

A Study to Determine a User's Requirements for the Design of a PACS-Based Healthcare System in Iraq

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Abstract

INTRODUCTION: The Iraqi healthcare sector faces significant challenges in the management of medical images, leading to diagnostic delays and increased error rates. Picture Archiving and Communication Systems (PACS) are essential for improving workflow and patient care, yet their implementation in Iraq remains limited and underexplored.

OBJECTIVES: This study aims to identify the essential user requirements and major obstacles for implementing PACS in Iraqi hospitals, and to propose solutions tailored to the local context.

METHODS: A quantitative survey was conducted among 60 healthcare professionals to assess both functional and non-functional requirements for PACS. The survey also explored current usage, perceived barriers, and user expectations.

RESULTS: Findings revealed that a significant proportion of respondents had never used PACS, highlighting the urgent need for comprehensive training and support. The main obstacles identified were high system upgrade costs, data security concerns, and slow image retrieval times. The study set specific goals: to improve image retrieval speed by at least 40%, ensure 95% data security, increase user satisfaction by 75%, address at least three major usability challenges, and develop and test a PACS prototype in two hospital departments.

CONCLUSION: The research recommends the development of a customised PACS solution for Iraq, addressing the unique needs of the healthcare environment. These findings provide a foundation for future digital health initiatives, aiming to enhance healthcare quality, reduce diagnostic errors, and improve operational efficiency in Iraqi hospitals.

Keywords: Picture Archiving and Communication Systems, Intelligent Hospital Management Systems, Hospital Management Challenges, Healthcare IT, Digital Transformation, Data Security, System Integration, Medical Imaging

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1. Introduction

Modern healthcare systems rely heavily on timely access to accurate medical images, yet many hospitals in Iraq continue to operate without a fully functional Picture Archiving and Communication System (PACS). The absence of such infrastructure results in slower diagnostic workflows, fragmented patient records, and increased risk of clinical errors. Despite the global shift toward digital radiology, there is a limited understanding of how PACS

can be deployed effectively in Iraq's constrained healthcare environment. This gap provides the main motivation for the present study, which seeks to identify user requirements and implementation challenges to guide the development of a PACS model tailored to the Iraqi context.

The healthcare sector in Iraq faces significant challenges in managing medical images, resulting in delays to diagnosis and an increased risk of errors. Although precise statistics on the adoption of PACS are scarce,

indicators suggest a pressing need for digital solutions. For instance, the Iraqi healthcare system comprises around 295 government-run and 155 private hospitals, as well as over 2,800 primary healthcare centres. These facilities serve a population with just 1.2 beds per 1,000 people. Nevertheless, many institutions, particularly in the public sector, continue to rely on traditional paper-based records, which hinders efficient access to critical patient information [1].

Although the Ministry of Health, in collaboration with the World Health Organisation, launched the Health Resources and Services Availability Monitoring System (HeRAMS) in 2022 to digitise healthcare management, this initiative is primarily focused on basic data collection and has yet to address the comprehensive digitisation of medical imaging across the country. To the best of our knowledge, this study is the first of its kind to systematically investigate the specific user requirements and challenges of implementing PACS in the Iraqi healthcare context, thus addressing a significant gap in the current literature [2].

Globally, PACS has fundamentally transformed the storage, access, and sharing of medical images. Traditionally, film-based storage was the cornerstone of medical imaging, yet it was both costly and time-consuming. The advent of PACS has enabled healthcare institutions to transition to digital repositories for radiological images, streamlining workflows and ensuring that sensitive patient data is readily accessible [3]. When integrated with hospital management systems, PACS facilitates seamless communication among medical staff, thereby enhancing patient outcomes and supporting more accurate diagnoses [4]. Beyond mere storage and retrieval, PACS contributes to improved treatment planning, high diagnostic precision, and the facilitation of remote consultations [5]. By allowing clinicians and radiologists to access images from remote locations, PACS removes geographical barriers and supports telemedicine and remote patient monitoring [6]. Furthermore, digital imaging alleviates the logistical and administrative burdens associated with physical film, thereby increasing operational efficiency [7]. Recent advances in artificial intelligence (AI), machine learning, and deep learning have further evolved PACS into an intelligent system capable of automated image analysis and diagnostic support. Machine learning algorithms can identify patterns in radiological images, helping radiologists detect tumours, fractures, and other pathological features. Deep learning models, trained on large datasets, have demonstrated remarkable accuracy, enabled earlier disease detection, and reduced diagnostic errors. These AI-driven innovations accelerate diagnostic assessments and enhance workflow efficiency by prioritising urgent cases and automating routine tasks.

Cloud computing represents another major driver in modernising PACS. Cloud-based PACS solutions offer scalability and secure access, allowing medical professionals to store, retrieve, and share images from virtually any location. The integration of PACS with AI,

deep learning, and cloud computing represents a major advance in contemporary healthcare, paving the way for faster and more accurate diagnoses. As healthcare institutions in Iraq and worldwide increasingly pursue digital transformation, PACS is becoming indispensable for advanced medical imaging, improved workflow, and ultimately, better patient care.

