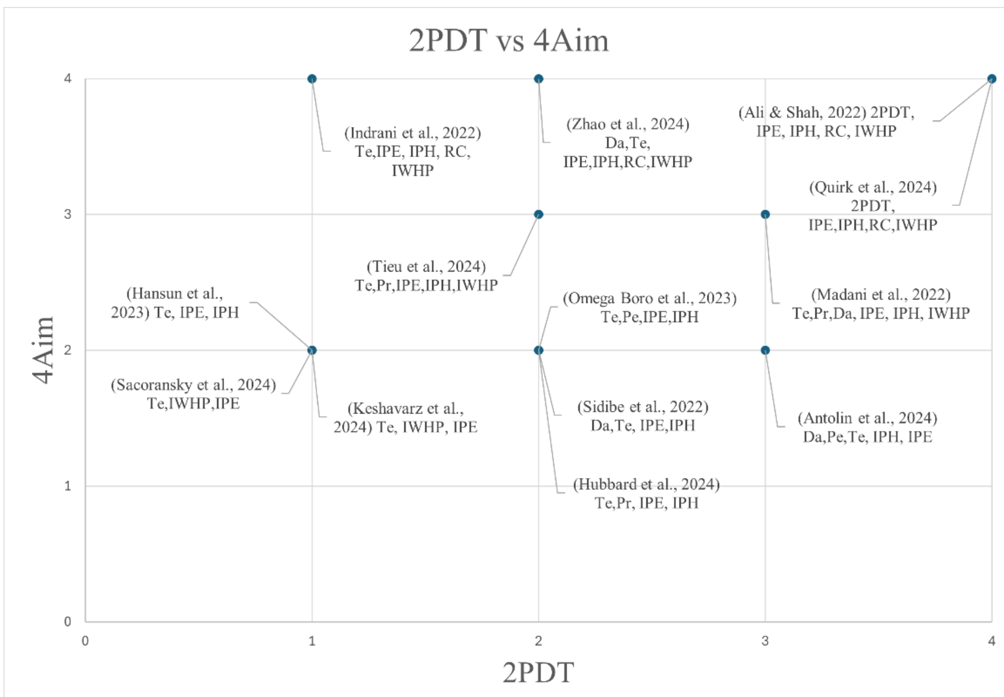

Figure 3. 2PDT–4Aim Distribution of AI Literature Scatter Plot

Figure 7 presents a scatter plot analysis of the literature review categorized by the 2PDT framework and its alignment with the Quadruple Aim objectives. Visualization highlights two critical gaps in the current body of research. First, most studies focus heavily on technology and less on data, people, and processes. Second, for systems to be further aligned with the Quadruple Aim, the literature primarily focuses on Improving Patient Experience (IPE) and Improving People's Health (IPH), indicating that most studies focused on providing practical patient experience and population health improvement. There was less focus on reducing Costs (RC) and improving the work-life of healthcare providers (IWHP).

Discussion

The findings of the Meta-Analysis identified three gaps in the current research knowledge on Artificial Intelligence, Radiologists, and their Role. The first gap is identified, especially when aligned with the 2PDT framework. One of the important findings from the analysis is that there is a heavy focus on Technology rather than on all four dimensions of 2PDT. This variance indicates that while technological advancements in AI help radiologists, the importance of Data, Processes, and People is underexplored. Where healthcare relies heavily on data, processes, and people, there needs to be a heavy focus on collaboration and a balanced approach to leverage AI's potential in healthcare fully. This Meta-Analysis highlighted this gap, which will help researchers and practitioners learn from their past experiences and improve future studies by integrating all four dimensions of 2PDT in the healthcare organization.

The second gap states that the heavy focus is on improving patient experience and population health, though it is a vital aspect to consider; however, reducing costs and improving the work-life of healthcare providers also play a crucial role in running the healthcare organization. Figure 7 underscores the need for a more holistic research approach that moves beyond technological advancements and considers AI’s broader implications for healthcare efficiency, economic sustainability, and workforce well-being. While AI significantly enhances diagnostic accuracy and workflow efficiency, a research gap exists in its financial impact within radiology. Cost reduction (RC) remains underexplored, in part due to the high cost of AI. However, effectively implemented AI is predicted to reduce costs by minimizing unnecessary imaging through more accurate early-stage diagnostics, reducing repeat scans, optimizing resource allocation, lowering operational costs in radiology departments, shortening diagnostic timelines, and reducing patient hospital stays and associated expenses. Additionally, AI’s impact on healthcare providers’ work-life balance (IWHP) is often overlooked. While AI reduces workload, studies seldom explore its long-term effects on burnout prevention. One more important observation is that there were zero systematic literature reviews (SLR) articles published in 2019, 2020, and 2021 that address the integration of 2PDT and 4Aim, addressing the third gap. Despite AI's technological advances, systematic reviews were scarce during this time, highlighting the need for comprehensive research on AI's broader implications for healthcare, including cost reduction, work-life balance for providers, and workflow integration.

The consensus exists that AI-driven technologies like deep learning (DL), machine learning (ML), and convolutional neural networks (CNNs) have improved the efficiency in the workflow and diagnosis accuracy of radiologists. AI applications like computer-aided detection (CAD), early detection of diseases, automated report generation, and reduction of repetitive tasks provide valuable decision support to clinicians, which is agreed upon in most studies (Antolin et al., 2024; Keshavarz et al., 2024; Quirk et al., 2024) according to the research. These innovations are largely credited with enhancing the patient experience (IPE) and population health (IPH) within the Quadruple Aim framework. Despite these advancements, when the healthcare system reduces operational costs, it lowers the workload for radiologists for automating routine tasks, but there is minimal and inconsistent information on its long-term economic benefits and its effects on cognitive load, burnout prevention, and job satisfaction. The literature also lacks evaluation of AI integration with existing systems, data governance, and the human factors within clinical workflow. Concerns remain about AI model generalizability, training data biases, and automation's ethical consequences. Further study is needed to examine AI-driven innovation and address issues related to cost-effectiveness and provider work-life balance.

