



An-Najah National University
Faculty of Graduate Studies

**THE PERCEPTION OF RADIOGRAPHERS IN
RADIOLOGY DEPARTMENT TOWARDS THE
IMPLEMENTATION OF PICTURE ARCHIVING AND
COMMUNICATION (PACS) IN PALESTINIAN
HOSPITALS**

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**This Thesis is Submitted in Partial Fulfillment of the Requirements for the Degree of
Master of Public Health Management, Faculty of Graduate Studies, An-Najah National
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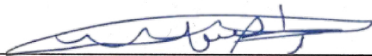
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Dedication

I dedicate the harvest of my effort to my family, father, mother, brothers and sisters.

To my in-law, husband and daughters

To my friends, teachers, colleges and every one supported me during my study directly or in directly.

Acknowledgements

Praise is to Allah, who helped me to complete this research, and made use of all means of assistance and facilitation.

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Finally, I would like to thank Palestinian Association of Medical Radiation Technologists (PAMRT) for their facilitation for this research and information.

Declaration

I, the undersigned, declare that I submitted the thesis entitled:

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TOWARDS THE IMPLEMENTATION OF PICTURE ARCHIVING AND
COMMUNICATION (PACS) IN PUBLIC HOSPITALS IN NORTH PALESTINE**

I declare that the work provided in this thesis, unless otherwise referenced, is the researcher's own work, and has not been submitted elsewhere for any other degree or qualification.

Student's Name: Nada "Joul Jamal" Saleem Shalabi

Signature: 

Date: 7/8/2024

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THE PERCEPTION OF RADIOGRAPHERS IN RADIOLOGY DEPARTMENT TOWARDS THE IMPLEMENTATION OF PICTURE ARCHIVING AND COMMUNICATION (PACS) IN PALESTINIAN HOSPITALS

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Abstract

Introduction: Picture Archiving and Communication System (PACS), is one of the most necessary systems recured in radiology department for archiving and retrieving medical imaging. The perception of its users considered as one of the important impacts on its adaptation. The aim of this study is to measure the acceptance of PACS in Palestinian public hospitals.

Method: in 2023 a cross-sectional study was conducted at Palestinian general hospitals. The targeted population was all radiographers working in radiology department at general hospitals. Out of (170) participant only (151) answered the distributed questionnaire. The questionnaire consisted of five inter- related variables i.e., socio-demographics factor, external environment, expected outcome, expected challenges and satisfaction. These factors were designed to measure the acceptance of PACS in radiology department.

Results: this study showed a significant relationship between the acceptance of PACS and the related variables i.e., socio-demographics factor, external environment, expected outcome, expected challenges and satisfaction. It also explained the positive impact of PACS.

Conclusion: this study showed the positive perception of users toward PACS in Radiology department. Also, the effect of PACS on users’ productivity and the ability to adopt the system in radiology department. The result of this study aims to provide health care worker a better understanding to increase the adaptation of PACS from radiographers in radiology department.

Keyword: Picture Archiving and Communication System (PACS); Radiology Department; Socio-demographics Factor; External Environment; Expected Outcome; Expected Challenges and Users' Satisfaction.

Chapter One

Introduction and Theoretical Background

1.1 Background

Healthcare systems around the world aim to serve people well by providing the most appropriate healthcare services. Health systems, whether in developed or developing countries, struggle to manage healthcare delivery under resource-constrained conditions. Healthcare organizations are expected to provide more consumer-oriented services. In order to achieve this goal, improving service quality is an absolute necessity, which requires timely access to high-quality information. Health care primary task is to maintain the health of the population in order to achieve this it's important to improve and reserve the intellectual capital and the labor potential. Therefore, the most important evaluation and analytical categories for healthcare facilities is the quality of costumer cervices provided. The quality of healthcare services describes the accuracy of healthcare organization in delivering their processes to meet the needs for the patients. On the other hand, it also describes the properties available at health care organization that focuses on achieving the desired results at the appropriate level for consumers (Dudin, Sertakova et al. 2017).

There are two main key factors that largely influence the level of quality of health care services. At first, competences of health institution, professionalism and competencies of healthcare professionals (doctors, nurses, laboratory, etc.). the second factor, on the sufficiency and completeness of healthcare facilities (healthcare organization). In other words, the provision of healthcare services requires both staff and certain material and technical resource. This shows the need for urgent development of scientific and methodological approaches to improve the quality of healthcare services (Abbasi, Jabali et al. 2020). The shaping of healthcare domain affected by Information and Communication Technology (ICT). ICT makes significant new opportunities to many areas, including many benefits for health sector, and the quality of healthcare services delivered by increasing efficiency and quality. The usage of health ICT in healthcare developed a new term e-health which is referred to the usage of ICTs in healthcare. Due the growing population the demand on healthcare services is in an increasing manner that requires update in the dealing with health information and Health institutions, which are complex organizations, naturally need sophisticated information management systems for

effective and efficient health service delivery. this leads to the Health Information Technology (HIT) (Aceto, Persico et al. 2018).

1.1.1 Health information technology

Health Information Technology (HIT) has for both patients and service providers in terms of quality in health services. Healthcare information technology (HIT) is defined as “the is the processing of information and data of health involving both computer hardware and software that deals with the storage, sharing, retrieval, and use of data, information, and knowledge for decision making and communication”. the HIT includes various technology’s that support decision making and integration with medical technology. This facilitates the improving and transforming healthcare services such as; improving clinical outcomes, facilitating care, reducing human errors, improving practice efficiencies, tracking data, and coordination over time (Alotaibi and Federico 2017). One of the important technology’s that HIT affected more is Electronic Health Record (HER).

1.1.2 Electronic health record

Electronic Health Record (HER) is “a documentation tool that yields data useful in are corporate systems that have the potential to overcome inefficiencies and contain costs”(Lavin, Harper et al. 2015). And Electronic health record (EHR) is “data collected from millions of patients are now routinely collected across diverse healthcare institutions. They consist of heterogeneous data elements, including patient demographic information, diagnoses, laboratory test results, medication prescriptions, clinical notes, and medical images (Xiao, Choi et al. 2018). Also, EHRs “represent longitudinal data (in electronic format) that are collected during routine delivery of health care. it generally contains demographic, vital statistics, administrative, claims (medical and pharmacy), clinical, and patient-centered (e.g., originating from health-related quality-of-life instruments, home-monitoring devices, and frailty or caregiver assessments) data” (Cowie, Blomster et al. 2017).

EHR improves the performance and service delivery of health services. Electronic health records have the potential to strengthen the quality of the relationship between physicians and patients, as well as providing access to complete and up-to-date patient information from practices or remote locations, it also has the functions to keeping patient records, reducing errors, saving administrative costs, increasing productivity and improved patient

satisfaction (Cowie, Blomster et al. 2017). The spread of EHR and HIT requires more efficient sharing of patient information, which require more efficient patient documentation quality to enhance patient safety, quality of care and reducing the cost of health system. the result of the transitions from paper-based to electronic health record will lead to decrease staff documentation time and increase time for patient direct care (Baumann, Baker et al. 2018). Despite all these advantages but there is low adaptation of the system.

According to the third global research report of the World Health Organization (WHO) E-Health Global Observatory (2016), there has been steady growth in the adoption of national HIT systems in the last 15 years, with (46%) of the global increase in the last five years. (50%) of upper-middle and high-income countries have adopted national HIT systems. However, the rate of adoption is much lower in low-middle-income countries (35%) and low-income countries (15%). Moreover, the majority of the member countries with national IHC systems have integrated HIT systems with laboratory (77%) and pharmacy (72%) information systems, which means integration with picture archiving and communication systems (56%).

1.1.3 Health information system

Health information system (HIS) is “an integrated electronic system which is used in collecting, storing, retrieving, and displaying patient data and information for example: patient history, laboratory result, diagnosis, billing and hospital related procedures”. Also” The Hospital Information System (HIS) is a computer system aimed at providing a paperless environment that covers all aspects of the hospital's operation such as clinical, administrative, and financial systems (Nilashi, Jannach et al. 2016). The system includes several components, such as Laboratory Information System (LIS), Financial Information System (FIS), Radiology Information System (RIS), Picture Archiving Communication System (PACS) these component can be linked together with the different characteristics (Ismail, Abdullah et al. 2015). In the resent years the HIS had a crucial role in healthcare delivery, safety of patient, and the clinical practices. The appropriate usage and implementation of this system will increase health care worker satisfaction which intern will enhance the level of engaging with these systems (Cohen, Coleman et al. 2016). So to enable decision-making process in building health system that accounts on the reliable information which is necessary for building strategy, policy and implementation, health

research, health education and training, human resources and financing the proper understanding and usage of system functionally is required (WHO 2009).

Many research shows that HIS system rapidly increases the efficiency and reduce the expenditure of health cost. Using effective technology such as HIS system will eventually reduce clinical errors, increase patients access to health services, support clinicians, support remote care, improve information management, and enhance the continuity of health services. HIS is expected to affect the social and economic benefit for families, patient and healthcare provider. Despite all technology in healthcare sector, there's a slow adaptation of new technology compared to other industries. The implementation of any HIS system suggest to enhance the safety of patient and also reduce the expected cost for health services (Inamura and Kim 2011).

Many challenges may be an obstacle in implementing the HIS system, these challenges may include technology such as poor product and insufficient planning. Innovation characteristic as safety, risk, and performance. Resistant of change is phenomenon widely recognized because users consider new technology as time-consuming, not aware for the benefit, patient privacy and confidentiality, legal responsibility, and fear from facing new kind of errors because of new system. On the other hand, the successful implementation of HIS requires IT infrastructure that includes different types of devices and technology, the technology should be easy to use, requires small or no training, flexible, clear and understandable, also it requires on-set training and ongoing support to implementation to occurs, effective communication between technological staff and the clinical and managerial staff is considered crucial (Sligo, Gauld et al. 2017).

The health information system is a highly complex system that includes complex hardware and software, so its users (healthcare professionals) must have a certain level of Health Information usage skilled. In addition, Health Information System has a number of capacity (technical) problems that are the subject of the complaints of healthcare professionals which need to be solved and developed. There are many studies pointing out the deficiencies of healthcare professionals in computer use skills, technical training and support, and guidance for the use of the HIS. The reason for this is the obstacles that exist between the capacity of healthcare professionals and the capacities of the systems (Juris Bennett, Walston et al. 2015).

The hospital information system (HIS), cardiovascular information systems (CVIS), picture archiving communication system (PACS), clinical information system (CIS), radiology information system (RIS), and electronic health record (EHR) are the integral components of a hospital.

1.1.4 Picture archiving and communication system (PACS)

All the technologies aim in the first place to increase the efficiency and quality of health care system, including PACS as integrated part from HIS system. There is a need for a systematic entity for processing images in radiology department as it cannot be processed like other hospital data (Goodarzi, Khatami et al. 2016).

medical images require routing, storing, and retrieving for which the invention of a specialized system such as a picture archiving and communication system (PACS) (Aldosari, Saddik et al. 2018). PACS defined as “the system allows the medical imaging to be stored, transmitted, retrieved, and displayed in several location of health system and hospitals” (Goodarzi, Khatami et al. 2016). It also defined as “is a subsystem of the health information system that aims to facilitate the storing, archiving, and managing of digital images as well as their transmission” (Hamta, Mohammadzadeh et al. 2020). Also “is system is required to fetch, archive, and process images from one or many sources. The main purpose of the system is to improve image routing, retrieval, and display capabilities among a healthcare facility, specifically the radiology department. PACS is integrated with more than one imaging modalities such as X-Ray, magnetic resonance imaging (MRI), computed tomography (CT), ultrasound and nuclear medicine (NM), and other similar technologies (Aldosari, Saddik et al. 2018). PACS is” an electronic information system (IS) used to acquire, store, transmit, and display medical images (Buabbas, Al-Shamali et al. 2016). Was first introduced in the 1980s (Inamura and Kim 2011). It has an important role in transmission from paper-based imaging to digitalized imaging although the transition from paper-based to electronic based increased complexity while simplifying documentation. documentation has always been an essential component of professional care services (Haux 2006). The users of PACS include technologist, physicians, radiologist, nurse and image library personals (Aldosari and making 2012). The concept of digital image communication and display is first introduced in 1979’s in Europe (Lemke 2011). Due to the lack of technology at that time the first implementation of PACS were in the early 1980s in different part of the world starting from the USA

(Huang 2011). In the late 1980's there were a start to integrate the PACS with HIS system and radiology information system (RIS), And with digital imaging and communication in medicine (DICOM) (10). At first the systems only focused on single department or section within the organization. In the early 1990s the PACS were introduced at the hospital level including the whole department. After that at the late 1990s the PACS covered a wide-area including several hospital or health institution. the implementation of the PACS affected by the socioeconomical state of the country, the industries in health sector, and the political condition of the country. Therefor the implementation of PACS rolled in developing countries in Asia and Europe. On the other hand, the concept of IHE (integrating healthcare enterprise) aligned with RIS and HIS contributed to effective implementation of PACS (Huang 2011, Inamura and Kim 2011, Lemke 2011). In these days PACS is used widely used in both developing and developed countries. In fact, it's becoming one of the most used digital imaging tools (Alhajeri and Shah 2019).

PACS offers several important uses. At first replacing hard-copy-images in processing images. It also decreases the price of radiology images, decreasing the cost of storing and archiving images, it provides off-set image reviewing. Furthermore, it provides electronic platform to allow images to integrate with other modalities (Khaleel, Rahmat et al. 2018).