Despite these advancements, the implementation of PACS in Iraq faces several unique challenges. These include delayed access to patient data, human errors in data entry, high costs of system upgrades, and a lack of interoperability with existing hospital management systems. Addressing these issues is crucial for the successful adoption of PACS in the Iraqi context. The system suggested in this study aims to solve these problems by improving how accurately diagnoses are made, allowing for quick access and safe sharing of medical images, and helping to train AI models while keeping patient privacy intact. We envision the platform as a catalyst for improved diagnostics, optimised healthcare operations, and a sustainable environment for medical research and education in Iraq.

Although PACS and AI-driven medical imaging solutions have been widely researched and implemented in developed countries, the unique context of Iraq presents distinct challenges that have not been adequately addressed in the literature. The majority of existing studies assume the presence of robust digital infrastructure and sufficient technical expertise, conditions that are often lacking in Iraq due to years of conflict, underinvestment, and ongoing instability. As a result, there is a significant gap in understanding how such advanced healthcare technologies can be effectively adopted and tailored to environments with limited resources, unreliable internet connectivity, and a shortage of digitally trained healthcare professionals. This study seeks to address this issue by carefully examining what users need and the challenges they face in using PACS in Iraq's healthcare system, offering useful information for other places with similar resource limitations.

The proposed platform is designed to improve diagnostic accuracy and make healthcare operations more efficient. It also aims to create a supportive environment for research and education in Iraq. The system layout, shown in Figure 1, is built on a PACS platform that uses a hybrid algorithm combining Content-Based Image Retrieval (CBIR) and Federated Learning (FL) techniques. This innovative approach enables efficient and secure retrieval of medical images, supports privacy-preserving AI model training across multiple healthcare institutions, and provides advanced diagnostic support for clinicians. Using these technologies helps solve problems like data security and system compatibility, and makes it easier to expand and update the system in the future.

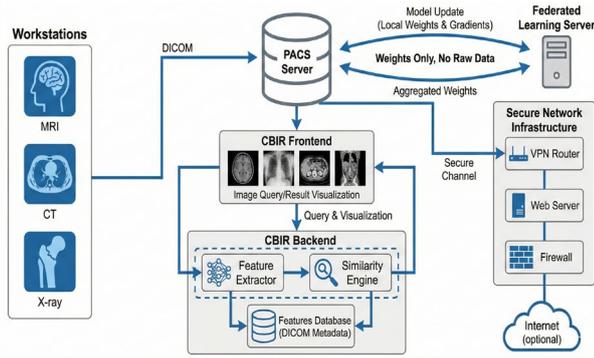


Figure 1. PACS-integrated CBIR and Federated Learning Architecture

To enhance clarity and reproducibility, Algorithm 1 summarises the workflow of the proposed PACS model illustrated in Figure 1.

```

Input: MRI DICOM image from PACS
Output: Tumor probability,
         segmentation mask,
         boundary map,
         Top-K similar cases

1. // Pre-processing
2. I ← LoadDICOM()
3. I ← Apply Contrast Limited Adaptive Histogram Equalization(I)
4. I ← Normalize(I)
5. I ← Resize(I, 320×320)
6. I ← ExpandChannels(I, 1→3)

7. // ALSB-Net Encoder
8. F ← EfficientNetV2_B1_Encoder(I)

9. // Dual-Path Feature Routing
10. F1D ← Flatten(F) // 1D token pathway
11. F2D ← Reshape(F) // 2D segmentation pathway

12. // 1D Token Processor
13. T ← LayerNorm(F1D)
14. T ← BiLSTM(T)
15. T ← SelfAttention(T)
16. T ← TokenEmbedding(T)

17. // Classification Head
18. P_tumor ← Classification(T)

19. // Segmentation Decoder
20. S ← Decoder(F2D)
21. Mask ← SegmentationHead(S)
22. Boundary ← BoundaryHead(S)

23. // CBIR Retrieval Module
24. LocalDB ← LoadLocalEmbeddingStore()
25. TopK_local ← RetrieveSimilar(LocalDB, T)

26. if |TopK_local| < K then
27.     TopK_external ← RetrieveFromExternalSources(T)
28.     Results ← Merge(TopK_local, TopK_external)
29. else
30.     Results ← TopK_local
31. end if

32. // Output to PACS Viewer
33. Display(P_tumor, Mask, Boundary, Results)

34. // Federated Learning Update (periodic)
35. LocalWeights ← TrainLocalModel()
36. SendToServer(LocalWeights)
37. GlobalWeights ← SmartFedAvg(ServerUpdates)
38. UpdateModel(GlobalWeights)

End Algorithm
    
```

Algorithm 1. Proposed PACS-Integrated ALSB-Net with CBIR and Smart Federated Learning

Contributions of the Study

This study offers several key contributions to the understanding and development of PACS in the Iraqi healthcare context:

- Provides the first systematic assessment of user requirements, expectations, and challenges related to PACS adoption in Iraq, addressing a gap in the existing literature.
- Identifies both functional and non-functional requirements essential for designing a PACS solution aligned with the operational realities of Iraqi hospitals.
- Highlights major technical, organisational, and infrastructural barriers—including system costs, limited interoperability, and insufficient training—that influence PACS implementation.
- Establishes measurable performance targets, such as improving image retrieval time by 40% and achieving 95% data security compliance, based on user feedback and international benchmarks.
- Proposes a preliminary PACS framework supported by CBIR and Federated Learning technologies to improve diagnostic accuracy, protect patient privacy, and enable distributed model training across hospitals.
- Provides evidence-based recommendations for policymakers and healthcare administrators to guide future digital transformation initiatives in Iraq.

