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DETERMINING THE EFFECT OF THE PICTURE ARCHIVING AND COMMUNICATION SYSTEM (PACS) ON DIFFERENT DIMENSIONS OF USERS' WORK IN THE RADIOLOGY DEPARTMENT

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Abstract

The Picture Archiving and Communication System (PACS) has revolutionized radiological practices by digitizing image storage and retrieval. A crucial part of contemporary radiology and diagnostic imaging services is the Picture Archiving and Communication System (PACS). It is intended to increase access to medical images, shorten diagnosis times, do away with the necessity for physical film storage, and enable quicker and more effective communication amongst healthcare professionals. The lack of a methodical evaluation of PACS from the viewpoint of users leads to a number of issues. First, if users are not properly trained or supported, it could result in underutilization of the system's capabilities. Second, it may lead to resistance to change, which would be detrimental to production and morale. The primary objective of this study is to investigate the impact of PACS on various aspects of users' work in the radiology department of Indus University Hospital. This study employs a quantitative, correlational design to assess the impact of the Picture Archiving and Communication System (PACS) on various work dimensions among healthcare professionals. The research was conducted in the radiology department of Indus University Hospital, Karachi, where PACS has been operational for at least one year. The study spanned a duration of six months, including the phases of tool development, data collection, data analysis, and report writing. The target population comprises radiologists, radiographers, PACS administrators, and physicians who frequently interact with PACS within their clinical workflows. Those without direct exposure to PACS, interns, trainees, or those unwilling to participate were excluded. A stratified random sampling technique was used to ensure proportional representation across the different professional groups. The sample size was 70. Data was collected through a structured, self-administered questionnaire that comprises sections on demographics, PACS usage patterns, and various work dimensions, including workflow efficiency, communication effectiveness, system usability, and job satisfaction. Data was analysed using SPSS version 26. Increased workflow efficiency, particularly in image retrieval and reporting speed are positively correlated with PACS. Users report better multidisciplinary communication.Users who are well-versed in PACS and operate in settings with robust IT assistance are more satisfied with their jobs. Certain issues, such as system outages, a lack of advanced training, or opposition to change are found.

Keywords: PACS, healthcare informatics, radiology, workflow, user satisfaction

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Introduction

A Picture Archiving and Communication System (PACS) is a digital medical imaging technology that safely stores, retrieves, manages, and distributes images (such as X-rays, CTs, and MRIs) and reports (Akter, 2025). It replaces older, laborious film-based systems with effective digital workflows and remote viewing, doing away with physical film and providing healthcare providers with instant access (Uddin, 2025). This was the norm for almost a century.

Because X-rays were recorded on film, a lengthy chemical development procedure in a darkroom was necessary (Jia, 2025). Image deterioration over time, the requirement for physical storage space, and the inability to modify images after exposure—which frequently necessitated repeat X-rays if the initial image was flawed. (Sharif Bakhsh, 2025) . Computer Topography was an intermediary step that was introduced in the late 1970s and early 1980s (Liang, 2025). A reusable imaging plate with photostimulable phosphors took the role of the film cassette (Amasya, 2025). A laser was used to scan the plate after exposure in order to create a digital image (Huang, 2025). This made it possible to employ current X-ray equipment with a digital workflow, doing away with the requirement for wet chemical processing and darkrooms. The current standard is digital radiography (DR), which first appeared in the later half of the 20th century (Starosta, 2025) . DR systems instantaneously take pictures and communicate them straight to a computer by integrating a flat-panel detector (direct or indirect conversion) with the X-ray equipment. Compared to CR, this approach delivers notable speed and efficiency gains (Cai, 2025). Several significant advantages drove the switch to digital systems. Diagnosis and treatment planning are accelerated by the nearly instantaneous availability of digital pictures for review. Sharper, more detailed images are produced by digital technologies (Heilmann, 2025). Healthcare practitioners can improve diagnostic accuracy by adjusting brightness, contrast, and zoom to better perceive particular areas (Maita, 2023). Because digital sensors are more sensitive than film, high-quality images can be obtained with far lower radiation exposures, improving patient safety (Quaia, 2025).