PACS consists from four major parts: image acquisition devices (imaging modalities), communication networks, PACS archive and server, and integrated display workstations (WS). It's connected to healthcare system through communication networks. Image acquisition devices consisted from device imaging modalities such as magnetic resonance imaging, computed tomography, PET, X-ray angiography and others. And acquisition gateway computers that connects between imaging modalities and PACS servers. It also converts image data from the format of manufacture modalities to the PACS standard format that called DICOM, and also execute some preprocessing function such as, resizing, background removal and orientation calibration. The communication network is the way of transition medical data from PACS component and other systems parts such as communication between gateway computer, imaging modalities, display and review WSs, PACS server, HIS/RIS systems and any other remote medical locations. PACS archive, is where all patients imaging examination and information are sent from for saved. server from the acquisition gateway computers and from HIS/RIS systems. the PACS server, is the engine, has two main parts: archive system and storage media

(database). There is two level of archiving: short term that retrieve data (image) in 2 second. and long term that retrieve image in 3 minutes. integrated display workstations (WS) are an important role in the acceptance of PACS, it plays role in the acceptance of PACS. It's the replacement of the manual light box of radiology system (Khaleel, Rahmat et al. 2018).

Many advantages have been noticed from using the PACS, mainly it has been an alternative for film-based imaging. It had an effect in increasing the productivity and efficiency of physicians which in turn reduce reporting time, lowering number of lost images, enhance the communication between radiology department and clinical unite, increase image quality and accessibility, decrease re-imaging and exposure patient to harmful x-rays, and reducing patient waiting time (Abbasi, Jabali et al. 2020).

Recently the PACS are being applied in an increasing manner in all country due to its effect on the managerial, departmental, and clinical level. At the first the adapting of PACS had an effect of reducing the cost results from process of producing films including material cost, storing space, and labor for traditional film (Alhajeri and Shah 2019). secondly, this technology had a role in increasing the productivity of radiology department due to digitally performing tasks though enhancing the satisfaction on the part of physicians and radiology staff and also for the patent, thirdly the clinical level which enhance the diagnosis and interpretation of images (Buabbas, Al-Shamali et al. 2016). On the other hand, PACS also facilitate the accesses to medical image anywhere at any time, reducing the time of retrieving and turn-over time for clinical report. Otherwise, it attached the scans to the patient electronic health record which enhance the long-distance consultations, and improve the scheduling for radiology equipment while enhancing the work flow (Aldosari and making 2012).

In spite of the high potential benefit of the PACS there still a low implementation rate of the system due to some significant changes, such as the cost, the need for adequate capacity to handle with the necessary computer infrastructure, the requirement for changes in healthcare personals, and the shortage in user's accreditation. But the lake of acceptance of the new technology's remains the main obstacles that must be eliminated to adapt these technology's such as PACS (Abdekhoda and Salih 2017). In order to meet a successful implementation for PACS its necessary to adopt strategy that take into consideration all technical, organizational, human, and financial challenge.

The user acceptance of new technology is considered one of the main challenges in the success of their technology. The user acceptance is defined by Esmailzadeh et al. as the willingness to adopt information technology to support task. It is also defined as the willingness of user group to use information technology to support task. Moreover, it's important to take into consideration all users point of view within group, because the resistance of one member within group may delay the adaptation of the technology. Additionally, it's important to motivate users and discover the source of resistance for new systems. The proper IT technology, continuous training, and well-trained radiologist will have an effect on the implementation of PACS (Abdekhoda and Salih 2017).

For many years Technology acceptance model (TAM) has been the most used models in projects in the field of information system community. It's considered as the most commonly used theory to measure individual acceptance for information system. TAM assume that individual acceptance is decided by two variables, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) (Rahimi, Nadri et al. 2018).

In addition to the TAM, Technological, Organizational and Environmental model (TOE) also used for measuring the effect of new technology introduction. The TOE model explains the three element of model that influence the adaptation decision. These three elements are technological, the organizational, and the environmental context. The technological model includes the relevant technology already used and as well the technologies are available in the marketplace but not currently in use. Determining these technology play roles in the set of scope of technological change adoption. On the other hand, the organizational model reflects the effect of resources and characteristics of organizational firm on the adaptation and implementation decision. The firms include the linking structures between employees, communication process, number of slack resources, and firm size. Additionally, the environmental model, which influence the adaptation of innovation. It includes the presence or absence of technology service providers, the regulatory environment, and the structure of the industry (Baker 2012).

1.1.5 PACS main components

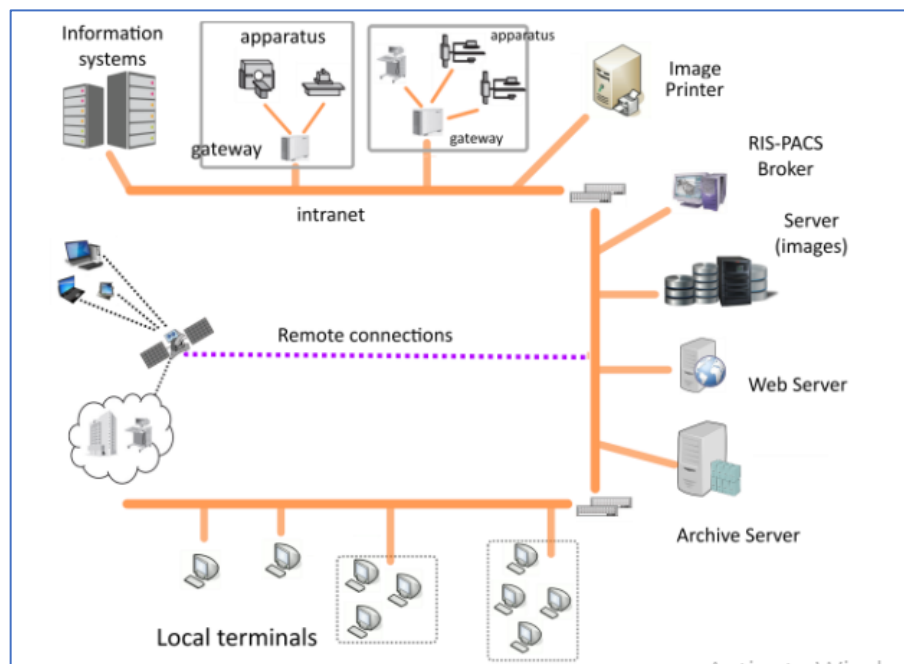
The development of PACS has evolved through several stages. A key feature of all these stages is that the systems were designed to align with nearly identical infrastructure architectures. This trend of maintaining similar infrastructure persists, even with the growing adoption of newer programming technologies and advanced types of medical devices. At present, the infrastructure on which PACS is based has a number of physical components (Fig. 1):

- First side – devices generating digital medical images that are distributed and stored by PACS.
- Second side – all images viewing infrastructure.

A primary characteristic used to evaluate modern PACS is its capability to modify the underlying infrastructure by adding or removing nodes and communication buses.

Figure 1

PACS main component



1.1.5.1 Medical Imaging Equipment

Digital imaging devices encompass a range of technologies, including computerized tomography (CT) scanners, magnetic resonance imaging (MRI) machines, ultrasonography, digital radiography, digital angiography, digital fluoroscopy, and digital mammography. Typically, these devices operate independently, with each component

connected to a shared system via an internal network (intranet). Additionally, there are devices that convert traditional projection radiography, which previously relied on analog screen-film detectors and recorded images on film or plates, into digital formats.

Most commonly, devices within departments connect to a gateway that facilitates access to the internal network, while direct connections to the internal network are less frequent. If a device does not support the PACS storage format, a local server is utilized to convert data into the PACS-compatible format.

In terms of interfaces and direct integration capabilities with PACS, digital devices of this nature should offer the following features:

- Receiving demographic information: Ability to obtain patient data from Regional Information Systems.
- Quality control: Capability to check and adjust images for quality assurance.
- DICOM descriptions: Provision of DICOM (Information Object Definition) parameters for transmitting device specifications, such as cathode tube voltage in X-ray machines (kVp), exposure time, and more.
- Study-specific image processing: Implementation of image processing tailored to specific studies.

1.1.5.2 Image Server

The image server functions as a database management system for images, incorporating additional textual information. It is one of the two primary components of PACS. Modern implementations typically focus on a technical solution that includes a central computer equipped with multiple high-speed processors, extensible HDD storage (potentially structured as RAID), substantial RAM, and multi-layer cache memory.

The software installed on this computer must ensure the monitoring of information, images, and their formats, as well as tracking image attributes, source information, and timestamps for image modifications. In cases where very large volumes of data are anticipated, some PACS implementations utilize a broker as an intermediary layer between two or more databases of this type.

A less common architecture is the decentralized or distributed PACS, where server functionality and image repositories (local databases linked to components of the decentralized or distributed system) are distributed across the network.

1.1.5.3 Archiving System

The archiving system is a crucial component of PACS, responsible for the electronic storage of images and their associated data. Advances in storage devices, coupled with intelligent data search and extraction software, have alleviated the primary challenges associated with expanding this functionality. Hard drives serve as the main storage medium, with their capacity continually increasing; creating repositories of hundreds of terabytes is now more of an economic and infrastructure challenge than a technical one.

Typically, the technical solution involves a quick access archive and a long-term archive, with significantly different access times. This division is primarily an economic strategy, as the rapid access technology required for recently archived images tends to be more costly. To safeguard against data loss from disasters, a duplication of the archive is often implemented for recovery purposes. It's important to note that rapid advancements in storage technologies can lead to a reduction in device prices by half over a five-year span. Consequently, scalability and workload assessments are essential considerations when acquiring a PACS archiving system. Realistic estimates of expected data and image volumes, workload (i.e., transfer rates to and from the repository), annual data growth, and access points to PACS should be made, as these factors can initiate archive access procedures. Additionally, it is vital to determine whether the archiving process will be automated or require manual activation each time.

1.1.5.4 Broker for Communication with RIS and Other Information Systems of Image Generating Departments

A vital component of PACS infrastructure is the communication broker that connects with other information systems. Successful integration with these systems and the ability to present relevant data are crucial for the effective use of PACS. At the workstation level, images can only be utilized if they are linked to patient information. Current technological solutions provide various ways to address these challenges. The relationship between the Radiology Information System (RIS) and PACS is particularly significant. This importance arises from the growing prevalence of RIS-based architectures, which connect with other information systems within hospitals or healthcare facilities. The increase in digital image sources and the volume of images necessitate efficient data transfer, as transferring raw images to a central server and then back to the medical investigation is often inefficient. Most modern RIS are developed, installed, and operated independently

of PACS but can be integrated with it. Manufacturers typically utilize the HL7 standard to facilitate the connection between RIS and PACS.

To minimize redundant data and discrepancies across different server archives, many PACS systems rely on RIS as the primary source of patient information. This dependence requires a stable connection between PACS and RIS, usually facilitated by a “broker” that converts relevant data from HL7 to DICOM or vice versa. Radiology is not the only department producing medical images; other departments such as endoscopy, cardiology, Doppler imaging, pathology, and ultrasound diagnostics also generate significant amounts of data. Many of these devices produce large and complex single images or sets of images, as well as high-resolution videos. Clinicians often integrate information from these images with other clinical data to make informed decisions for patients. This results in substantial data streams and images that must be effectively managed within the PACS.

1.1.5.5 Terminal Workstations

The terminal workstation, which serves as the computer viewer for medical images, is a critical component of the PACS infrastructure. It is arguably the most visible aspect of PACS, as this is where medical staff interact with images managed by the system. Displaying images in PACS is a flexible and dynamic process, allowing medical personnel to engage directly with the images on their workstations. Each workstation comprises two main components: software and hardware. The effectiveness of a workstation is dependent on the specific combination of these two elements. At the hardware level, a significant challenge lies in ensuring that monitors can display images of consistent quality, regardless of the device used. This issue is prevalent in many PACS systems, which often operate with default settings based on the configuration of the installed operating system and the medical imaging visualization module. In practice, specialized and finely-tuned imaging monitors are seldom found in radiology departments. In a PACS environment, workstations serve various purposes, including primary reading, consulting, and reviewing images. To determine the requirements for these devices, it is helpful to categorize them based on their intended use:

- Primary Class Device: Used primarily in radiology departments.
- Secondary Class Device: Utilized in the medical practices of other specialists.

The main specifications for display workstations can generally be grouped into three categories:

1. Ergonomics: Positioning (on a stand or wall-mounted), Angle and height adjustment options, Screen dimensions, Distance from the user, Room lighting conditions.
2. Physical Characteristics: Resolution, Inter-pixel distances along both axes, Refresh rate, Geometric distortion, Anti-reflective coating.
3. Optical Characteristics: Contrast, Maximum illumination, Illumination uniformity, Depth of gray (number of shades of gray), Chromaticity, Number of defective pixels, Angular variation of illumination, Contrast at the pixel level.

These specifications are essential for ensuring that terminal workstations meet the needs of medical professionals in their imaging tasks. It is also important to know if additional workstations have additional functions such as brightness stabilization, image shape recognition, image mapping, autocalibration, remote calibration, ambient light sensor (external or internal), brightness remote control and contrast. A critical aspect of PACS evaluation is the ability to incorporate user functionalities through the use of an API or an internal command scripting language. This capability allows for customization tailored to specific user needs, thus increasing the overall effectiveness of the PACS system.