2. Literature Review

The following paragraphs discuss various approaches to overcoming the challenges of implementing a PACS system in healthcare. Most of these solutions aim to expand system functionality and resolve interoperability issues, making medical imaging and hospital management systems more usable, secure, and efficient.

In 2012, Aldosari conducted a study on the adoption of PACS in Saudi Arabian hospitals, emphasizing its role in improving workflow efficiency and radiology department performance. The research highlighted that those hospitals using PACS experienced faster image retrieval, reduced diagnosis time, and better communication among medical staff. However, the study also noted challenges such as resistance from healthcare professionals and the need for proper training programmes to maximise system benefits [3].

In 2016, Goodarzi and Khatami investigated user acceptance of PACS in emergency departments, focusing on factors influencing clinicians' willingness to adopt the system. Their findings highlighted that perceived usefulness, ease of use, and system quality significantly affected acceptance levels among medical staff. The study

emphasized that organisational readiness and adequate training programmes were essential for improving satisfaction and promoting successful PACS adoption [7].

In 2016, Khalifa & Househ assessed barriers to PACS adoption, identifying high installation costs, resistance to change among medical staff, and cybersecurity concerns as major obstacles. Their findings suggested that implementing training programmes and user awareness campaigns could improve PACS acceptance and usability [8].

In 2017, Shen et al. provided a comprehensive analysis of deep learning applications in medical imaging, showing that advanced neural networks can support PACS-based diagnostic processes by improving precision and reducing interpretation errors [9].

In 2017, Mohamed investigated the adoption of healthcare information systems, including PACS, in public hospitals in the Kurdistan region of Iraq. The study identified financial constraints, lack of IT expertise, and absence of standardized implementation strategies as the primary challenges facing PACS adoption in Iraq [5].

In 2018, Al-Shorbaji et al. examined the impact of interoperability on PACS efficiency in Middle Eastern hospitals. They concluded that a lack of integration with other healthcare IT systems resulted in fragmented data storage and hindered clinical decision-making. The study emphasized the need for unified health informatics policies [6].

In 2020, Budd et al. examined the role of digital technologies in supporting healthcare systems during the COVID-19 pandemic. Their analysis demonstrated how telemedicine platforms, digital communication tools, and remote diagnostic technologies improved continuity of care and reduced physical contact between patients and healthcare providers. Although the study did not focus specifically on PACS, it highlighted the growing reliance on digital health solutions, underscoring the importance of adopting modern imaging and data-management systems in resource-limited settings [10].

In 2020, Singh et al. extended this concept by integrating deep learning into PACS, allowing for higher accuracy in detecting abnormalities in medical imaging. Their research demonstrated that neural networks could analyse large datasets efficiently, enabling early disease detection and faster decision-making [11].

In 2020, Islam et al. studied how to keep cloud-based PACS safe, showing that using strong encryption and secure cloud storage is very important for protecting medical data and lowering the chances of cyber-attacks [12].

In 2022, Eid et al. explored PACS integration with Radiology Information Systems (RIS) in the Middle East. Their study revealed that hospitals without structured integration faced workflow inefficiencies, data retrieval delays, and poor system compatibility. The authors recommended standardized frameworks for smooth PACS implementation [4].

In 2022, Wang et al. conducted an extensive review of deep learning methods in radiology, reinforcing their

potential to enhance diagnostic precision within PACS platforms [13].

In 2023, Laghari et al. proposed a deep residual-dense network combined with a bidirectional recurrent neural network for atrial fibrillation detection, demonstrating the effectiveness of hybrid architectures in biomedical signal interpretation [14].

In 2023, Khamis, N. N., and Mustaf, R. S., have significantly improved the speed and accuracy of medical imaging analysis. By leveraging deep learning models hosted on AWS, these systems can rapidly process Magnetic Resonance Imaging (MRI) scans, enabling faster and more precise tumour detection. The use of HTTP/2 optimises data transmission, reducing latency and enhancing the efficiency of remote diagnosis workflows. This advancement not only accelerates diagnostic processes but also enhances scalability and accessibility for medical professionals worldwide [15].

In 2024, Laghari et al. explored medical imaging captured under challenging nanoscale-hyperspectral conditions, emphasising robust preprocessing methods for accurate interpretation [16].