Driven by technological improvements and the demand for increased efficiency and accuracy, the shift from traditional film-based radiology to digital systems has been a major change in healthcare (Alkhoraif, 2025) . This shift has transformed radiology departments, enabling better image quality, faster processing, and enhanced patient care (Pérez-Sanpablo, 2025) . The main elements of this shift are described in the sections that follow. Screen-film technology has been superseded with digital radiography detectors, which have improved image capture and quality. ACS are now

necessary because they make it possible to store, retrieve, and share images effectively, which lessens the need for actual film (Robertson, 2024). The transition to digital has made it easier to integrate radiological data with EMRs, improving data accessibility and optimizing workflows (Lee, 2025). Traditional transcription methods have been largely replaced by voice recognition, improving efficiency in reporting (Eftekhari, 2024).

By giving prompt access to imaging data, digital technologies facilitate sophisticated diagnostic processes and raise the standard of treatment overall (Luo, 2025). Compared to conventional techniques, digital technologies enable superior dose management and patient safety procedures (Dehbaghi, 2026) . Compared to conventional techniques, digital technologies enable superior dose management and patient safety procedures (Razek, 2026).

Globally, PACS has been recognized for enhancing workflow efficiency, minimizing the physical storage space required for radiographic films, and reducing the turnaround time of radiology reports (Badnjević, 2026).It allows healthcare professionals to access and review diagnostic images remotely, facilitates image sharing across departments, and integrates seamlessly with other health information systems such as Hospital Information Systems (HIS) and Radiology Information Systems (RIS) (Pérez-Sanpablo, 2025). These capabilities support a more collaborative and efficient healthcare delivery model. In many high-income countries, PACS has become a standard part of radiology services (Hanna, 2025). However, in low- and middle-income countries like Pakistan, the implementation and optimization of PACS are still in a developing phase (Qamar, 2024) . While many tertiary care hospitals have adopted PACS to modernize their imaging departments, the actual impact of this system on the workflow, communication, productivity, job satisfaction, and overall work environment of users has not been adequately incorporated (Pérez-Sanpablo, 2025).

The use of PACS introduces changes not only in how images are handled but also in how healthcare professionals communicate and collaborate (Pérez-Sanpablo, 2025). For instance, it may alter the dynamics between radiologists and referring physicians, streamline or disrupt daily routines, and affect perceived workload and satisfaction. Without a proper understanding of these impacts, institutions may face underutilization, resistance to adoption, or failure to leverage the full benefits of PACS. Hence, there is a pressing need to explore and evaluate how PACS influences various dimensions of work from the users' point of view. This understanding is critical to inform evidence-based strategies for system training, support, and enhancement.

Statement of the Problem

The Picture Archiving and Communication System (PACS) has become an essential component of modern radiology and diagnostic imaging services (Rahnama, 2025). It is designed to improve access to medical images, reduce delays in diagnosis, eliminate the need for physical film storage, and facilitate faster and more efficient communication among healthcare professionals. While the technical capabilities of PACS are well-documented in the literature, there is a notable gap in understanding how these systems affect the actual work experience of users, particularly in developing healthcare systems like Pakistan (Ali, 2025).

In many tertiary care hospitals in Pakistan, PACS has been introduced as part of digital transformation initiatives (Eloy, 2025) . However, there is limited empirical evidence regarding its real-world impact on key dimensions of users' work, such as workflow efficiency, time management, communication patterns, system usability, adaptability, and job satisfaction. Radiologists, radiographers, IT professionals, and referring clinicians interact with PACS daily, yet their insights and experiences with the system are rarely studied or incorporated into system evaluation or improvement processes.