1.1.5.6 Remote Access to PACS Resources

From the early implementations of PACS, it has been recognized that the economic justification for installing PACS is contingent upon its ability to ensure effective dissemination and utilization of images across the entire hospital or medical organization, rather than being limited to the radiology department or other imaging departments. The distribution of medical imaging throughout the hospital or organization presents unique challenges that are significantly more complex than those faced by traditional PACS designed for radiology wards. Users outside the radiology department may have unpredictable needs regarding:

- Image Requirements: What images they need.
- Viewing Locations: Where they should access these images.
- Timing: When they need to view them.

These users can often be more demanding than radiologists concerning image transmission performance, which creates a substantial technological challenge. Over the past decade, the challenges associated with remote access to PACS have become

significantly more complex due to the rise of remote work. This capability has now become a standard requirement for any serious PACS product. Typically, remote access is facilitated through: Web Servers and Specialized PACS Client Software installed at remote locations.

The primary issue involves accessing medical information outside the medical center via the Internet, which raises several concerns:

- Data Security: Ensuring patient confidentiality (encryption is essential).
- Speed: Limited bandwidth can affect performance.
- Image Quality: Potential degradation due to compression and display issues.
- Legal Implications: Medical-legal consequences related to telemedicine.

These challenges must be effectively managed to ensure the secure and reliable use of PACS resources in a remote access environment.

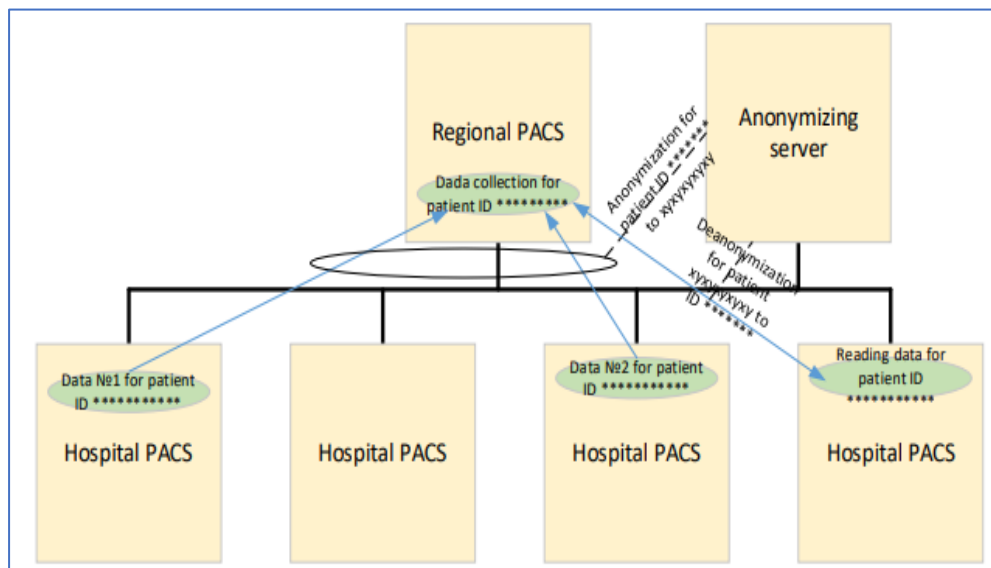
1.1.5.7 Structure of regional PACS and Hospital PACS

The structural development of PACS were designed as:

- Hospital PACS Structure: connect hospital department.
- Regional PACS Structure: connect several hospitals together.

A principal scheme illustrating the connection of regional PACS to hospital systems is presented in Figure 2.

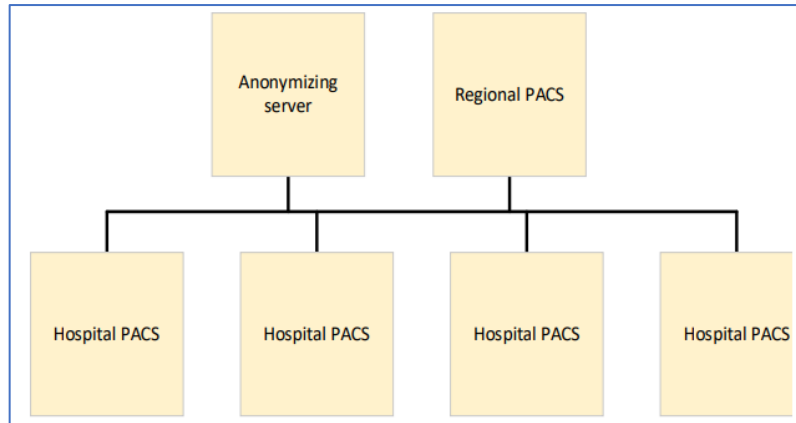
Figure 2
Regional PACS Component



This scheme provides a basic understanding of the overall structure that needs to be maintained. It serves as the foundation for developing a principal scheme for accessing patient data from various hospitals connected to the regional PACS. This scheme is illustrated in Figure 3.

Figure 3

Structure of realization of data records for the same patient from different facilities

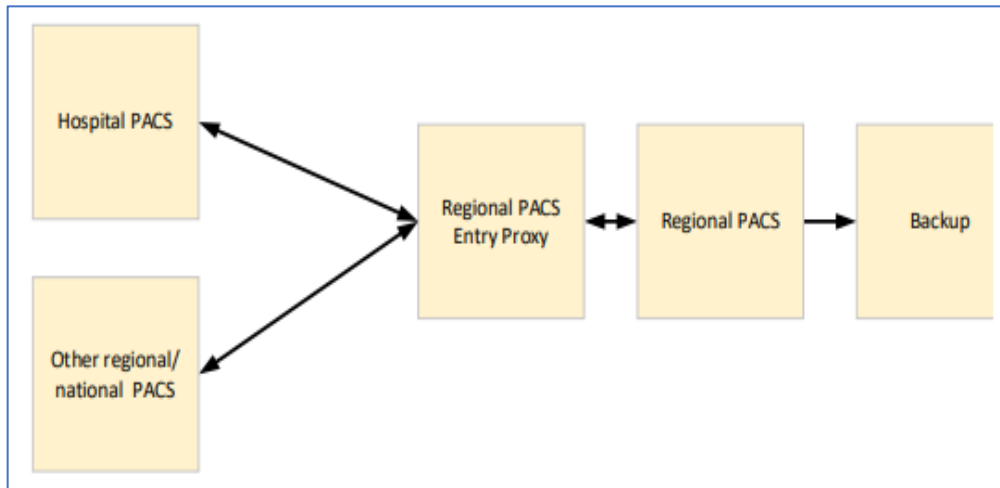


In response to the need for external access to PACS (beyond the hospital infrastructure), hospital staff can access PACS through a DICOM WEB Browser, which is part of the installed PACS system. Access is secured by personal accounts and passwords. Similar to internal access to images, users have read-only access to PACS and work with local copies of the images. The original content cannot be modified (Ivanov, Gueorguiev et al. 2021).

The detailed structure of the regional PACS is illustrated in Figure 4

Figure 4

Structure of Regional PACS



1.1.6 PACS scope in Palestine

The Palestinian ministry of health start working in the 1994 after entering the Palestinian authority as considered the main health provider for the Palestinian The health system in Palestine Lack of infrastructure to support population in need for the health services. A critical lake of infrastructure in the Palestinian hospital due to the restriction on the imports and the medical supply. Despite the difficulties faced by the Palestinian Ministry of Health, it was able to fulfill many of its roles in providing health care as well as promoting its institutions at a high level, including at the software level and the application of highly professional systems such as health information system (HIS) (anear).

In September 2012, the first HIS implementation in the Palestinian medical complex hospital were conducted as AviCenna Hospital Information Management Platform. After the adaptation in this hospital, it was implemented in four other Palestinian governmental hospitals. The target of the system included the education of medical staff in hospitals by the AviCenna HIS engineers. In the model train-the-trainer, the head of each department was responsible for teaching his staff. Unlike other developing countries, Palestine faces more difficulties in adaptation of HIS due to the limits of accessing outside the country for learning new technology (Salameh, Eddy et al. 2019).

1.1.7 Research problem

The purpose of the study is to assess the current situation of PACS and HIS system implementation and factors facilitate of prevent their implementation in Palestinian public hospitals. And to develop an extension of TAM, which includes five structures: demographic (personal), literacy level, technological, organizational, and environmental factors, based on the perceptions of healthcare professionals. No previous study has been found that handles these factors comprehensively in Palestine. The main motivation behind this study is to clearly identify and examine the factors affecting the acceptance of the HIS and PACS in Palestinian public hospitals. In addition to the capacity utilization of the system.

In the study we aim to study the perception of healthcare professionals towards the implementation of PAC in Palestinian public hospitals, we included all Palestinian public

hospital in West Bank (18 hospital). The problem to discuss focus on the effect of implementing PACS on staff at radiology department.

1.1.8 Study aim

In this study we aim to study the perception of healthcare professionals towards the implementation of PAC in Palestinian public hospitals. The problem to discuss focus on the effect of implementing PACS on staff at radiology department. This research provides a great important in the Palestinian public hospital, as it focus on the implementation of PASC in different factors. This study will explain the effect of employee demographics such as age, gender, education degree, computer skill, and work experience on the implementation of PACS Also, the effect on the expected outcome such as department management, number of repeated images, patient registration, time in radiology department, reporting time, the quality of images, the quality of reports and reducing errors. Another factor is the external environment of the organization such as the ease of access to radiology image, the effect on enhancing the communication between different department, and the improve the transition of radiology images. The next factor affected by PACS is patient care delivery such as patient satisfaction, reduce medical error, and reduce time in radiology department. Additionally, this research results will enhance the dealing with PACS and affect the future implementation of different projects in the Palestinian public hospitals. On the other hand, it will explain the challenges in implementation PACS in order to reduce these challenges in future event.

1.1.9 Study objectives

This descriptive study will be carried out to assess the perception of radiographers toward the use of PACS in west bank, Palestine.

1. To assess the impact of PACS on its users.
2. To determine the relationship between PACS implementation and users' demographics.
3. To measure the effect of PACS implementation on the external environment.
4. To assess the relationship between PACS implementation and the quality of service.
5. To determine the relationship between PACS implementation and the expected outcome.
6. To measure the acceptance of PACS from its users.

1.1.10 Study Questions

The study tries to answer the following main questions:

- What are the factors affecting the adoption of Picture archiving and communication system (PACS) in Palestinian public hospitals?
- Are there significant statistical differences at the level of ($\alpha \leq 0.5$) in the study sample perspectives towards factors affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals due to the variables of gender, qualification, age, English language level, years of experience and knowledge about electronic health?

1.1.10.1 Literature Review

In this literature review these key words were used PASC, Radiology, health information system and users. Search were done between (2015-2022), using searching engines PubMed and google schooler. In this proposal 12 article were analyzed. The studies focused on the benefits and challenges in the process of implementing PACS.

1.2 International studie

article published by (Song, Mango et al. 2017) on the implementation of PACS in the period between 2012-2014 (Successful Implementation of a PACS in Tanzania). The PACS implementation started from the Muhimbili Orthopaedic Institute (MOI). The implementation experiment had four phases: planning, installation, expansion, and maintenance phases. The planning phase lasted for 2 years in order to reach the needs and requirements of PACS and radiology department to address a budget. This included assessing the inventory of infrastructure and the workflow in the radiology department. The installation phase duration was 3 months long to proof the compatibility between the workflow and proposed PACS. Open-resource PACS software were selected for structure the test server and workstation. The expansion phase was 6 months long to expand the storage capacity, server memory, and PACS workstation.

Maintenance phase lasted for one year after the first installation. It included the maintenance and expanding the PACS. There was a successful implementation of PACS o lower the cost and improve access to x-ray images as a result there was a financial saving. The result explains that benefit of PACS exceeded the disadvantage and the ability to zoom, retrieve, pan, save, and compare images on PACS workstations has improved

the radiology resident learning experience. There was a successful implementation of PACS and the effort of lowering the cost and improving the access for x-ray images (Song, Mango et al. 2017).

A study conducted in South Africa country in 2019 (PACS implementation challenges in a public healthcare institution: a South African vendor perspective). the aim of the study identifies and describe the challenges endured by PACS vendors during PACS implementation. A qualitative research approach used in this study using an interpretive. this enabled an information rich narration of a population of PACS vendor employees to collect data from their live experiences and to report on their meanings and understandings. The data collected using methodology approach qualitative in nature throw semi structured interview for 10 PACS expert and then analyzed. The study found countless challenges related to the vendor the lake of space to position the PACS workstations was the major. Also, the related peripheral devices were a challenge due to the lake of proper furniture. Another concern was about the minor system changes such as uncomfortable ergonomic positioning of equipment.

Moreover, respondents note about the x-ray darkroom was being converted to unsafe server room which will affect the equipment. In South Africa they have faced the lake of working room such as offices and general space. The power and electricity also were a general problem, in South Africa there was a lack of the needed power and electricity that affects all sectors, including business and healthcare. This clearly pose a challenge to provide the stable power for the system. Another barrier was related to the financial support, funds are available, but the concerns was about the space modification, maintenance of the system and replacement for theft of equipment, and budgets for future upgrades. A widespread deficiency in IT knowledge has been identified as a significant obstacle to the implementation of PACS systems, as effective training for PACS software depends on a foundational understanding of IT. This issue has also been documented within the healthcare sector. Another obstacle related to the absence of specialized training, insufficient manpower for large projects, and delays in professional support from international manufacturers are key issues.