In 2024, Yin et al. introduced a Mask-RCNN and attention-based framework for brain CT classification, achieving enhanced lesion localisation accuracy [17].

In 2024, Munir et al. developed sparse regularised autoencoders for mutation prediction in lung cancer radiomics [18], while Saeed et al. proposed DeepLeukNet, a CNN-based model for improved leukemia diagnosis [19].

In 2024, Varghese et al. conducted a comprehensive study on the emerging applications of PACS integrated with AI and their influence on research and education in medical imaging. The study highlighted that combining PACS with artificial intelligence (AI) significantly enhances diagnostic accuracy and workflow efficiency. One of the major advantages identified in their research was the increase in diagnostic accuracy. AI-powered PACS systems demonstrated the ability to identify abnormalities in radiographic images with an accuracy of 92.5%. The integration of deep learning models allowed for faster and more precise disease identification, reducing dependency on manual interpretation. The study emphasized that AI-enhanced PACS have been reported to implement advanced encryption techniques and anomaly detection mechanisms, which improved data security protocols by 85%. These enhancements minimised risks of data breaches and unauthorized access, ensuring patient information remained protected against cyber threats [20].

While AI integration has significantly enhanced diagnostic workflows, data privacy and retrieval efficiency remain critical challenges in modern healthcare environments. To mitigate privacy risks associated with sharing sensitive medical data, recent research has increasingly focused on Federated Learning (FL). In 2024, independent surveys [21, 22] identified FL as a foundational technology for enabling collaborative model training across healthcare institutions without transferring

raw patient data. By exchanging only model updates, FL effectively addresses the longstanding “data silo” problem prevalent in hospitals [23, 24].

In parallel, the rapid growth of medical imaging has intensified the need for advanced Content-Based Medical Image Retrieval (CBMIR) systems. Deep learning-based CBMIR frameworks introduced in 2023 and 2024 have demonstrated substantial improvements in retrieving clinically relevant historical cases, thereby supporting more informed diagnostic decisions [25, 26]. More recently, hybrid systems integrating FL with CBMIR have emerged, aiming to offer privacy-preserving retrieval capabilities that scale across distributed medical networks [27, 28].

Despite these technological advancements, implementation challenges in developing regions remain considerable. Reports from 2024 highlight that Iraq’s limited digital healthcare infrastructure continues to hinder efficient patient data management and diagnostic accuracy [29]. Nevertheless, patient acceptance of electronic medical records is gradually improving. Closing the gap between cutting-edge FL-enabled imaging technologies and the infrastructural constraints of Iraqi hospitals is therefore essential for sustainable adoption [30, 31].

Furthermore, recent studies in 2024 and 2025 have expanded the scope of digital health architectures. New frameworks have emerged focusing on Edge Computing to reduce latency in real-time IoMT applications [32, 33]. Security remains a critical concern, with blockchain-based approaches enabling decentralized medical data sharing and access control [34, 35]. Federated Learning has gained momentum as a privacy-preserving paradigm for collaborative medical image analysis [36, 37]. On the diagnostic front, Vision Transformers are increasingly recognized as powerful alternatives to CNNs in complex medical imaging tasks [38, 39]. Moreover, Generative AI and foundation models are reshaping radiology by enabling advanced image synthesis and automated clinical report generation [40].

From the presented literature review on AI-integrated PACS systems, it is revealed that this sector is a rapidly evolving research area, with significant opportunities for further advancements. This study aims to identify and address key gaps in the field, particularly in enhancing PACS accuracy, security, and reliability through AI and cloud-based solutions, ensuring improved healthcare efficiency and medical imaging performance.

Some similar systems have been analysed, and the strengths and weaknesses of the related systems are shown in Table I.

Table 1. Related Projects

Related work	Strengths	Weaknesses
"User acceptance of a picture archiving and	1- Improved workflow	1- Resistance to adoption among

communication system (PACS) in a Saudi Arabian hospital radiology department" [3]	efficiency. 2- Faster image retrieval.	medical staff. 2- High maintenance costs.
"User acceptance of PACS in emergency departments"[7].	1- Identified key factors influencing PACS acceptance. 2- Highlighted the importance of system usability and training.	1- Adoption barriers due to limited organisational readiness. 2-Need for continuous staff training.
"Barriers to PACS adoption" [8]	1- Identified cybersecurity concerns. 2- Highlighted the importance of staff training.	1- High installation costs. 2- Resistance to organisational change.
"Adoption of healthcare information systems in public hospitals in Kurdistan " [5]	1- Resistance to organisational change. 2- Analysed financial constraints affecting PACS implementation.	1- Lack of standard implementation strategies. 2- Shortage of IT expertise.
"Impact of interoperability on PACS efficiency in Middle Eastern hospitals" [6]	1- Emphasised the need for unified interoperability standards. 2- Analysed data fragmentation issues.	1- Poor system integration limits clinical decision-making.
"Digital technologies in healthcare response (COVID-19 context)" [10]	1- Enhanced collaboration via remote digital access. 2- Highlighted the importance of telemedicine tools.	1- Dependence on stable internet connectivity
"Deep learning integration into PACS for higher accuracy " [11]	1- Enable early disease detection. 2- Improved diagnostic precision using deep neural models.	1- High computational cost of training deep learning models.
"Security measures in cloud-based PACS" [12]	1- Highlighted the importance of strong encryption. 2- Demonstrated reduced cybersecurity risks.	1- Complex encryption mechanisms may slow image retrieval.
"PACS Integration with Radiology Information Systems in the Middle East" [4]	1- Identified challenges in interoperability. 2. Proposed structured integration frameworks.	1- Workflow inefficiencies due to a lack of structured integration.
"Advanced AI-driven MRI tumor diagnosis using cloud-based PACS" [15]	1- Improved MRI analysis speed and accuracy. 2- Reduced latency using HTTP/2 for data transfers.	1- Heavy reliance on external cloud service providers.
"Emerging Applications of PACS and Their Impact on Research and Education" [20]	1- Achieved high diagnostic accuracy (up to 92.5%). 2- Reduced	1- Requires large computational resources. 2- Potential for algorithmic bias in