The absence of systematic assessment of PACS from the users' perspective creates several problems (Wong, 2025) . First, it may lead to underutilization of the system's potential, especially if users are not fully trained or supported. Second, it can result in resistance to change, negatively affecting morale and productivity (Asif, 2025). Third, without identifying areas of difficulty or dissatisfaction, hospital administrators and policymakers may continue investing in technologies without understanding whether or how they improve work outcomes (Keyvanlo, 2025). This misalignment can limit the return on investment and even create new inefficiencies in already burdened healthcare environments. Furthermore, most of the existing studies on PACS focus on its diagnostic or technical benefits, with minimal exploration into how it influences human factors and organizational workflow (Keyvanlo, 2025).There is also a scarcity of context-specific studies that consider the infrastructural, cultural, and operational realities of Pakistani healthcare institutions. As a result, decision-makers lack the local evidence necessary to make informed choices regarding system training, upgrades, or integration strategies.

Given this gap, it is crucial to investigate how PACS affects different aspects of users' work in Pakistan's healthcare setting. Such an evaluation will not only identify strengths and challenges but will also provide actionable insights to enhance the

system's usability, improve job satisfaction, and ultimately lead to better patient care outcomes.

Research Questions

i. What is the impact of PACS on workflow efficiency, communication, and job satisfaction among healthcare professionals in radiology departments?
ii. How do users perceive the usability and adaptability of PACS in their routine work practices?

Research Objective

To assess the effect of PACS on different dimensions of users' work in radiology Department

Hypothesis

Null Hypothesis (H_0): The use of PACS does not significantly improve efficiency or satisfaction among healthcare professionals.

Alternative Hypothesis (H_1): The use of PACS significantly improves efficiency and satisfaction among healthcare professionals.