These factors can result in implementation delays and dissatisfied customers, which in turn contribute to resistance against the implementation of PACS. PACS vendors anticipate these challenges when facing a public healthcare institution, and it is recommended that the hospital management and potential PACS stakeholders be made

aware of these challenges to mitigate their effects and Vol. 25 • No. 4 • October 2019
www.e-hir.org 331 PACS Implementation Challenges to aid in a successful
implementation (Abbas and Singh 2019).

Recently a study was made in Bulgaria in 2021 (Design and implementation of a regional PACS), the study shows that offered on market of PACS had increased more than 10 times in the period between 2005-2020 due to offering varies capabilities and function. according to this study, many advantages cased this rapid increase for example, Enhanced usage scenarios and simplified operations Improved capacity for input-output requests related to image handling, leading to faster electronic archiving, reduced response times for processing requests, an increased variety of image manipulation options available within the system, enhanced performance in image processing, remote and simultaneous access to image data, better computer archiving through new algorithms for indexing and searching by various features, capability to handle images from both digital and analog radiological machines, cost reductions and extended operational time due to a modular development approach, which lowers the expenses associated with upgrading medical imaging equipment in radiology departments, improved cost-effectiveness resulting from decreased expenses for computers and communication infrastructure, as more operating systems and general-purpose protocols are being utilized. PACS systems are susceptible to technical issues and operational drawbacks. Problems can occur due to improper or incomplete installation or configuration, especially when they exceed the initially intended resources and tasks, or when new image-generating devices are added or images are displayed. Specific challenges for hospital and interhospital networks include compliance with DICOM protocol requirements.

Many communication devices do not support all the protocols mandated by DICOM. The security of local and regional PACS relies on several fundamental requirements: Complete protection of the main database, Prohibition of any HTTP exchanges with the main PACS, Anonymization/ deanonymization, Transport of anonymized data, Identification of DICOM viewers, Exported DICOM viewers, HTTP exchanges. Moreover, the system improves the use and operation of data, increase the input and output capacity required for work, reducing processing time, increase number of processed images, improve image processing, referment the remote access to images data, improve searching and indexing data by using new algorithms technology, increasing operation time and reducing the cost, and reducing the cost of infrastructure in order to

increase cost-effectiveness. Within the activities carried out by the National Scientific Program “e-Health in Bulgaria”, PACS was selected and an installation of local hospital PACS and regional PACS was made (Ivanov, Gueorguiev et al. 2021).

1.2.1 Study at Regional level

In 2017 in Saudi Arabia at King Saud bin Abdul-Aziz University for Health Sciences research in systematic review (Evaluating latest developments in PACS and their impact on radiology practices: A systematic literature review) (Alhajeri, et al.,2017). A systematic review to analyze the empirical literature examining various features of PACS and evaluate the impact of recent developments in PACS. 17 articles from different regions of the world were included in the review. This review aimed to conduct a systematic review to assess the evidence surrounding the technical characteristics of the most effective PACS and to evaluate the impact of recent developments in PACS on radiology practices from 2004 to 2015. During this decade, information technology has advanced rapidly, providing an opportunity to explore the latest developments and trends in PACS. A wide range of studies addressing various aspects of PACS exists. However, a comprehensive systematic review that identifies the shortcomings of current PACS used by radiologists globally, examines the new features needed to meet future user requirements, and enhances functionality, accessibility, and maturity has not been found. Additionally, existing studies have not explored how the latest developments in PACS will impact radiology practice and its users. Despite the increasing global use of PACS, a database search for papers published in the last decade yielded only 17 relevant studies, with US research groups contributing eight and European researchers four. This scarcity limits the ability to draw definitive conclusions about PACS's impact across different healthcare scenarios. Furthermore, most studies have focused on only a few PACS-related aspects, which restricts a comprehensive understanding of PACS's effects within specific organizations. Although various PACS platforms are commercially available, only one study was identified that examined different PACS platforms in detail. This review summarized the successful themes for PACS implementation: best characteristics of selected PACS, PACS influence on radiologist and radiograph workplace, user acceptance of PACS, and satisfaction of users (Alhajeri, et al.,2017).

Another study in Saudi Arabia at Riyadh region in King Abdulaziz Medical City in 2018 (Impact of picture archiving and communication system (PACS) on radiology staff)

(Aldosari, Saddik et al. 2018). This study aimed to discuss the effect of implementing PACS on the radiology staff and its advantages in improving the quality of health system. And the relationship between user's characteristic and the acceptance of the system in hospitals facilities in Saudi Arabia. This quantitative study employs an exploratory descriptive approach as its overarching framework and relies on distributed questionnaires to collect the necessary data.

The study focuses on five variables that describe the impact of the health information system: External Communication, Service Outcomes, Personal Intentions, Personal Hassles and Increased Blame. Investigating radiologists' responses to these variables will enhance our understanding of the impact of PACS on their work. Additionally, by analyzing the relationship between user characteristics and the study's impact variables, it identified which user characteristics correlate most significantly with these variables. Given that the study examines the impact of PACS on radiologists, this design is particularly suitable for gathering information and establishing a foundation to comprehend the limitations and scope of the research questions. The systematic literature review highlights several themes essential for the successful implementation of PACS: Features for Selecting the Best PACS, User Acceptance of PACS, Teleradiology and PACS, Impact of PACS on the Work Environment of Radiologists and Radiographers, User Satisfaction with the Virtual Organization of the Medical Imaging Department, PACS Success Model, Image Viewing Platforms, and PACS Maturity Framework. Despite numerous advancements in PACS that have aided clinicians in enhancing radiology practices, several areas of concern for PACS users still require attention.

These issues must be addressed in the development of more sophisticated and integrated technologies for the next generation of PACS. The study showed that there is a positive effect of PACS on its users and there were well perceiving for PACS benefits among the physicians and radiologists. Also, there were a disadvantage in PACS as insufficient training, difficulty in finding images, and recruitment downtime (Aldosari, Saddik et al. 2018).

In Saudi Arabia a study was conducted to assess the clinician's perception of PACS in 2021 (Clinicians' Perceptions of Picture Archiving and Communication System (PACS) Use in Patient Care in Eastern Province Hospitals in Saudi Arabia) (Al-Kahtani, Al-Dhaif et al. 2021). The primary aims of this study were to investigate clinicians' perceptions of

PACS, examine how they utilize the system, assess the advantages and disadvantages of its use, and gather their suggestions for improving its implementation. Additionally, the study sought to identify the factors that influence clinicians' perceptions and use of PACS to provide insights into ways to enhance its utilization.

The following research questions were addressed: Do hospital clinicians use PACS in their practice? What are the perceived advantages of PACS use? What are the perceived disadvantages of and/or barriers to PACS use? What are clinicians' recommendations for improving PACS use? This study utilized a qualitative research approach grounded in theory to explore the use of PACS from a clinician's perspective in three hospitals located in the Eastern Province of Saudi Arabia. Qualitative research aims to "discover the world from the participants' perspective." Data were collected through semi-structured interviews and analyzed using grounded theory methods. A grounded theory study is an inductive approach that develops abstractions, concepts, hypotheses, and theories based on participants' words. The data gathered from the interviews were used to formulate a theory regarding the phenomenon of PACS use in patient care within hospitals.

The sample consisted of 18 participants contained radiologist, resident and consultants. the result of the study shows the Clinicians' acceptance of PACS is crucial for the successful implementation of the system, and this acceptance is influenced by their perceived advantages and disadvantages of the system and its usage. The theoretical model developed in this study identifies three key factors that shape clinicians' perceptions: Demographic Factors, System-Related Factors and Hospital-Related Factors. These factors can help pinpoint areas for improvement to ensure effective PACS implementation in hospital settings. It also reviled the barriers included low-speed internet connections and technical problems (Al-Kahtani, Al-Dhaif et al. 2021).

A study conducted in Iran in 2017 titled (Acceptability of picture archiving and communication system (PACS) among hospital healthcare personnel based on a unified theory of acceptance and use of technology) to investigate the influence of PACS on its users. Various theories address the use and acceptance of technology, aiming to describe the behaviors and attitudes of end users toward information technologies. This study explored the factors influencing users' acceptance of PACS in military hospitals in Tehran. This study applied analytical and cross-sectional study conducted in 2016, involving a population of 151 healthcare personnel who utilized PACS in five military

hospitals in Tehran. They employed the Unified Theory of Acceptance and Use of Technology to identify the factors influencing users' acceptance of PACS. Data were collected using a researcher-designed questionnaire. To ensure the questionnaire was suitable for this research, we reviewed articles related to the Unified Theory of Acceptance and Use of Technology model. The study considered the following variables: Performance Expectancy, Effort Expectancy, Social Impact, Facilitating Conditions, and Behavioral Intention. The questionnaire was divided into two parts. The first part gathered demographic information, including age, sex, education, work experience, and the names of the organization and hospital (seven items).

The second part consisted of six sub-sections: performance expectancy, effort expectancy, social influence, facilitating conditions, behavioral intention, and actual use. In total, 27 items were adapted from Davis's questionnaire and other resources related to the integrated model of acceptance and use of information technologies. Responses were rated on a 5-point Likert scale (from completely disagree to completely agree). Before distributing the questionnaire to participants, its validity was confirmed by a panel of experts, and its reliability was assessed through a pilot study involving 30 hospital healthcare personnel, yielding a Cronbach's alpha of ($\alpha = 0.91$). The data were analyzed using both descriptive and inferential statistics. Results had showed efforts expectancy, social impact, expected performance and facilitating conditions affect directly on the behavior's intention toward the acceptance of PACS.

The behavioral intention among hospital healthcare employees has a significant association with social influence, effort expectancy, Performance expectancy, and facilitating condition. Each of the studied variables is influential in the decision to use PACS and should be considered by medical centers' authorities to successfully implement PACS. Training healthcare personnel in the use of PACS appears to be essential. Additionally, it is recommended that future studies explore the acceptance of healthcare technology systems, such as PACS, using structural equation models and technology acceptance models (Ahmadi, Mehrabi et al. 2017).

Another study published in Iran in 2019 titled (Effect of implementation of picture archiving and communication system on radiologist reporting time and utilization of radiology services: a case study in Iran.) In this study the aim was to study the effect of PACS on radiology reporting time and service utilization. A cross-sectional approach was

conducted in 2018 in Nohome Dey Hospital in Torbat Heidaryeh city, Khorasan, Iran. Which is a general hospital, governmental and non-teaching. It consisted from 190 beds. the study used data collected from a (5074) patients with (6613) exam was collected in three period of 6 months. These periods included before implementation, immediately after implementation, and 1 year after implementation. To avoid possible seasonal impact the data collected from similar months in the three period. the data were collected from the early July 2015 to the end of December 2015 (6 months period before the system implementation), the early July 2016 to the end of December 2016 as the period of immediately after PACS (the first 6 months after system implementation) and early July 2017 to the end of `December 2017 as the period of 1 year after PACS implementation. The data collected from CT examination and radiographers.

The reporting time were calculated throw estimating the time between patient order and physicians report and the utilization rate was calculated throw these variables: the average number of examinations per patients with an examination, the average number of examinations per all admitted, and the average number of examinations per patient day, respectively. This study showed a significance decrease in reporting time after 1 year of implementation. Besides, increasing in utilization rate in the long and short-term in radiography and CT scan in radiology department. which suggest that radiology department use the system to increase utilization of radiology services and to improve the reporting time of radiologists (Hasani, Hosseini et al. 2020).

In Kerman city in Iran in 2020 titled (Investigating the satisfaction level of physicians in regards to implementing medical Picture Archiving and Communication System (PACS)). The study conducted to measure the physician satisfaction of PACS and compare the features of traditional film-based system. as it's important criteria in the acceptance of the model in hospitals of Kerman city in Iran. In this study the author's see user satisfaction is a critical factor influencing the successful implementation of information systems. When users feel satisfied with a system, they are more likely to engage with it effectively, leading to improved overall performance. Conversely, user resistance to these systems can create significant inefficiencies, which can hinder organizational productivity and effectiveness.

This resistance may stem from various factors, including usability issues, lack of training, or inadequate support. Over time, persistent dissatisfaction can lead to system withdrawal, where users abandon the system altogether in favor of alternative solutions. given that

user satisfaction with an information system directly correlates with employees' productivity and their likelihood of continued use, it becomes essential for organizations to prioritize understanding and addressing the factors that contribute to users' dissatisfaction. Identifying these issues not only helps to enhance user experience but also fosters a more productive work environment.

Therefore, organizations should actively seek feedback from users and implement strategies to resolve any concerns, ensuring that the information systems in place effectively meet the needs of their users. A cross-sectional approach was applied on 59 resident seniors using a questioner consisted of three parts. The first part measures the demographics information such as: gender, age, computer skill, PACS experience, specialty, and the number of images interrupted by physicians using PACS. second part measure the satisfaction of the system using 14 question of 7-choice on Likert scale (from "completely disagree" to "completely agree").

The third part questions compared features between digital and traditional film-based using 8 questions of 5-choices on Likert scale (from score1 to 5). This study showed that The Physicians satisfaction was at moderate level, problems were found in the implementation of PACS. It hasn't met all the demands in radiology department. most of physicians and radiologist are satisfied with using PACS. Although the users with high computer skills are more satisfied than low computer skills, those see PACS as a time-wasting system.

The study results indicated that, although physicians' satisfaction with PACS was rated as moderate to high, challenges remain in successfully implementing the system and achieving interoperability across different treatment centers. PACS have not fully met physicians' needs, and some healthcare facilities have not realized their intended objectives, such as access from various locations. To address these issues, the study recommends increasing the number of workstations for PACS and utilizing personal digital assistants (PDAs) to reduce the time spent accessing the system at patients' bedsides. User-specific training is also crucial for effective implementation. Additionally, adding a printing feature could facilitate sharing images with external centers, enhancing collaboration and patient care (Abbas and Singh 2019).