	workload through advanced automation.	diagnosis.
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3. Questionnaires and Sampling

The quantitative questionnaire presented in this paper aims to identify the functional and non-functional requirements for a PACS-based user-driven healthcare system in Iraq to determine users’ needs for designing, implementing, and interacting with such systems. This questionnaire builds on previous studies by evaluating different important areas of PACS, like usability, safety, lineament, and AI integration challenges.

Purposive sampling was used, and respondents who had encountered PACS, such as healthcare personnel, radiologists, IT specialists, and hospital administrators, filled out the questionnaire online. To get a variety of perspectives, we targeted 60 people with various medical and technical backgrounds.

The questionnaire comprised three sections:

- The first category collected demographic and professional background information.
- The second category assessed experience with PACS, identifying adoption barriers and key system limitations.
- The last category focused on defining essential functional and non-functional requirements, including system performance, security measures, AI-assisted diagnostics, and cloud-based accessibility.

Descriptive statistical analysis was applied to analyse the survey responses, and the results are presented using percentage-based distributions.

4. Analysis of Results

The proposed healthcare system architecture, focused on a PACS, aims to enhance medical image accessibility, usability, and security for clinicians in Iraqi government and private hospitals, research centres, and community clinics. To optimise radiology, telemedicine, and clinical decision support across disparate locations, workflow processes, and protected data transmission must be streamlined.

4.1 Background of the participants

The demographic distribution of this study includes 60 participants from diverse medical backgrounds. 55% of the participants were male, while 45% were female, indicating a balanced representation of professionals in the healthcare sector. Regarding age distribution, the majority (58.3%) of participants were between 30 and 40 years old, followed by 16.7% aged 18-30 and 16.7% aged 40-50.

Participants were also categorized according to their professional roles and expertise in healthcare. Half of the participants work in government hospitals (50%); 13.3% of them work in private hospitals; 11.7% work in medical research institutions, while others work in health centres, universities, or private healthcare. Most participants were clinicians and clinical IT staff, including physicians, nurses, pharmacists, and hospital administrators, who were fully assessing PACS user needs.

Participants were recruited from hospitals and healthcare centers in Baghdad.

4.2 Questions for PACS

The second category of the questionnaire focuses specifically on healthcare professionals' experience with PACS, evaluating their familiarity, frequency of use, and key challenges they encounter with the system. These questions aim to gather insights into how effectively PACS meets its requirements and to identify any barriers that may hinder optimal usage. By understanding these challenges, we can develop targeted strategies to enhance the system's functionality and improve overall user satisfaction. We asked the participants about their PACS experience to gauge their familiarity with medical imaging technologies.

Figure 2 shows that 18.3% of participants were familiar with PACS and had used it, 38.3% had heard of it but never used it, and 43.3% had no prior knowledge of it. This indicates a low adoption rate and limited awareness of PACS among healthcare professionals in Iraq, highlighting the need for training programmes and system integration efforts.

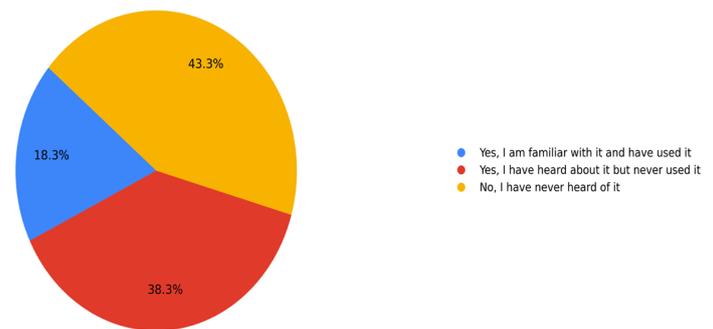


Figure 2. Experience with the PACS

Participants were also asked to consider the importance of various features within an Intelligent Hospital Management System (IHMS). The responses indicated that data security, privacy, and Electronic Health Records (EHR) were deemed the most critical, with a majority categorising them as "Very Important" due to their essential role in ensuring secure management and accessibility of patient data. Telemedicine services received strong support, underscoring the increasing

demand for remote healthcare solutions. While AI-based diagnostics were regarded as beneficial, some participants raised concerns about their accuracy and reliability. Automated appointment scheduling was viewed as useful, though not essential, particularly compared to the prioritised areas of security and Electronic Health Records (EHR). In contrast, Internet of Things (IoT) integration was assigned the lowest priority, indicating that awareness and adoption of IoT-based healthcare technologies remain relatively low among respondents. These findings are illustrated in Figure 3.