Literature Review

Theoretical Framework

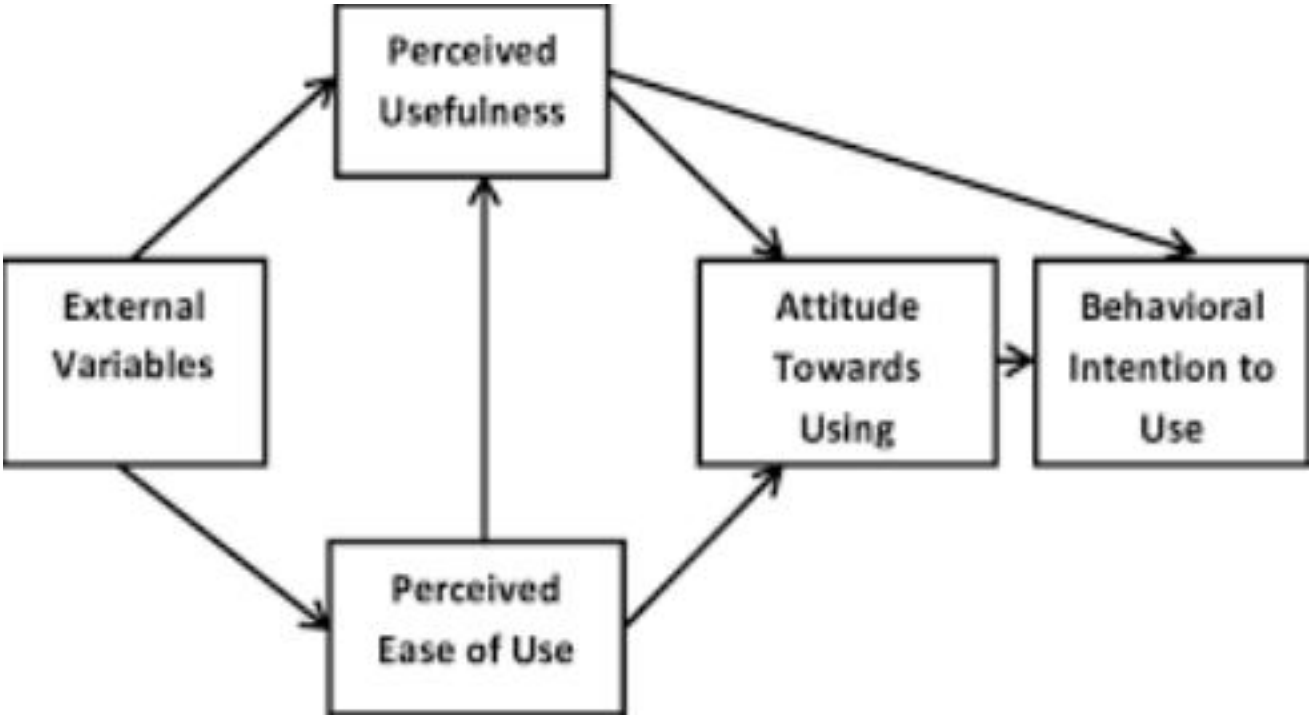

Fig 1: Technology Acceptance Model (Davis,1989)

TAM's primary goal was to elucidate the mechanisms underlying technology adoption, enabling the prediction of its behaviour and providing a theoretical justification for its effective application (Lee A. T., 2025). TAM's practical goal was to educate practitioners about potential pre-system implementation actions. Several actions were taken to achieve the theory's goals. By defining the mechanisms governing the relationship between IS characteristics (external factors) and actual system use, Davis started to create the model of technology acceptance. The Theory of Reasoned Action, which offered a psychological viewpoint on human behaviour that was absent from the literature at the time, served as the model's foundation. The second phase involved finding and defining variables, as well as validating metrics that strongly correlated with system use. Multi-item measures for perceived utility and ease of use were created, pre-tested, and validated in several studies based on earlier empirical research on human behaviour and information system management. Based on evidence from earlier studies, it was hypothesized that the two constructs were essential determinants of user approval. According to the research, a person's decision to engage in a behaviour is the outcome of weighing the expected benefits of the behaviour against the costs and effort involved (Davis, 1989).

By influencing user attitudes and intentions toward new technologies, the Perceived Acceptance Component (PAC) has a substantial impact on the Technology Acceptance Model (TAM) (Wang, 2025) . PAC includes elements, including perceived utility, perceived usability, and perceived trust, all of which together influence how users accept technology (Prasetyo, 2025). This is a major factor in TAM, where users evaluate a technology's short-term and long-term advantages. Behavioural intention is more strongly influenced by perceived near-term usefulness than by long-term usefulness (Duan, 2025) . Although it has long been seen as a crucial component, new research indicates that perceived usefulness may have a more direct impact on behavioural intention (Alshammari, 2025) . One of the most important factors influencing user attitudes and intentions is trust in technology, especially about security and dependability (Yu, 2025). It was discovered that the most important element influencing user attitude in the context of mobile banking was perceived trust (Apau, 2025) . The explanatory power of TAM is also improved by elements like system quality and user pleasure, suggesting that PAC is not just restricted to perceived utility and usability.

Universal Challenges in PACS (C1)

Technical, operational, and infrastructure problems are the main universal concerns that Picture Archiving and Communication Systems (PACS) in healthcare facilities confront (Candelario, 2025). These difficulties impede the efficient use and deployment of PACS,

which affects patient care and workflow effectiveness. Problems with HIS/RIS/PACS connectivity and the DICOM standard may make it more difficult to collect and distribute data, which may have an impact on clinical value (Fares, 2025). Smooth image sharing and transfer is complicated by the fact that different institutions frequently utilize different suppliers and proprietary methods (Ho, 2025). It might be challenging to integrate PACS into current workflows, necessitating considerable process modifications and employee training (Pérez-Sanpablo, 2025). Particularly in low-income environments, institutions may find it difficult to secure the financial and personnel resources required for PACS operation (Keyvanlo, 2025). ACS functionality can be significantly constrained by inadequate power supply and internet connectivity, particularly in locations with limited resources (Rehman, 2025). A lack of room for installation and maintenance may hamper PACS equipment deployment (Marey, 2025).