Another study conducted in Iran in 2022 (Determining the Effect of the Picture Archiving and Communication System (PACS) on Different Dimensions of User). the study aims

to discover and enhance the effect of PACS on users work at Kerman University of Medical Sciences. The impact of (PACS) on various aspects of healthcare, including costs, information access, image quality, and user workflow, has been the subject of extensive research. These studies have provided valuable insights into how PACS can enhance efficiency and effectiveness in medical imaging and patient care. However, despite this wealth of information, there remains a notable lack of evidence regarding the effects of PACS on different dimensions of users' work experiences.

Recognizing this gap, the objective of the present study was to thoroughly evaluate the impact of PACS on several critical dimensions of users' work. Specifically, the study focused on external communication, service quality, user intention to utilize PACS, the influence on daily routines, and the nature of complaints reported by users. By examining these factors, the study aimed to provide a comprehensive understanding of how PACS affects the daily operations of healthcare professionals. Furthermore, the research sought to compare the opinions and experiences of various user groups regarding the PACS. This comparison is essential, as different users—such as radiologists, technicians, and administrative staff—may interact with the system in distinct ways and have varying perceptions of its effectiveness.

By gathering and analyzing feedback from these diverse groups, the study aims to highlight potential areas for improvement and inform future implementations of PACS in healthcare settings. A cross sectional approaches a questionnaire was used for collecting data from 72 of radiology staff include, radiologists, radiology staff, ward heads, and physicians. This study showed that the PACS has a positive effect on users' work, especially on user intention to use the system, external communication, and service quality. It also measured the negative impact of PACS such as complaints and pressure on the radiology department. The author recommended that medical centers implement PACS to effectively support users' work. This implementation is crucial for maintaining and enhancing the capabilities and functions of radiology departments, ensuring they can deliver high-quality imaging services efficiently (Montazeri, Khajouei et al. 2022).

A study in Kuwait in 2016 (Users' Perspectives on a Picture Archiving and Communication System (PACS): An In-Depth Study in a Teaching Hospital in Kuwait). This study aims to thoroughly explore the various factors that contribute to the success or failure PACS in determining their clinical value. By focusing specifically on the experiences and perspectives of the direct users of this system—such as radiologists,

technicians, and administrative staff—the research seeks to provide a comprehensive understanding of how PACS impacts daily operations in a healthcare setting. The conceptual basis of this study is centered on assessing the impact of PACS within a regional hospital in Kuwait. The evaluation is conducted using specific criteria designed to measure various dimensions of the system's effectiveness, including user satisfaction, workflow efficiency, and the quality of patient care. This approach allows for a nuanced analysis of how PACS functions in a real-world environment and its implications for clinical practice. Importantly, this study is groundbreaking in the context of Kuwait, as it represents the first research of its kind in the region.

There is a notable scarcity of literature addressing the implementation and impact of PACS in Kuwaiti healthcare facilities, making this study a significant contribution to the field. By filling this gap, the research not only enhances the understanding of PACS in a local context but also provides valuable insights that can inform future implementations and improvements of such systems in Kuwait and similar healthcare environments. An in-depth study Data collected from 60 radiologist and technologist, both quantitative and qualitative methods through a mixed-methods approach, comprising: Survey Questionnaires: Distributed to radiologists and technologists at Mubarak Al-Kabeer Hospital to gather information on PACS usage and Semi-Structured Interviews: Conducted with PACS administrators for insights into the system's implementation. A validated questionnaire, translated from French to English, was pretested for clarity and relevance, simplifying a 7-point Likert scale to 5 points.

The evaluation of PACS success was based on a model derived from DeLone and McLean, enhanced with constructs for system continuance intention and confirmation oexpectations. The questionnaire assessed users' perspectives across eight dimensions, including system quality, information quality, service quality, usage, satisfaction, net benefits, continuance intention, and confirmed expectations. Additionally, interviews with PACS administrators provided valuable insights into the clinical environment, focusing on the experiences of technologists managing PACS and RIS operations, thereby enriching the study's findings. The study finds that almost three quarter of the participants rate PACS positively productive impact of PACS on the performance of radiologist and technologist (Buabbas, Al-Shamali et al. 2016).

A study in Egypt 2021 (Implementations of PACS and Teleradiology Systems in Sohag University Hospital). This study aimed to evaluate, enhance current use and acquire

experience of implementation of PACS and teleradiology in the period (2015-2017) in Suhag, Egypt. Descriptive analytical model was applied. the data collected and analyzed from 57453 patients in period between 2015-2017. The result showed the impact of implementation of PACS such as, rapid access to images, reduction of images loss, reduction on cost, increase productivity, and improve patient care (Abodahab, Alhewaig et al. 2021).

Table 1

The list of previous studies

Country	Study	Author, year	Collection tool	Population
International studies				
Tanzania	Successful Implementation of a PACS in Tanzania	Song, Mango et al. 2017	Cross sectional survey	Radiology department at Muhimbili Orthopaedic Institute in Tanzania
South Africa	Pacs implementation challenges in a public healthcare institution: a South African vendor perspective	Abbas & Singh, 2019	semi structured interview	10 PACS expert
Bulgaria	Design and implementation of a regional PACS	Georgieva,& Ivanov, 2021	Self-data collection	
Regional studies				
	Evaluating latest developments in PACS and their impact on radiology practices: A systematic literature review	Alhajeri, et al.,2017	Systematic review of previous studies	
Saudi Arabia	Impact of picture archiving and communication system (PACS) on radiology staff	Aldosari et al., 2018	Questionnaire	200 radiology department users.
	Clinicians' Perceptions of Picture Archiving and Communication System (PACS) Use in Patient Care in Eastern Province Hospitals in Saudi Arabia	Kahtani, Al-Dhaif et al. 2021	semi-structured interviews	18 residents, radiologists, and consultants.
	Acceptability of picture archiving and communication system (PACS) among hospital healthcare personnel based on a unified theory of acceptance and use of technology	Ahmadi, et al.,2017	Questionnaire	151 healthcare employees
Iran	Effect of implementation of picture archiving and communication system on radiologist reporting time and utilization of radiology services: a case study in Iran	Hasani, Hosseini, & Sheikhtaheri, 2020	Patient data collection	5074 patients
	Investigating the satisfaction level of physicians in regards to implementing medical Picture Archiving and Communication System (PACS)	Abbas & Singh, 2019	Questionnaire	59 residents
	Determining the Effect of the Picture Archiving and Communication System (PACS) on Different Dimensions of User	Montazeri, Khajouei, & Practice, 2022	Questionnaire	72 of radiology staff
Kuwait	Users' Perspectives on a Picture Archiving and Communication System (PACS)	Buabbas et al., 2016	Questionnaire	60 radiologist and technologist
Egypt	(Implementations of PACS and Teleradiology Systems in Sohag University Hospital	(Abodahab, Alhewaig, Alserafi, & Fawzy, 2021	Patient data collection	57453 patients

Chapter Two

Method

2.1 Study design

According to the study problem and its objectives, and through the questions that this study seeks to answer, the cross-sectional descriptive study has been relied upon, which provides data for describing the status of phenomena or relationships among phenomena-related variables at a fixed point in time.

2.2 Study population

This study will include all radiology staff, using PACS working in governmental hospitals in the population refers to all the elements of the study, or elements being investigated, the research population included all hospital in west bank who were (170) at the time of the study.

2.3 Study sample

Since the study population is relatively small and very stratified, this research study utilized a comprehensive sampling approach by inviting all the (170) employees of hospitals to participate in the survey. Employees-related information was provided by the Palestinian medical imaging associations. The questionnaire (Appendix B) was distributed to the study sample through on the site of the Palestinian medical imaging associations.

- Inclusion criteria: all radiographers working in the Palestinian governmental hospitals registered in the Palestinian Association of Medical Radiation Technologists.
- Exclusion criteria: radiographers working in clinicals and private center.

The sample consisted of 151 PACS users in Palestinian hospitals. The sample is a stratified random sample. The background of the study sample is varied in terms of gender, qualification, age, English level and years of experience.

2.4 Study instrument

Data resources in this study can be divided into primary (direct) and secondary (Indirect) resources.

- Primary data: Questionnaire were the main instruments of this study; the questionnaire was designed keeping in view the study's objective. It was kept as concise as possible as a short questionnaire with conceptually clear and concise statements desired by both respondents and the researcher.

A questionnaire was prepared by reviewing several studies that dealt with the same topic as our current study. Questioner structured, close-ended, and design in Arabic language to ensure completely understand of the questionnaire because we have old radiographers. comprising (35) questions. A 5-point Likert-type scale was used to assume that the strength/intensity of the experience is linear, i.e., on a continuum from strongly disagree to agree strongly. To achieve the objectives of the study, we used a 35-item of factors affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals by using previous literature and the researcher's own experience in the field of studying public health management At Al Najah National University. Respondents were offered a choice of one to five, were responses to the neutral point being neither agree nor disagree; whereby one refers to strongly disagree, two refers to disagree, three refers to neutral, four refers to agree, and finally, five refers to strongly agree. The questionnaire consisted of five main sections (appendix B).

- Section 1. It covers socio-demographic related to gender and type of practice, it consists of (9) questions (i.e., age, gender, region of work, computer skills and level of education.)
- Section 2. It covers the effect of PACS on the external communication it consists of (4) questions (i.e., the ease access to images, the communication between different department, and the benefit between the clinical and radiology department).
- Section 3. This section will cover the expected outcome from using the PACS, it consists of (10) questions (i.e., repeated images, reporting time, reducing the cost and improving overall quality)
- Section 4. It will discuss the challenges in using the PACS, it consists of (6) questions (i.e., technical challenges and poor computer skills.).

– Section 5. it will discuss the user’s satisfaction in using PACS, it consists of (6) questions

The scores of responses to each item were calculated according to a five-point Likert scale for the first three domains’ responses in which strongly agree =5 points, agree =4 points, neutral = 3, disagree = 2 points and strongly disagree = 1 point.

2.5 Study validation

The questionnaire was developed based on previous study in the field of PACS, the data was collected and reviewed by (5) researchers in health management and medical imaging. The response was viewed from (3) researchers Appendix (A) The respondents’ comments and the jury’s suggestions were taken into consideration to modify and improve the questionnaire’s content and wordings by omitting, adding or rephrasing items bringing the number of items remained 35 items. it was modified and addition as possible.

2.6 Reliability of the Questionnaire

The reliability of the questionnaire was calculated through Cronbach Alpha formula and the following table illustrates the results:

Table 2
Cronbach Alpha test for the study tools

Study Tool/ Domains	Items	Cornbach Alpha
External environment	4	0.966
Expected outcomes	10	0.969
Expected challenges	6	0.961
Satisfactions	6	0.944
Total	26	0.985

Results in table (3) illustrate that Cronbach Alpha coefficient for the total degree was (0.985) which is Excellent and acceptable for the purpose of the study. The Cronbach Alpha coefficient of the domains ranged between (0.961) for Expected challenges and (0.969) for Expected outcomes among PACS users in Palestinian hospitals. In order to evaluate the results of Cronbach Alpha, the following scale is used as demonstrated in the following table:

Table 3

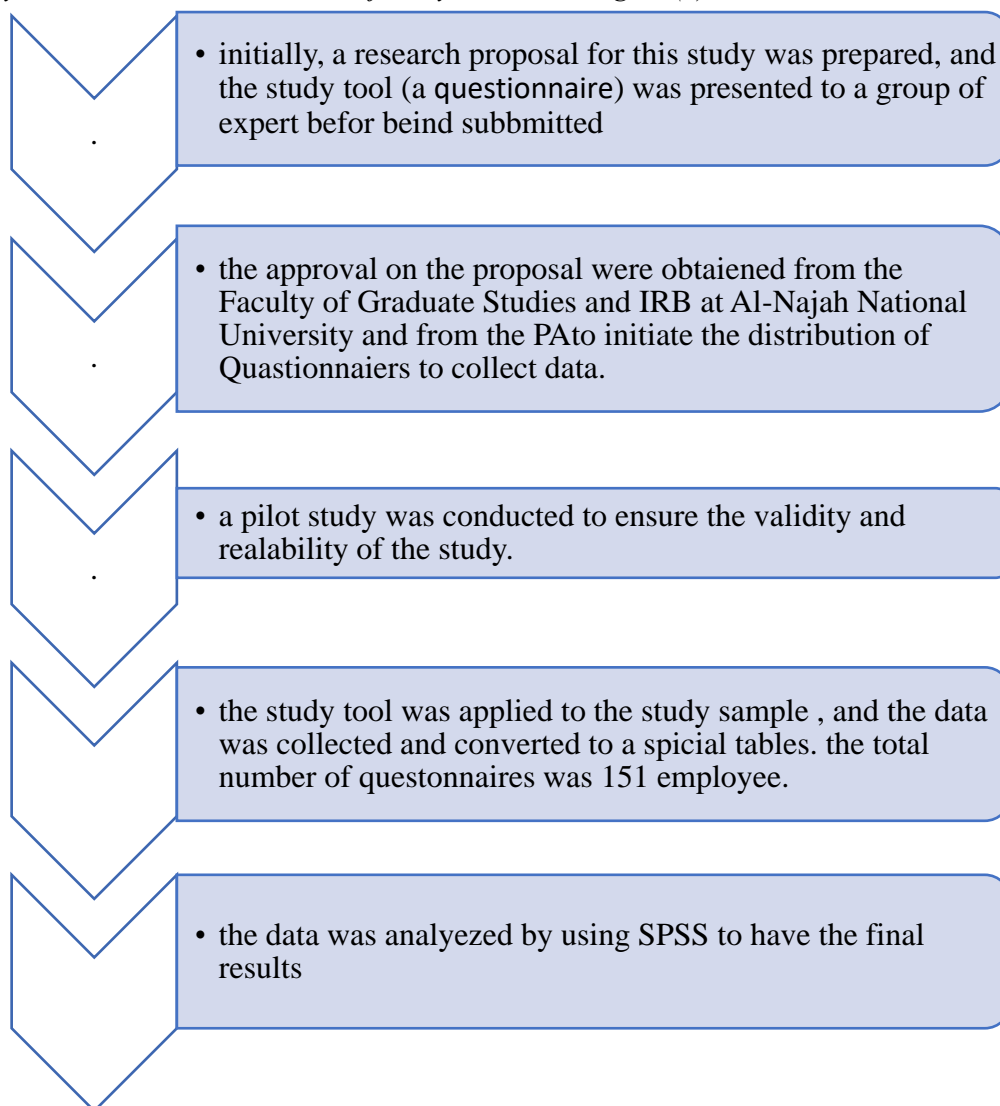
Cronbach alpha Internal Consistency

Cronbach alpha	Internal Consistency
$\alpha \geq 0.9$	Excellent
$0.7 \leq \alpha < 0.9$	Good
$0.6 \leq \alpha < 0.7$	Acceptable

2.7 Study procedures

Figure 1

Study Procedure: The Procedures of Study Showed in Figure (1)



2.8 Statistical Procedures

The data collected were analyzed using SPSS version 17.0 in order to provide answers the questions of the study, the researcher used the following: Means, frequencies, standard deviations, percentages-tests for Independent Samples, One-Way Analysis of Variance (ANOVA), Cronbach Alpha is used, and Post hoc test.