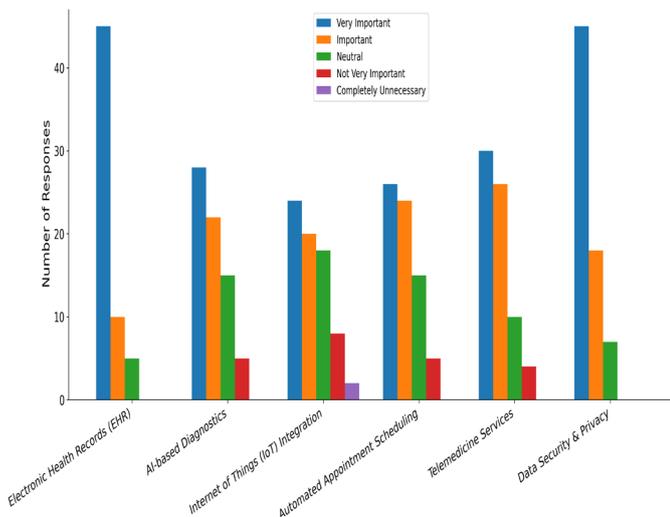


Figure 3. Importance of Features in an IHMS

Figure 4 shows the key challenges in the hospital management system based on participants' responses. According to the participants' answers, the most common cause was delayed access to patient data (65%), underscoring the crucial value of efficient digital record management and access processes. The other major red flag mentioned was human mistakes in data entry (58.3%), suggesting that we need automation and AI-based validation systems for better accuracy.

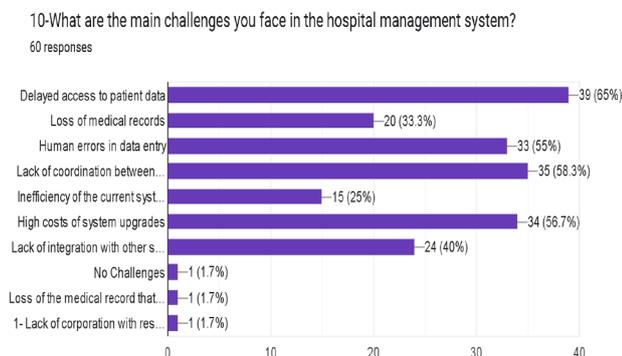


Figure 4. Main Challenges in the Hospital Management System

Another key issue identified was the cost of upgrading hospitals', healthcare centres', institutions' systems, at 56.7%, which highlights the financial challenges in the way of implementing new healthcare IT. Also, interoperability between different systems is important, with 40% reporting no integration with other systems and 58.3% reporting a lack of coordination.

Based on the reported challenges and expectations responses, performance targets such as reducing image retrieval time by approximately 40% and achieving 95% compliance with data security requirements were defined. These targets reflect commonly cited benchmarks in PACS-related studies and represent practical goals aligned with the operational needs of Iraqi healthcare institutions.

In another question, we asked the participants, How important are the usability requirements for the system? (the easy-to-use, learn, operate, and interact with the system)? As depicted in the Figure. 5, the survey results illustrate the importance of usability requirements in the proposed PACS-based healthcare system, particularly in terms of ease of use, learning, operation, and interaction. The majority of respondents acknowledged the importance of an intuitive system, with 43.3% rating usability as "Very Important" and 50% considering it "Important".

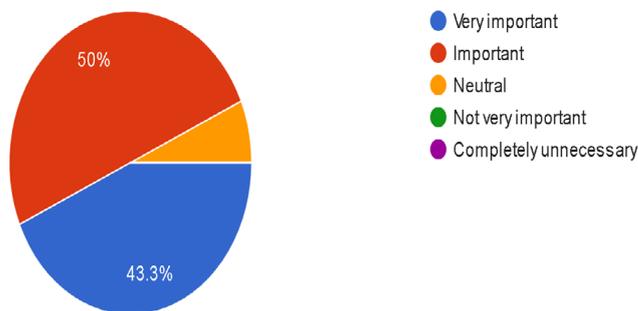


Figure 5. Importance of Usability Requirements in the System

The researchers also developed a survey question to evaluate the significance of reliability criteria for the system, focusing on its ability to perform intended functions under specified conditions for a predetermined amount of time without failure. Figure 6 survey findings indicate that the suggested PACS-based healthcare system places a strong focus on reliability needs. With 46.7% of respondents deeming system dependability "very Important" and 46.7% deeming it "important," nearly all respondents viewed it as a crucial component, indicating a significant need for a system that is stable and reliably operates without malfunctioning under specific conditions.