User Satisfaction and Professional Experience

Professional expertise and the usability of Picture Archiving and Communication Systems (PACS) have a major impact on user satisfaction (Lobi, 2025) . According to research, the use of PACS has enhanced access to medical reports and images, which has raised satisfaction among medical workers, especially radiologists and doctors (Huang J. M., 2025) . However, there are still issues with using advanced functions effectively and the requirement for continual training. After PACS was implemented, user satisfaction levels increased from 23.74 to 32.05, according to research, suggesting a favourable effect on user experience (Zhou, 2025) . Compared to traditional film methods, users reported better photographs and less frustration, which improved their professional lives (Dodoo, 2025).Despite using PACS several times a day, many clinicians only make use of its most basic functionalities, indicating a lack of training and system familiarity (Nowrangi, 2025) .For less experienced users to get the most out of PACS, improved training programs are crucial (Raman, 2025) . Although PACS has been well received overall, some users express ambivalence about how it affects clinical efficiency (Santiago-Torner, 2025).

Radiological workflows and healthcare delivery have been profoundly altered by the use of digital technology in healthcare, especially the Picture Archiving and Communication System (PACS) (Wong, 2025) . PACS reduces the need for film-based systems and improves access to diagnostic data by facilitating the digital acquisition, storage, retrieval, and sharing of medical pictures (Hanna, 2025) . The way radiologists and other medical professionals carry out their duties has undergone significant modifications as a result of this shift (Mazaheri, 2025). PACS integration has been linked to gains in healthcare provider communication and workflow efficiency, according to a

number of worldwide studies (Torricelli, 2025).PACS integration has been linked to gains in healthcare provider communication and workflow efficiency (Hanna, 2025). According to research by PACS greatly accelerated clinical decision-making by reducing image retrieval time and improving report turnaround (Joy, 2025) . In a similar vein, recent research has shown that PACS decreases delays in diagnostic and treatment planning and enhances interdepartmental communication. Positive results in terms of user satisfaction have also been linked to PACS (Tyllinen, 2025).The satisfaction was found to be significantly influenced by PACS's usability, especially when the system was coupled with electronic health records (EHRs).

Methodology

Research Design: This study employs a quantitative, descriptive correlational design to assess the effect of PACS on various work-related dimensions among healthcare professionals in the radiology department. The research approach is cross-sectional. Data is collected at a single point in time using a structured questionnaire. The study was conducted in the radiology departments of Indus University Hospitals and Health Network, Karachi. The hospital serves as a tertiary care hospital where the Picture Archiving and Communication System (PACS) has been implemented and actively used. The selected settings are equipped with digital imaging infrastructure and staffed by radiologists, technologists, and other healthcare professionals who routinely interact with PACS in their clinical workflow.

Inclusion Criteria

- Healthcare professionals (radiologists, radiographers, physicians, PACS administrators)
- Minimum of 6 months' experience using PACS
- Currently working in radiology department
- Willing to participate and provide informed consent

Exclusion Criteria

- Healthcare professionals not directly using PACS
- Interns, trainees, or temporary staff
- Individuals with less than 6 months of PACS experience
- Those who decline to provide informed consent

Sampling Technique

Stratified random sampling technique was used. A total of 70 participants were included in the study. To achieve accurate and trustworthy survey results than simple random sampling, stratified sampling is a statistical technique that divides a population into discrete, non-overlapping subgroups (strata) based on shared characteristics (Michelucci,

2025) . A random sample is then taken from each subgroup to ensure proportional representation. This allows for adequate representation of various PACS users across Radiology department of Indus University Hospital and Health Network.

Data Collection Instrument: A structured self-administered questionnaire was used as the primary data collection tool. The questionnaire was designed in English and was consisted of demographic questions, closed-ended questions, and Likert-scale statements on knowledge, attitudes, and information sources. Informed consent was ensured before participation. The questionnaire had 6 sections. The first section covers the demographic details of the participant. The rest of the parts explore the queries regarding workflow efficiency, communication and accessibility, productivity and workload, usability and satisfaction and lastly the challenges.