2.9 Study analysis

Accordingly, the researcher used the following scale to represent the estimation level of sample responses. In order to limit the length of the cells of the five-point Likert scale (minimum and maximum limits, range has been calculated $(5-1=4)$, divided on the correct length of the cell $(4/5=0.80)$ and added to the lowest value of the scale (1) in order to reach the highest limit of this cell. Cell limits became as in Table (4):

Table 4

Scale for representing the estimation level of sample responses

Mean	Percentage %	Estimation Level
4.20 and more	84.0 % and more	Very High
3.40-4.19	68.0 – 83.8 %	High
2.60-3.39	52.0 – 67.8 %	Moderate
1.80- 2.59	36.0 – 51.8 %	Low
Less than 1.8	35.9% and less	Very Low

2.10 Ethical approval

The Institutional Review Board (IRB) at An-Najah National University and the scientific research committee of the Public Health Management Department (Appendix c) approved the study proposal. An explanatory letter was attached to each questionnaire for all participants to explain the aim, importance, and privacy, with optional participation (Appendix D). In addition, a permission taken from the Palestinian Association of Medical Radiation Technologists to publish this questioner on their website.

Chapter Three

Result

This study aimed at identifying factors affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals. It also aimed at identifying the effect of several variables on the responses. To accomplish the aims of the study, the researcher analyzed the data of the questionnaire in the accordance with the study questions and hypotheses. The sample consisted of (151) respondent constants collected with a response rate of (88%) from PACS users in Palestinian hospitals. The sample is a stratified random sample.

3.1 Sample Demographics

The demographic distribution of the study sample is varied in terms of gender, qualification, age, English language level, years of experience, area of occupation, computer skills, knowledge in electronic health record and PACS training in department. In this study (77.5%) of the study sample was male, (67.5%) having B.A degree, the highest age group with 49.9% was (31-40) years old, (41.7%) had a faire English language level, (6-11) years of experience was (47%) of sample, (47.0%) of the study sample working in general radiology and Computed Tomography. (CT), (51.0%) of the study sample has adequate computer skills, (81.0%) has excellent knowledge about electronic and health record system and PACS have not provided 82.8% training as showed in table (5).

Table 5
Distribution of Sample responses on users' demographics

Variable	Class	Frequency	Percentage %
Gender	Male	117	77.5
	Female	34	22.5
Qualification	Bachelor degree	102	67.5
	Master degree	44	29.2
	Ph.D. or more	5	3.3
Age	From (22-30) Years Old	57	37.7
	From (31-40) Years Old	75	49.7
	From (41-50) Years Old	17	11.3
	Older than 51 years	2	1.3
English level	Poor	20	13.3
	Fair	63	41.7
	Good	52	34.4
	Excellent	16	10.6
Years of experience	≤ (5) Years	53	35.1
	From (6-11) Years Old	71	47.0
	From (12-19) Years Old	25	16.6
	≥ (20) Years	2	1.3
What is the area in radiology department that describe your current position	General radiography	39	25.8
	Computed Tomography. (CT)	21	13.9
	Magnetic Resonance image (MRI)	15	9.9
	Nuclear Medicine	2	1.3
	Others	3	2.0
	General radiography and Computed Tomography. (CT)	71	47.0
Computer skills	Poor	57	37.7
	Adequate	78	51.7
	Excellent	16	10.6
Knowledge about electronic health record system	very little	17	11.3
	A little	5	3.3
	Good	6	4.0
	Excellent	123	81.5
Which of the following describe the PACS training that was provided to you	I was trained with a group	3	2.0
	I was trained individually	8	5.3
	I was trained using web-based tutorial training	15	9.9
	I have not been trained	125	82.8
Total		151	100.0

3.2 Perception of users toward impact of PACS

Based on the questionnaire used in this study, the factor divided into four variables. The responses to the impact of the four variables of the questionnaire are described explicitly in table (6-9)

Table (6) shows that the total degree for of the items of factors affecting the adoption of PACS in External environment domain, according to users was (4.17) which suggests high level of estimation. The highest mean was given to the item (PACS affects the ease of access to radiology images and data). The lowest was for the item (Communication with other clinical departments has enhanced since PACS was installed).

Table 6

The response rate of the External environment impact variables in Palestinian hospitals in descending order

Rank	No. in the Questionnaire	Domain	Means	standard deviations	Percentage %	Estimated level
1	1	PACS affects the ease of access to radiology images and data	4.21	0.86	84.2	Very High
2	2	PACS enables easy access and sharing of radiology data and images with other clinical departments.	4.19	0.91	83.8	High
3	4	PACS facilitates patients file sharing between hospitals	4.14	0.84	82.8	High
4	3	Communication with other clinical departments has enhanced since PACS was installed	4.13	0.94	82.6	High
Total			4.17	0.82	83.4	High

Table (7) shows that the total degree for of the items of factors affecting the adoption of PACS) in Expected outcomes according to users was (3.99) which suggests high level of estimation. The highest mean was given to the item (PACS reduces errors in patient registration). The lowest was for the item (PACS improves and helps reserve the quality of image).

Table 7

Response rate to the Expected outcomes impact variable in Palestinian hospitals in descending order

Rank	No. in the Questionnaire	Domain	Means	standard deviations	Percentage %	Estimated level
1	3	PACS reduces errors in patient registration	4.11	0.84	82.2	High
2	1	PACS affected better management for radiology department.	4.03	0.86	80.6	High
3	2	PACS reduced the number of repeated images	4.02	0.84	80.4	High
4	7	PACS provides the ability to view pictures from different angles	4.01	0.83	80.2	High
5	4	PACS reduces waiting time for patients in radiology department.	4.00	0.79	80.0	High
5	5	PACS had reduces reporting time for images.	4.00	0.79	80.0	High
5	8	PACS allow to attach patient reports to the images	4.00	0.82	80.0	High
5	10	PACS allow remote diagnosis	4.00	0.87	80.0	High
6	9	PACS helps in reducing medical errors by providing better and accurate diagnoses	3.88	0.94	77.6	High
7	6	PACS improves and helps reserve the quality of image	3.84	.94	76.8	High
Total			3.99	0.74	79.8	High

Table (8) shows that the total degree for of the items of factors affecting the adoption of PACS) in Expected challenges, according to users was (4.01) which suggests high level of estimation. The highest mean was given to the item (PACS increase the technical problems that may occur). The lowest was for the item (There was a difficulty in logging in to the system from different departments).

Table 8

the response rate to the Expected challenges impact variable in Palestinian hospitals in descending order

Rank	No. in the Questionnaire	Domain	Means	standard deviations	Percentage %	Estimated level
1	1	PACS increase the technical problems that may occur.	4.17	0.85	83.4	High
2	2	People with lack computers skill effect on PACS use.	4.14	0.87	82.8	High
3	3	PACS affect costly due to consistent maintenance.	4.01	0.90	80.2	High
4	4	PACS affected the quality of image when viewed remotely (e.g., from doctor office)	3.96	0.92	79.2	High
5	5	There was a difficulty in retrieving images in PACS	3.94	0.94	78.8	High
6	6	There was a difficulty in logging in to the system from different departments	3.82	1.05	76.4	High
Total			4.01	0.82	80.2	High

Table (9) shows that the total degree for of the items of factors affecting the adoption of PACS) in Satisfactions according to users was (3.91) which suggests high level of estimation. The highest mean was given to the item (the use of PACS is not easy). The lowest was for the item (I rarely make a mistake or omit an error while using PACS).

Table 9

The response rate to the Satisfactions impact variable in Palestinian hospitals in descending order

Rank	No. in the Questionnaire	Domain	Means	standard deviations	Percentage %	Estimated Level
1	2	The use of PACS is not easy	4.15	0.83	83.0	High
2	3	Facing difficulties in using PACS.	4.08	0.80	81.6	High
3	6	I prefer PACS to the traditional system of paper-based and film-based printing.	3.86	1.08	77.2	High
4	1	PACS is admirable and I like it	3.82	1.03	76.4	High
5	4	Use of PACS requires a high level of proficiency.	3.78	1.13	75.6	High
6	5	I rarely make a mistake or commit an error while using PACS.	3.77	1.17	75.4	High
Total			3.91	0.87	78.2	High

3.3 Correlation between impact variables and user's characteristic

To determine the relation between the factors affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals due to the variables of gender, qualification, age, English language level, years of experience area in radiology, Working place, Computers skill, knowledge about electronic health and Training. the researcher analyzed the data using ANOVA test to study the relation between the impact variables and user's characteristic showed in table (10):

The Analysis of Variance (ANOVA) is used to test the level of impact of the study variables (external communication, expected outcome, expected challenges, and user characteristics) on the user characteristic. Table (10) display the result of ANOVA test showing the significant correlation between external communication and four user characteristics, i.e., Age (sig =0.037≤0.05), English language level (sig =0.001≤0.05), computer skill (sig =0.001 ≤0.05) and training (sig =0.000≤0.05). in addition, expected outcome showed significant correlation with four user characteristics, i.e., qualification (sig =0.022 ≤0.05), Age (sig =0.010≤0.05), English language level (sig =0.023≤0.05), and training (sig =0.000≤0.05). Moreover, expected challenges also showed significant correlation with four user characteristics, i.e., Age (sig =0.017≤0.05), English language level (sig =0.037≤0.05), years of experience (sig =0.003≤0.05) and training (sig =0.000≤0.05). finally, users' satisfaction also showed significant correlation with five user characteristics, i.e., gender (sig =0.026≤0.05), Age (sig =0.005≤0.05), years of experience (sig =0.004≤0.05), hospitals attributed to area in radiology (sig =0.020≤0.05), and training (sig =0.000≤0.05).

Table 10*ANOVA results showing variance between impact variables and user characteristics*

User characteristic	External environment		Expected outcome		Expected challenges		Users Satisfaction	
	F	Sig	F	Sig	F	Sig	F	Sig
Gender	-0.813	0.418	0.372	0.720	1.086	0.279	2.244	0.026*
Qualification	1.984	0.141	3.896	0.022*	2.104	0.126	2.605	0.077
Age	2.896	0.037*	3.943	0.010*	3.514	0.017*	4.452	0.005*
English language level	5.863	0.001*	3.279	0.023*	2.904	0.037*	2.336	0.076
Years of experience	1.991	0.118	2.295	0.080	4.756	0.003*	4.595	0.004*
hospitals attributed to area in radiology.	0.879	0.497	0.800	0.552	2.114	0.063	2.769	0.020*
to computers skill.	7.745	0.001*	1.576	0.201	0.182	0.834	1.698	0.187
Knowledge about electronic health record system	0.757	0.520	0.166	0.919	0.558	0.643	1.703	0.169
training.	75.712	0.000*	74.750	0.000*	49.217	0.000*	32.241	0.000*

* The mean difference is significant at the 0.05 level.

Chapter Four

Discussions, Conclusions and Recommendation

In this chapter, a discussion, conclusions, and recommendations will be presented.

4.1 Discussions

According to the collected data from this study, which consists data from radiographers working in Palestinian governmental hospitals. The objective of study was achieved, which include measuring the effect of PACS on radiographers and their relationship toward the effect of using PACS on the external environment in the hospitals, also the effect on the outcome expected in the different department of hospitals. We also discussed the relationship between the socio-demographics and the acceptance of using PACS. As well as dissection of the expected challenges in the adaptation of PACS. And finally, measuring the satisfaction of users toward the system. Therefore, the results were discussed and compared with previous studies in order to come up with a number of critical recommendations that will help decision-makers to re-evaluate and develop the using of PACS in Palestinian governmental hospitals.