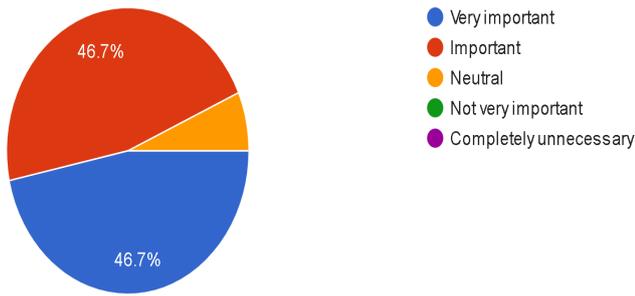


Figure 6. Importance of Reliability Requirements in the System

A small percentage of participants (6.6%) considered it neutral, suggesting that while reliability is essential, other system aspects, such as security and usability, might also influence their priorities. Notably, none of the respondents considered reliability "Not Very Important" or "Completely Unnecessary," underscoring its critical role in maintaining seamless healthcare operations.

The survey also assessed the importance of maintainability requirements in the PACS-based healthcare system, focusing on its ability to be easily repaired, improved, or adapted to a changing environment. As shown in Figure 7, a significant majority of respondents recognised maintainability as an important requirement, with 41.7% rating it as "Very Important" and 50% considering it "Important."

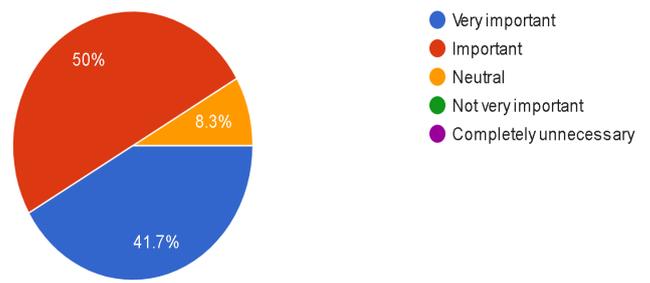


Figure 7. Importance of maintainability requirements in the system

Although maintainability is essential, some customers may prioritise other requirements, like usability or performance, as indicated by the smaller percentage (8.3%) who viewed maintainability as neutral. The fact that none of the respondents gave maintainability a "Not very important" or "Completely unnecessary" rating highlights how crucial it is to guarantee the long-term performance and adaptability of systems.

These results highlight the necessity of developing a scalable and maintainable PACS system, ensuring quick fault repairs, seamless updates, and adaptability to future technological advancements in Iraq's healthcare sector.

4.3 Key Factors Affecting the Adoption of Intelligent Systems in Hospitals

To explore the main factors for adopting IHMS, participants were asked, "What are the key factors that could encourage hospitals to adopt intelligent systems?" The results, illustrated in Figure 8, reveal several critical factors that influence the decision-making process for implementing AI-driven and digital healthcare solutions.

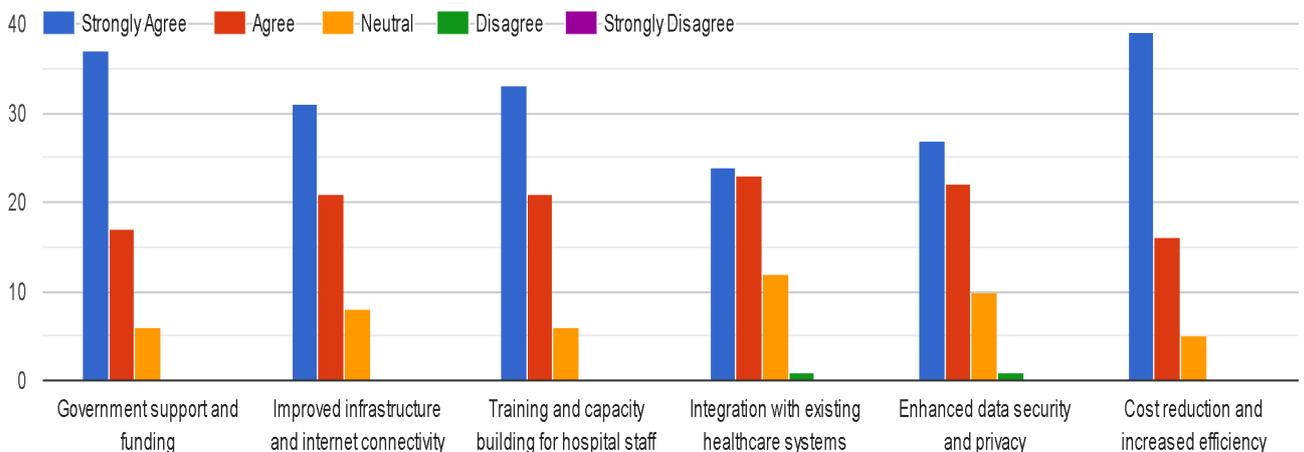


Figure 8. illustrates the key factors that encourage hospitals to adopt intelligent systems

The majority of participants strongly agreed that government support and funding play an essential role in encouraging hospitals to adopt intelligent systems, highlighting the need for financial incentives and policy-driven initiatives. Additionally, improved infrastructure and internet connectivity were widely supported, highlighting the importance of stable digital infrastructure for seamless system integration.