Ethical Considerations: All the ethical protocols were followed according to the BERA framework ethical guidelines. Institutional Review Board (IRB) approval was taken prior to data collection. In addition, informed consent was taken from all the participants of the study. It was mentioned that data is used strictly for study purpose and information will be kept in a password-protected file. The data will be disposed of after one year.

Data Analysis

The data was analysed using SPSS version 26. Descriptive statistics, including frequencies and means, were used to summarize demographic data and responses related to PACS usage and its impact on various work dimensions. For inferential analysis, Spearman's rho test was run. A p-value suggested the affirmation of the hypothesis.

Results: This part of the research displays the statistical results of the collected data and the findings after running statistical tests on SPSS version 26.

Table 1: *Descriptive Statistics*

	N	Minimum	Maximum	Mean	Std. Deviation
Your Role in the Radiology Department:	70	1	2	1.91	.282
Years of Experience Using PACS:	70	1	3	2.13	.448
W1	70	5.00	7.00	5.5286	.69619
C1	70	4.00	7.00	5.2286	.88746
P1	70	5.00	7.00	6.2286	.64091
US1	70	5.00	8.00	6.4000	.80578
Valid N (listwise)	70				

The study variables' descriptive statistics (N=70) show that the radiology department's use of PACS is generally seen favourably. The highest mean score (M=6.40, SD=0.81) was recorded by User Satisfaction (US1), closely followed by System Performance (M=6.23, SD=0.64). Notably, the lowest recorded score on the Likert scale for criteria related to workflow, performance, and satisfaction was 5.00, indicating a "ceiling effect" in which no participant voiced discontent. Nevertheless, System Challenges (C1) produced the biggest standard deviation (SD=0.89) and the lowest mean (M=5.23). This greater variance indicates that, despite the system's perceived technical performance, staff members' experiences navigating system-related difficulties are less consistent, which is the main source of friction during the digital shift.

Table 2: *Correlations*

			Years of Experience Using PACS:	Challenges faced when using PACS?
Spearman's rho	Years of Experience Using PACS:	Correlation Coefficient	1.000	.159
		Sig. (2-tailed)	.	.188
		N	70	70
	Challenges faced when using PACS?	Correlation Coefficient	.159	1.000
		Sig. (2-tailed)	.188	.
		N	70	70

The association between healthcare professionals' years of experience using PACS and the reported difficulties experienced during its operation was examined using Spearman's rank-order correlation. Experience and difficulties had a very weak positive connection (rho =.159, N = 70) However, it was not statistically significant (p =.188). These findings suggest that an individual's experience level has little bearing on the number or intensity of difficulties they encounter when utilizing the system. The lack of a significant link (p =.188) between years of experience and PACS challenges indicates that system issues are probably present throughout the department. This suggests that technical or workflow-related challenges are not always lessened by the "learning curve" associated with PACS. Staff members seem to face identical systemic obstacles regardless of seniority, indicating that system-wide technology enhancements rather than individual user training should be the main focus of interventions.

Discussion

Years of experience and system difficulties did not significantly correlate, according to the analysis (rho =.159, p =.188). This conclusion is especially significant because it defies the conventional belief that more professional experience results in improved technical skill and fewer operational obstacles. This implies that systemic rather than user-cantered concerns are impeding the "Perceived Ease of Use" within the context of the Technology Acceptance Model (TAM). The problems that participants reported—like software flaws or system latency—are part of the PACS infrastructure because a rookie technician and a veteran radiographer are equally susceptible to these technical obstacles, institutional reforms should put hardware optimization ahead of repetitive user training.