4.1.1 Socio-Demographic indicators from the respondents' response about adopting PACS

According to the study findings, there was a significant difference between the adoption of PACS and socio-demographic indicators (Age, Gender, study qualifications, English level and years of experience).

Because of Palestinian community considered a young aging community, the result showed that acceptance of PACS among younger people are high than the elderly people. This result is also affected by the ability of young people to accept new system more than the elderly people. On the other hand, the closer to retire and less desire to accept the changes in working environment. According to the gender indicator of this study we found that male is more satisfied than females for using the system, this is due to the nature of gender within the Palestinian system. Were males representing (77%) of all participant. In contrast with these result a studies of (Goodarzi, Khatami et al. 2016) in Iran, (Aldosari, Saddik et al. 2018) in Saudi Arabia, and (Abbasi, Sadeqi Jabali et al. 2020) in Iran found there is no significance relationship between age and gender towered

the acceptance of PACS. This contrast of result due to the differences of Palestinian environment than other countries, the studying nature and the culture from other studies.

The result collected on study qualification in this study shows a significant difference between high study qualification with master degree and the acceptance of PACS within the Palestinian governmental hospital. This is due to the better understanding from highly degreed participant to the benefit dragged from the adaptation of PACS. This finding of the study is supported by previous study of (Goodarzi, Khatami et al. 2016) and (Ahmadi, Mehrabi et al. 2017) in Iran. Goodarzi study supported that people with highly education degree had a higher mean acceptance score for adoption of PACS compared other groups. This is due to the working with the technology is easier for them. On the other hand Ahmadi statement in his study that the group with high education affect the adoption and use of PACS according to the unified theory of acceptance.

The results collected related to English level indicator in this study showed a significant difference in the relationship between the English level of the participant and the acceptance of PACS in Palestinian governmental hospitals. This finding is explained in miner of the better the English level the better the understanding of the system therefore more acceptance for the system. These result are supported by the study of (Al-Kahtani, Al-Dhaif et al. 2021) in Saudi Arabia. this study showed a disadvantage of using PACS among its users which is lake of understanding of the system, which indicates the importance of English language in using PACS.

The results also showed a significant difference in years of experience of participant and the acceptance of PACS. The less the year of experience the more the acceptance of adaptation of PACS, this can explain as the less year of experience are freshly graduated having better education level and more enthusiasms for work and production. This result is supported by the study of (Montazeri, Khajouei et al. 2022) in Iran and (Aldosari, Saddik et al. 2018) in Saudi Arabia. Montazeri statement that the users with lower work experience were more positive to system and their intention to use PACS increases. He explained this as the users with lower work experience used PACS for most of their work period and can easily adopt the system. On the other hand, people with high work experience are more resistant to use PACS due to the long-term use of the previous system and need time to change their habits. Aldosari explained that users with experience less than 2 years are more likely to have a positive point of view toward the system.

On the other hand, there were no significant differences in the indicators of working area, knowledge in electronic health record, and PACS training. This is because all of these factors are being learned theoretically within courses in the study of Medical Imaging in the Palestinian universities.

4.1.2 External environment indicators toward the adaptation of PACS

The result of the population collected from this study in the section related to the effect of PACS on the external environment of the radiographers was relatively high, with an estimation level (4.17). the highest mean was given to the item (PACS affects the ease of access to radiology images and data). This can explain as the PACS enhance the reach to the images and data of patient as it is saved electronically on the system with other data, which intern keeps the images from being lost and reduce the number of repeated images related to the same purpose. The ease of use also represented in the ability of the users to retrieve, zoom, make copies, and compare images on the PACS work station. The results are supported by the study of (Abbasi, Sadeqi Jabali et al. 2020) in Iran , (Abdekhoda and Salih 2017) in Iraq and (Ahmadi, Mehrabi et al. 2017) in Iran . Abbasi addressed in this study that more than the half of participant believed that the use of PACS is easy and meet their expectation and its user-friendly. And despite the variety of use of PACS it is also easy to learn who to use the system. Abdekhoda study statement that the use of PACS within the department make its easy to deal with the data and images of the patients within the system. On the other hand Ahmadi on his study and based on technology acceptance model, stated that PACS has an influence on the ease of use of information in the system. On contrast, the lowest mean was for the item (Communication with other clinical departments has enhanced since PACS was installed). This can be explained as there is no need to transfer images and data between different clinics at the same institution, as any physician can view the related data on PACS workstation.

4.1.3 Expected outcome indicator toward the adaptation of PACS

As a result of the collected data on the section related to the effect of PACS on the expected outcome from the system, the item (PACS reduces errors in patient registration) has the highest estimation level according to the users. This can be explained as using PACS transferred from paper-based registration to electronic registration which is more accurate and reduce the errors in the patient information. Although, the accuracy in patient registration reduces the number of repeated images and increase the quality of patient

care. The result of this study are cited by (Kovacs, Cho et al. 2019), which found that the installation of PACS reduces the errors related to patient data, which intern may effect on the accuracy of care presented to patient.

Another study support the finding is admitted by (Al-Kahtani, Al-Dhaif et al. 2021), in his study focused on the effect of PACS on the accuracy of registration of patient data. Increasing the quality of patient information by making it more relevant, accurate, and timely, improving the continuity of the patient care process. However, the item (PACS affected better management for radiology department.) was also significant according to the participant. This can be explained as PACS make the flow of work easier, more effective and functionally, which effect on the quality and satisfaction of patients. This findings is supported by the study of (Aldosari, Saddik et al. 2018) this study indicated the positive effect of PACS on the management of radiology department.

4.1.4 Expected challenges indicator towered the adaptation of PACS

Based on the result of this study, the indicator expected challenges related to the adaptation of PACS had a high estimation level (4.1). the highest estimation level was the item (PACS increase the technical problems that may occur). This is due to the complicated infrastructure related to the PACS. That require high and special training team to solve the expected problems related to the system. The obstruction of PACS will affect on the workflow in radiology department resulting in decreasing the quality of patient care. This can be supported by a previous study of (Buabbas, Al-Shamali et al. 2016) in Kuwait. This study indicated based on an interview with radiographers, that the technology-associated problems effect on the versatility and performance of the radiology department. Moreover, they mentioned as the IT support only delivered through the company that sold the PACS, which in turn affect the productivity of the department. Another study (Al-Kahtani, Al-Dhaif et al. 2021) in Saudi Arabia towards Clinicians' Perceptions of PACS confirmed that the existence of new technology may produce a technological barriers related to the maintenance. This may affect negatively on users' intention to use the system.

Also a study (Abbas 2019) in north Africa supported our finding. This study result explain that the lake of technological information and expert will affect the ability of

radiographers to adopt the system. This explain that the presence of PACS require a certain expert to deal with PACS.

4.1.5 Satisfaction indicators toward the adaptation of PACS

The results of the population study that collected, that the satisfaction toward the adaptation of PACS is relatively high, and the highest mean given to the item (It is difficult to learn how to use the PACS). This indicates to an important factor that effect on the use of PACS is the difficulties in learning how to use the system. therefore, it's important to teach radiographers how to use the system throw training courses including individual training, with groups, or online training to increase the satisfaction towered the adaptation of the system in the Palestinian hospitals. This is supported by other studies (Abbas 2019) in south Africa, addressed in their study the challenges and difficulties related to the use of PACS. They discussed the importance of the training courses to teach system users the basics of infrastructure to deal with the system. Another study of (Ahmadi, Mehrabi et al. 2017) in Iran also focused on the importance of training the team how to use PACS in the most effective way and its role in the productivity of the department also the satisfaction of users. (Al-Kahtani, Al-Dhaif et al. 2021) in Saudi Arabia also discussed the clinician's perceptions towered PACS. The study found that the lake of training from the user's perspective is considered a barrier to the successful and effective use of PACS. On the other hand, (Aldosari, Saddik et al. 2018) in Saudi Arabia in this study noted on the highly acceptance of the system due to the training presented to the users which affected on the productivity and efficiency of the system.

4.2 Conclusion

Picture Archiving and communication system (PACS) is considered a useful system in radiology department for the radiology staff. This study was conducted at Palestinian hospital in order to explore and assess the impact of PACS on its users in the radiology department. In this study the users have shown a positive perception toward PACS, and the impact of it on them and their work routine. We discussed several variables such as external environment, expected outcome, challenges, and the satisfaction toward the system. This study concluded that PACS has a great impact on improving external environment of the radiology department, increasing the intention to use the system, which increase the productivity of the system and enhance the outcome from the system. We also measured the negative aspect of PACS such as the challenges related to the use of system, for example, using PACS will increase the technical problem within the system. We also measured the level of satisfaction for the users of the system to identify the weakness point and improve the satisfaction of radiographers within radiology department in Palestinian hospitals.

4.3 Recommendations

In accordance with the findings of this study, and in order to successfully meet the objectives, some recommendations must be made to decision-makers in order to advance the discussion of perceived health care quality and its effect on patient satisfaction and access to the best options.

1. It's necessary to focus on the importance of improving the PACS between all healthcare facilities including different hospitals and clinics.
2. The importance of providing a maintenance team within the hospital to deal with any technical problem related to the system.
3. Every hospital should provide a specific team to ensure all new radiographers received the appropriate training for dealing with PACS.
4. They must focus on hiring younger people because of their high acceptance to use the new technology of PACS.
5. More researches about factors affecting the adoption of Picture archiving and communication (PACS) in Palestinian hospitals should be conducted.

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Appendices

Appendix A

The List of Researchers

- Dr. Wafaa Minawi: an academic in the Faculty of Medicine and Health Sciences, An-Najah National University. worked at An-Najah Biosciences Unit (NBU), Head of Quality Assurance Unit, An-Najah National University.
- Dr. Hussien Al Masri: Associate Professor, Head of Medical Imaging Department, Assistant Dean, Faculty of Health Professions, Al-Quds University. Ph.D. in Medicine, obtained from the Faculty of Medicine, Department of Radiology (Medical Imaging),

Appendix B

Questionnaire

This questionnaire is introduced to you by Nada Shalabi, a master's student of public health management At Al Najah National University. A study under the title of "Factor affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals ". this study aims to assess the impact of the PACS system on its users, to determine the benefit of the PACS system on quality of patient care such as, waiting time, reduce a repeated image, and access to images, to identify the characteristics associated with PACS users and to measure the acceptance of PACS system from its users. The outcome of this study will help to achieve results that will affect the scientific research in the field of PACS system and enhance radiographer's situation in Palestine.

This questioner is consisting of 5 parts, it will take a time of 10 minute to answer all questions. Your participation of scientific research is voluntary and all information will be treated confidentially

Section (1): Please choose the answers related to your socio-demographic and job-related factors Please put a tick (✓) in the appropriate box :

1. Gender:

A. Male.

B. Female

2. education degree:

A- Bachelors

B- Master.

C- Doctoral or high.

3. Age:

A- From (22-30) Years Old

B- From (31-40) Years Old

C- From (41-50) Years Old

D- From (51-60) Years Old

4. English level:

A- poor

B- fair

C- good

D- Excellent

5. Years of Experience:

A- \leq (5) Years

B- From (6-11) Years Old

C- From (12-19) Years Old

D- \geq (20) Years

6. what is the area in radiology department that describe your current position:

- A. General radiology.
- B. computed Tomography. (CT)
- C. Magnetic Resonance image (MRI)
- D. Nuclear Medicine.
- E. others:

7. computers skill:

- A. poor
- B. adequate
- C. excellent

8. Knowledge about electronic health record system.

- A. very little.
- B. A little
- C. Good
- D. Excellent

9. which of the following describe the PACS training that was provided to you:

- A. I was trained with a group.
- B. I was trained individually.
- C. I was trained using web-based tutorial training.
- D. I have not been trained

Section 2:						
The following question will measure your opinion about PACS system and its benefits for the external environment. Please read question carefully and put (√) for the best describes your opinion.						
	External environment	Strongly disagree(1)	Disagree(2)	Neutral (3)	Agree(4)	Strongly agree(5)
1.	PACS system affects the ease of access to radiology images and data					
2.	PACS enables easy access and sharing of radiology data and images with other clinical departments.					
3.	Communication with other clinical departments has enhanced since PACS was installed.					
4.	PACS facilitates patients file sharing between hospitals.					

Section 3:						
The following question will measure your opinion about PACS and its expected outcome. Please read question carefully and tick (√) the best describes your opinion.						
	Expected outcome	Strongly disagree(1)	Disagree(2)	Neutral (3)	Agree(4)	Strongly agree(5)

1.	PACS system affected better management for radiology department.					
2.	PACS system reduced the number of repeated images					
3.	PACS system reduces errors in patient registration.					
4.	PACS system reduces waiting time for patients in radiology department.					
5.	PACS system had reduces reporting time for images.					
6.	PACS system improves and helps reserve the quality of image					
7.	PACS provides the ability to view pictures from different angles.					
8.	PACS system allow to attach patient reports to the images					
9.	PACS helps in reducing medical errors by providing better and accurate diagnoses.					