Training and capacity building for hospital staff also received strong support, with many respondents agreeing that effective user training programs are essential for successful adoption. Also, connecting with current healthcare systems was seen as very important, emphasising the need for different systems to work well together and share data easily.

4.4 Prototype Development for Intelligent MRI Segmentation and Classification within the Proposed PACS Framework

This is an intelligent PACS system prototype with intelligent segmentation and classification algorithms. It is an automated analysis of a medical imaging prototype for diagnosis in clinical tests.

Python was used for the model, making use of deep learning tools such as TensorFlow and Keras. The Y-Net model was optimised for both segmentation and classification tasks. Publicly available MRI data were used for training and validation to ensure the model's robustness and generalisability.

The prototype is built for the best fit with the intended PACS system. Once an MRI image is uploaded, the system automatically segments the tumour region, classifies it as tumour-like or non-tumour-like, and processes the image itself. Through the PACS interface, the outcomes can be accessed by physicians so enabling educational use cases and decision-making.

The Optimised Y-Net model showed significant enhancements in brain tumour segmentation on MRI data. The Dice coefficient increased from 0.9036 to 0.928, whereas the Intersection over Union (IoU) rose from 0.8225 to 0.853. Classification accuracy increased from 95.96% to a validated range of 97.5% to 98.2%, with a 1.8% improvement in both sensitivity and specificity.

Figure 9 illustrates the segmentation outcomes, emphasising the model's proficiency in precisely identifying tumour locations. Figure 10 shows the confusion matrix for distinguishing between cancer and non-tumour categories, highlighting how accurate the classification part of the proposed Y-Net is. This is a bulleted list.

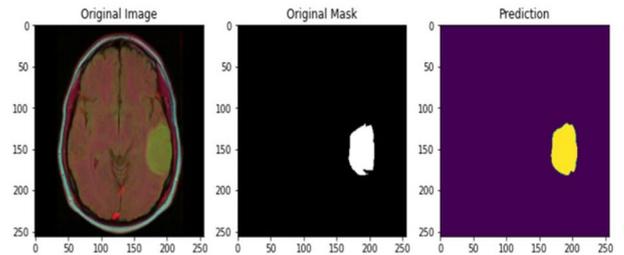


Figure 9. Segmentation of the brain tumour with original and predicted masks

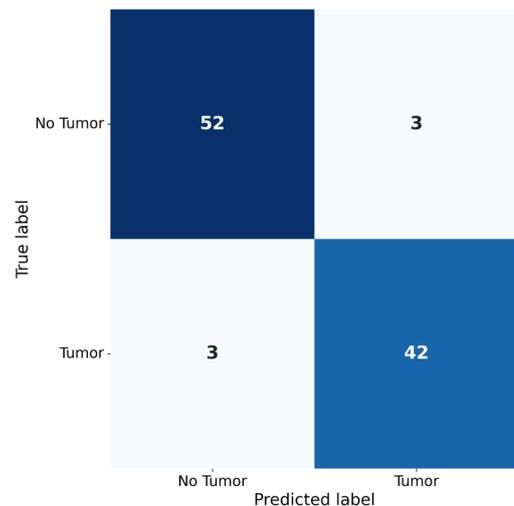


Figure 10. Confusion Matrix for Binary Classification of Brain Tumour

Many difficulties still exist, even with the encouraging outcomes. More varied and better-quality datasets would help the model to perform even more. Real-time clinical installations also depend on maximising processing performance. Expanding the dataset, improving the user interface, and completely integrating the prototype into the PACS environment to support daily clinical operations would be the main priorities of future work.

5. Conclusion

The results of this study emphasise the need to establish a PACS-based healthcare system in Iraq, integrated with AI and deep learning technologies to enhance the accuracy, efficiency, and security of medical imaging. The survey showed that users think usability (93.3%), reliability (93.4%), and maintainability (91.8%) are the most important things. In other words, users are looking for a system that is straightforward, reliable, and flexible enough to adapt to their needs. During our survey, many participants pointed out that it often takes too long to access patient data (65%), mistakes in data entry happen frequently (58.3%), and upgrading the system can be costly (56.7%). These challenges make it clear that there's

a real need for a smarter, automated PACS—one that uses AI to help healthcare teams work more smoothly and avoid unnecessary delays.

The AI-integrated PACS system will connect hospitals smoothly, automatically process images, and help find unusual things in the images. It will also work well with other hospital systems. Using deep learning, the system can provide more accurate diagnoses and help radiologists with their workload. Also, storing data in the cloud will make it more secure, allow doctors to access it from anywhere, and improve teamwork.

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