A radiographer cannot just "experience" their way out of problems like slow servers or software flaws, even with ten years of expertise, because these challenges are frequently caused by system design rather than human skill (Stogiannos, 2025) . The effectiveness and efficiency of medical imaging procedures are greatly influenced by the architecture and operation of health information technology systems, such as Picture Archiving and Communication Systems and Radiology Information Systems (Almasri, 2025) . Even the most seasoned user cannot prevent major inefficiencies and delays caused by poorly designed systems. Medical imaging delays and inefficiencies can result from design defects in health IT systems, such as system errors, malfunctions, and crashes (Hussin, 2025) .The necessity of adaptable and user-friendly software design is highlighted by the rigidity of present radiological technology, which can burden radiographers because it does not adjust to individual user demands or preferences (Tay, 2025) . The need for improved human-computer interaction design in medical imaging systems is highlighted by the fact that poorly designed software interfaces can cause user confusion and mistakes (Kaifosh, 2025) .System bottlenecks can be made worse by human errors like improper input settings or unnecessary keystrokes, however these are frequently signs of fundamental design problems rather than user incompetence (Kaxramonovich, 2025).

The efficiency of picture retrieval in digital departments is severely hampered by technical issues, especially those pertaining to network bandwidth (Wormenor, 2025) . Access to vital medical images may be delayed as a result of these constraints, which could affect patient care and overall workflow (Yoganathan, 2025) .The speed of picture retrieval can be significantly hampered by inadequate bandwidth, particularly when massive amounts of data are sent over wide area networks (Singh, 2025) .According to a research, a digital radiology department might produce about 15.7 GB of data every day,

requiring bandwidth that frequently surpasses available capacity (Kulkarni, 2025) .Different users are impacted by variations in network connections; physicians using web browsers retrieve information more slowly than radiologists with direct PACS access (Mackenzie, 2025). Increased latency brought on by technical obstacles makes it more difficult to obtain the images required for diagnosis promptly (Xu, 2025) . Optimizing network settings can greatly improve response times and overall efficiency, as demonstrated by modelling imaging procedures (Kanna, 2025). Optimizing network settings can greatly improve response times and overall efficiency, as demonstrated by modelling imaging procedures.

Conclusion

The purpose of this study was to assess how the deployment of the Picture Archiving and Communication System (PACS) affects the productivity and contentment of medical staff in the radiology department. The study offered important insights into how digital transformation affects clinical operations by examining data from practitioners. A significant degree of professional support for PACS technology was found in the descriptive study. It is clear that the system has successfully integrated into the clinical setting with a mean User Satisfaction score of 6.40/7.0 and a System Performance score of 6.23/7.0. Interestingly, the study found a "ceiling effect," meaning that none of the individuals had any unfavourable experiences with performance or efficiency.

Nevertheless, the Null Hypothesis was not rejected by the statistical analysis employing Spearman's rho correlation. Years of experience and the difficulties encountered ($p = .188$) and difficulties and image retrieval speed ($p = .083$) did not significantly correlate. The study's most important conclusion is that system problems are ubiquitous. The data indicate that PACS issues are not caused by a learning curve or a lack of user competency because experience level did not correspond with a decrease in obstacles. Rather, these issues are probably systemic, resulting from program design, network slowness, or hardware constraints.

In conclusion, the descriptive data clearly supports the conclusion that PACS is an essential and highly appreciated technology in modern radiology, even though the Alternative Hypothesis could not be statistically validated at the $p < 0.05$ level. To achieve an optimal, completely efficient digital process, it will be necessary to remove these systemic barriers. The remaining challenges are technical rather than instructional.

Recommendations

- To guarantee that high-resolution photos render quickly, the IT department should assess and expand network bandwidth.

- The hospital should prioritize upgrading its technical infrastructure above providing basic user training.
- To give both junior and senior employees a similar user experience, the PACS interface should be standardized and tailored for every workstation.
- Radiology department should establish a rapid-response technical team to handle real-time system malfunctions.

Future Research

Qualitative interviews should be used in future research to describe the Main Challenges found in this study precisely. This would explain the "why" of the numerical scores.

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