10.	PACS system allow remote diagnosis.					
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Section 4:						
The following question will measure your opinion about PACS and its expected challenges. Please read question carefully and tik (√) the best describes your opinion.						
	Expected challenges	Strongly disagree(1)	Disagree(2)	Neutral (3)	Agree(4)	Strongly agree(5)
1.	PACS system increase the technical problems that may occur.					
2.	People with lake computers skill effect on PACS use.					
3.	PACS system affect costly due to consistent maintenance.					
4.	PACS system affected the quality of image when viewed remotely (e.g., from doctor office)					

5.	There was a difficulty in retrieving images in PACS system					
6.	There was a difficulty in logging in to the system from different departments					

Section 5:						
The following question will measure your opinion about PACS and your satisfaction in using system. Please read question carefully and tik (√) the best describes your opinion.						
	Satisfactions	Strongly disagree(1)	Disagree(2)	Neutral (3)	Agree(4)	Strongly agree(5)
1.	PACS system is admirable and I like it					
2.	Facing difficulties in using PACS system.					
3.	The use of PACS system in not easy.					
4.	Use of PACS requires a high level of proficiency.					

5.	I rarely make a mistake or commit an error while using PACS.					
6.	I prefer PACS to the traditional system of paper-based and film-based printing.					

استبانة

هذه الاستبانة تقدمه لكم "ندى شلبي" , طالبة ماجستير في إدارة الصحة العامة في جامعة النجاح الوطنية. أقدم لكم دراسة بعنوان " تصور فني الأشعة في أقسام الأشعة اتجاه تطبيق نظام أرشفة الصور ونظام الاتصالات في المستشفيات العامة الفلسطينية". تهدف هذه الدراسة الى تقييم تأثير نظام أرشفة الصور والاتصالات الى مستخدميها، لتحديد الفائدة من النظام على جودة رعاية المرضى مثل وقت الانتظار و تقليل اعادة الصور وتسهيل الوصول الى الصور, وتحديد الخصائص المرتبطة بمستخدمي النظام و درجة قبوله من مستخدميها. ستساعد نتائج هذه الدراسة في تحقيق نتائج من شأنها ان تؤثر على البحث العلمي في هذا المجال وتساهم في تعزيز مجال التصوير الإشعاعي في فلسطين.

تتكون هذه الاستبانة من 5 أجزاء، سوف تستغرق الإجابة عنها 10 دقائق . مشاركتك في البحث العلمي تطوعية ، وسيتم التعامل مع جميع المعلومات بسرية تامة.

القسم الأول:

يتعلق هذا القسم بالعوامل الاجتماعية والديموغرافية و الوظيفية يرجى اختيار الإجابات المناسبة:

1. الجنس:

أ. أنثى

ب. ذكر

2. الدرجة العلمية:

أ. بكالوريوس.

ب. ماجستير.

ت. الدكتوراه.

3. العمر:

أ. من (22-30) عام.

ب. من (31-40) عام

ت. من (41-50) عام.

ث. من (51-60) عام.

4. مستوى اللغة الانجليزية :

أ. ضعيف

ب. متوسط

ت. جيد

ث. ممتاز

5. سنوات الخبرة:

أ. أقل من (5) سنوات

ب. من (6-11) سنة

ت. من (12-19) سنة

ث. اكثر من (20) سنة

6. ما هو الجهاز الذي تعمل عليه ضمن قسم الأشعة:

أ. الأشعة السينية

ب. التصوير المقطعي (CT)

ت. تصوير الرنين المغناطيسي (MRI).

ث. الطب النووي.

ج. جهاز آخر

7. مهارات الحاسوب :

أ. ضعيف .

ب. متوسط.

ت. ممتازة.

8. ما هو مدى معرفتك بالسجل الصحي الإلكتروني (electronic health record).

أ. ضعيف .

ب. متوسط.

ت. ممتاز.

9. أي مما يلي يصف التدريب الذي تلقيته للتعامل مع نظام أرشفة الصور و الاتصالات

:(PACS)

أ. تدريب مع مجموعة.

ب. تدريب فردي.

ت. تدريب عن طريق كورسات عن بعد (أونلاين)

ث. لم يتم تدريبي.

القسم الثاني :

يتضمن هذا القسم الإجابة عن الاسئلة المتعلقة بنظام أرشفة الصور والاتصالات (PACS) وتأثيره على البيئة الخارجية مع قسم الأشعة . اختار الإجابة التي تعطي أفضل وصف لرأيك.

الرقم	البيئة الخارجية	أرفض بشدة (1)	أرفض (2)	محايد (3)	أوافق (4)	أوافق بشدة (5)
1.	يؤثر نظام ال (PACS) على سهولة الوصول إلى صور وبيانات الأشعة .					
2.	يتيح نظام PACS سهولة الوصول للبيانات و الصور ومشاركتها مع الأقسام السريرية الأخرى.					
3.	سهل نظام PACS التواصل بين الأقسام الامختلفة.					
4.	يسهل نظام PACS مشاركة الملفات والصور بين المستشفيات المختلفة.					

القسم الثالث :

يتضمن هذا القسم الإجابة عن الاسئلة المتعلقة بنظام أرشفة الصور والاتصالات (PACS) وتأثيره على مخرجات قسم الأشعة . اختار الإجابة التي تعطي أفضل وصف لرأيك

الرقم	مخرجات قسم الأشعة	أرفض بشدة (1)	أرفض (2)	محايد (3)	أوافق (4)	أوافق بشدة (5)
1.	أثر نظام PACS على تحسين إدارة قسم الأشعة.					
2.	قلل نظام PACS من عدد الصور المتكررة.					
3.	قلل نظام PACS من الأخطاء في تسجيل بيانات المرضى.					
4.	قلل نظام PACS من الوقت الذي يقضيه المريض في قسم الأشعة.					
5.	قلل نظام PACS من الوقت اللازم لاعداد التقارير الخاصة بالمرضى.					
6.	أثر نظام PACS على جودة صور الأشعة.					
7.	يوفر نظام PACS امكانية عرض الصور من زوايا مختلفة.					
	يتمكن نظام PACS من امكانية ارفاق تقارير المرضى بالصور.					

					8. أثر نظام PACS على جودة التقارير الخاصة بالصور.
					9. ساهم نظام PACS في تقليل الأخطاء الطبية من خلال توفير تشخيص دقيق.
					10 يسمح نظام PACS من التشخيص عن بعد.

القسم الرابع:

يتضمن هذا القسم الإجابة عن الاسئلة المتعلقة بنظام أرشفة الصور والاتصالات (PACS) و التحديات المتعلقة بالنظام . اختار الإجابة التي تعطي أفضل وصف لرأيك

الرقم	التحديات المتعلقة بالنظام	أرفض بشدة (1)	أرفض (2)	محايد (3)	أوافق (4)	أوافق بشدة (5)
1.	يؤثر نظام PACS على المشاكل التقنية المتوقع حدوثها					
2.	يؤثر نظام PACS على أداء الأفراد الذين لديهم قدرات حاسوبية ضعيفة.					
3.	يرفع نظام PACS من التكلفة نتيجة الصيانة المتكررة					

					4. يؤثر نظام PACS على جودة الصورة عند عرضها عن بعد (من مكتب الطبيب)
					5. يوجد صعوبة في استرجاع الصور من نظام PACS
					6. يسبب نظام PACS صعوبة في الدخول الى النظام من أقسام مختلفة

القسم الخامس :					
يتضمن هذا القسم الإجابة عن الاسئلة المتعلقة بنظام أرشفة الصور والاتصالات (PACS) و مدى رضاك عن استخدام النظام . اختار الإجابة التي تعطي أفضل وصف لرأيك					
مدى رضى الموظف عن استخدام النظام	أرفض بشدة (1)	أرفض (2)	محايد (3)	أوافق (4)	أوافق بشدة (5)
1. نظام PACS مفيد وأنا استخدمه.					
2. أواجه صعوبة بالتعامل مع النظام.					
3. غالبا استخدام النظام يكون مزعج ويسبب لي صعوبات					
4. استخدام النظام يتطلب مني مستوى عالي من الكفاءة.					

					نادرا ما أرتكب خطأ أثناء استخدام النظام	5.
					أنا أفضل نظام PACS على النظام التقليدي للطباعة الورقية واستخدام الأفلام .	6.

Appendix C
Institutional Review Board (IRB)

An-Najah National
University
Faculty of Medicine &
Health Sciences
Institutional Review Board



جامعة النجاح الوطنية
كلية الطب وعلوم الصحة
لجنة أخلاقيات البحث العلمي

Ref : Mas. June. 2023/2

IRB Approval Letter

Title of Research:

*The perception of radiographers in radiology department towards the implementation of
Picture Archiving and Communication System (PACS) system in hospitals in north
Palestine."*

Submitted by:

Nada "Joul Jamal" Shalabi

Supervisor:

Raya sawalha

Approved:

5th June. 2023

Your Study Title "*The perception of radiographers in radiology department towards the
implementation of Picture Archiving and Communication System (PACS) system in hospitals
in north Palestine.*" reviewed by An-Najah National University IRB committee and was
approved on 5th, June . 2023


Hasan Fitian, MD

IRB Committee Chairman



Appendix D

Explanatory Litter

This questionnaire is introduced to you by Nada Shalabi, a master's student of public health management At Al Najah National University. A study under the title of "Factor affecting the adoption of Picture archiving and communication system (PACS) in Palestinian hospitals ". this study aims to assess the impact of the PACS system on its users, to determine the benefit of the PACS system on quality of patient care such as, waiting time, reduce a repeated image, and access to images, to identify the characteristics associated with PACS users and to measure the acceptance of PACS system from its users. The outcome of this study will help to achieve results that will affect the scientific research in the field of PACS system and enhance radiographer's situation in Palestine.

This questioner is consisting of 5 parts, it will take a time of 10 minute to answer all questions. Your participation of scientific research is voluntary and all information will be treated confidential.

Arabic

هذه الاستبانة تقدمه لكم "ندى شلبي" , طالبة ماجستير في إدارة الصحة العامة في جامعة النجاح الوطنية. أقدم لكم دراسة بعنوان " تصور فني الأشعة في أقسام الأشعة اتجاه تطبيق نظام أرشفة الصور ونظام الاتصالات في المستشفيات العامة الفلسطينية". تهدف هذه الدراسة الى تقييم تأثير نظام أرشفة الصور والاتصالات الى مستخدميها، لتحديد الفائدة من النظام على جودة رعاية المرضى مثل وقت الانتظار و تقليل اعادة الصور وتسهيل الوصول الى الصور, وتحديد الخصائص المرتبطة بمستخدمين النظام و درجة قبوله من مستخدميهم. ستساعد نتائج هذه الدراسة في تحقيق نتائج من شأنها ان تؤثر على البحث العلمي في هذا المجال وتساهم في تعزيز مجال التصوير الإشعاعي في فلسطين.

تتكون هذه الاستبانة من 5 أجزاء، سوف تستغرق الإجابة عنها 10 دقائق . مشاركتك في البحث العلمي تطوعية ، وسيتم التعامل مع جميع المعلومات بسرية تامة.



جامعة النجاح الوطنية
كلية الدراسات العليا

تصور فني الأشعة في أقسام الأشعة اتجاه تطبيق نظام أرشفة
الصور ونظام الاتصالات في المستشفيات العامة الفلسطينية

إعداد

ندى "جول جمال" سليم شلبي

إشراف

د. راية صوالحة

قدمت هذه الرسالة استكمالاً لمتطلبات الحصول على درجة الماجستير في إدارة الصحة العامة، من كلية الدراسات العليا، في جامعة النجاح الوطنية، نابلس - فلسطين.

2024

تصور فني الأشعة في أقسام الأشعة اتجاه تطبيق نظام أرشفة الصور ونظام الاتصالات في المستشفيات العامة الفلسطينية

إعداد
ندى "جول جمال" سليم شلبي
إشراف
د. راية صوالحة

الملخص

المقدمة: ان نظام أرشفة الصور ونظام الاتصالات في المستشفيات أصبح من الضروريات في أقسام الأشعة بهدف أرشفة واستعادة صور الأشعة المختلفة. ان تصور فني الأشعة في المستشفيات لهذا النظام دور مهم في تبني استخدامه. إن الهدف من هذه الدراسة هو قياس مدى تقبل فني الأشعة للنظام في المستشفيات الحكومية الفلسطينية.

الطريقة: بدأت دراسة مقطعية في عام 2023 في المستشفيات الحكومية الفلسطينية . تم توزيع استبانة على (170) من فني الأشعة العاملين في أقسام الأشعة في المستشفيات. تم استعادة (151) استبانة فقط . تكوّنت الاستبانة من 5 متغيرات كالتالي: عامل اجتماعي ديموغرافي، البيئة الخارجية، المخرجات المتوقعة، التحديات المتوقعة، والرضا لاستخدام النظام. هذه المتغيرات تم وضعها لقياس مدى تقبل فني الأشعة للنظام في أقسام الأشعة.

النتائج: أظهرت هذه الدراسة وجود علاقة ذات دلالة إحصائية بين قبول نظام PACS والمتغيرات ذات الصلة مثل العامل الاجتماعي والديموغرافي والبيئة الخارجية والنتائج المتوقعة والتحديات المتوقعة والرضا. كما أوضح التأثير الإيجابي لـ PACS.

الخلاصة : أظهرت هذه الدراسة التصور الإيجابي للمستخدمين تجاه نظام PACS في قسم الأشعة. وكذلك تأثير نظام PACS على إنتاجية المستخدمين والقدرة على اعتماد النظام في قسم الأشعة. تهدف نتيجة هذه الدراسة إلى تزويد العاملين في مجال الرعاية الصحية بفهم أفضل لتطوير تقبل فنيي الأشعة لنظام PACS.

الكلمات المفتاحية: نظام أرشفة الصور والاتصالات، قسم الأشعة، العامل الاجتماعي الديموغرافي، البيئة الخارجية، النتائج المتوقعة، التحديات المتوقعة ورضا المستخدمين.