Limitations

These findings direct significant upcoming interest in research in radiology and artificial intelligence. More research combining all four elements of the People, Process, Data, and Technology paradigm should initially take the front stage. This will ensure that AI solutions are not just cutting-edge in technology but also helpful, customer-oriented, and adept at data management and process simplification. The second thing that should be done is to make future studies of the Quadruple Aim more general when it comes to AI, focusing more on lowering costs and improving the health of healthcare workers. AI in radiology can better meet the needs of both patients and providers if these issues are addressed. This will lead to overall improvements in healthcare services. It is important to focus more on taking this literature as the foundation of AI in radiology, as there is a limited focus on reducing costs and improving the work-life of healthcare providers, data, processes, and people. The literature includes only five databases: ProQuest, IEEE, ACM, Science Direct, and PubMed. Finding the literature in the other databases might provide supportive results. Our search strategy includes titles and abstracts, which limits the search, though it is focused.

Conclusion

This systematic literature review (SLR) and meta-analysis examined the state of AI in radiology through the 2PDT framework and Quadruple Aim lens. Our findings highlight AI's transformative role in diagnostic accuracy, workflow automation, and structured decision-making. However, key research gaps remain in cost-effectiveness and physician well-being. Current AI applications focus on automating repetitive tasks and improving efficiency within healthcare organizations. Additionally, AI is making strides in precision diagnostics, such as detecting diabetic retinopathy and aiding in radiotherapy planning. Over the next 5–10 years, AI is expected to evolve with more powerful algorithms that require less data for training, integrate both structured and unstructured data sources, and facilitate precision therapeutics (Bajwa et al., 2021) rather than being replaced by artificial intelligence, radiologists are predicted to increasingly collaborate with AI to improve clinical decision-making, diagnostic accuracy, and streamline radiography workflow efficiency (Quirk et al., 2024). Healthcare providers will transition from merely adopting AI technologies to actively co-developing new AI-driven solutions as technology partners in the long term (beyond 10 years) (Bajwa et al., 2021). AI will play a transformative role in enabling precision medicine and connected care, moving healthcare from a generalized approach to a personalized, preventative, and data-driven model. AI will enhance patient outcomes while making healthcare delivery more cost-effective. Connected care will leverage AI to streamline patient management through intelligent health, wearables, and remote monitoring, allowing timely interventions. AI-powered virtual assistants and chatbots will aid in symptom detection and wellness management. At the same time, ambient intelligence will enable passive, sensor-based monitoring to enhance patient care without requiring external devices. Efforts will continue to integrate people, processes, technology, and data into the fabric of healthcare, with a focus on enhancing patients' experience, improving population health, reducing cost, and improving providers' workflows in pursuit of better healthcare outcomes.

To fully utilize the benefits of AI in radiology, and by addressing the actionable recommendations supplied, which will assist in closing existing gaps and enhancing the efficacy of AI on patient care, operational efficiency, and healthcare provider welfare, efforts should include refurbishing the advancements on AI, providing and participating in AI training programs to support transition and adoption, and offering feedback on the AI tools' performance, Assessing the influence of AI on clinical outcomes, cost-effectiveness, inventing new solutions that will integrate with existing radiology electronic health records and information systems, developing AI models to build clinicians trust and reduce bias to improve applicability and provider welfare, use data-driven measures to inform future investments, and ensuring that patients are informed about their safety and privacy during the prioritization of AI applications. Future research should prioritize a holistic approach by integrating People, Processes, Data, and Technology to ensure AI adoption balances technological advancements with healthcare efficiency and provider support. Additionally, AI’s long-term economic impact and ethical considerations require further exploration.

Research Agenda

To guide future research and address identified gaps, we propose the following research agenda:

1. Integration of the four components of the 2PDT Framework
   Future research should expand the focus beyond technology to include People, Processes, and Data, investigating how human-centered design, workflow restructuring, and data governance influence AI adoption and outcomes. (Monshizada et al., 2021).
2. Address the Quadruple Aim Gaps
   Studies should assess AI’s impact on cost reduction and healthcare provider well-being, two underexplored dimensions of the Quadruple Aim (Bodenheimer & Sinsky, 2014), particularly given the growing use of LLM tools like ChatGPT (Keshavarz et al., 2024; Sacoransky et al., 2024). Future research should focus on all four quadruple aim goals to enable complete evaluation of healthcare improvement factors.
3. Ethical and Human-Centered AI Design
   Research should explore algorithmic transparency, bias, and accountability frameworks, ensuring that AI applications in radiology are trustworthy, equitable, and interpretable (Hansun et al., 2023).
4. Developer and Clinician Informed Development for Human-AI Collaboration
   Investigations into collaborative innovation models between radiologists and developers can support more effective AI solutions and promote AI literacy and ownership among clinical stakeholders (Bajwa et al., 2021).
5. Future-Oriented Applications
   Research should assess AI’s evolving roles in precision medicine, remote diagnostics, wearables, and ambient intelligence, including long-term clinical and economic impacts (Quirk et al., 2024).

This agenda provides a roadmap for researchers and practitioners aiming to responsibly advance AI integration in radiology while addressing practical, ethical, and organizational dimensions in healthcare delivery.

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