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Benefits, barriers and attitudes of Iranian specialist physicians and radiologists toward the picture archiving and communication system

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Abstract

The aim of this qualitative study is to identify and compare the challenges of using PACS in hospitals affiliated with the Social Security Organization. This study was conducted with a qualitative approach using content analysis strategy. Thirteen specialist physicians and radiologists with at least three years of experience with PACS from two Social Security hospitals participated in the study. Data were collected using semi-structured interviews. Then, for data coding, qualitative content analysis method based on Graneheim and Landman method and MAXQDA 10 software were used. Lincoln and Guba evaluation criteria were used for data reliability. The benefits of PACS were finally classified into two categories: hospital and physician. According to experts, PACS problems are divided into three main categories: inadequate infrastructure, human factors, and financial problems and costs. Some recommendations were also proposed to improve PACS. Each category was divided into several sub-categories depending on the category. The key to successful implementation of any type of health information technology is the acceptance of end users. Their acceptance is influenced by the understandable advantages and disadvantages of the system and its application. Developing the benefits of a system and overcoming its limitations and challenges is effective in accepting the user and achieving the predetermined goals of that system.

Keywords: Picture archiving and communication systems, user satisfaction, radiology, hospital.

Introduction

Today, one of the main means of medical diagnosis is medical imaging (European Society of Radiology, 2019). Digital imaging systems are among the health information technology innovations that have been used in health care centers since the 1980s (Buabbas et al, 2016). The use of digital imaging techniques has increased in most hospitals

worldwide, leading to the improvement of the accuracy, speed, efficiency, effectiveness, and quality of treatment. However, these techniques alone cannot provide high-quality services and reduce costs, and therefore, other technologies such as picture archiving and communication systems (PACS) are required to manage medical images (Hasani, Hosseini & Sheikhtaheri, 2020). PACS can be defined as an electronic information system used to prepare, store, transmit, and display medical images (Tzeng, Kuo, Lin & Chen, 2013). PACS is a unique technology that provides a centralized repository for all imaging data and provides diagnostic images and radiological reports to physicians in care centers, electronically (Hains, Georgiou & Westbrook, 2012).

Over the past ten years, digital ICT-based PACS has revolutionized radiology and, in a sense, medical practice (Liu & Huang, 2020) and become one of the most important tools used in patient care worldwide. As one of the most essential information systems used in health care centers, PACS allows physicians to remotely communicate and consult about patients and view diagnostic images from different angles, thereby facilitating the diagnosis and treatment of patients (Al-Kahtani et al, 2021; Farzandipour, Sadeqi, Nickfarjam & Tadayon, 2021). Moreover, it improves the workflow and performance of physicians (Abdekhoda & Salih, 2017), improves the efficiency of radiology departments, and provides quick, online, and web-based access to diagnostic images (Hasani, Hosseini & Sheikhtaheri, 2020; van Ooijen, 2021). According to the study conducted by Nitrosi et al. in Italy, after implementing PACS, the reporting times of radiography, computerized tomography (CT) Scan, and magnetic resonance imaging (MRI) were reduced to 26.7, 20.5, and 11.9 hours, respectively (Nitrosi et al, 2007). Furthermore, other studies indicated that PACS increases the efficiency of physicians, increases the effectiveness of diagnoses, and shortens the average turnaround time of radiology reports from 80 to 20 hours (van Ooijen, 2021).

The importance of PACS has increased over time, and its benefits have been confirmed in numerous studies. According to some studies, PACS can reduce the length of hospital stay in patients (Alalawi, Eid & Albarrak, 2016). In their study, Nitrosi et al. found that PACS could reduce the length of hospital stay for neurology ward patients by increased efficiency and use of radiology services can be other important benefits of PACS (Nitrosi et al, 2007; Hwang et al, 2016; Mackinnon et al, 2008). The results of the study conducted by Hwang et al. indicated that after implementing PACS, the use of radiology and ultrasound services increased by 0.73% and 1.03%, respectively (Hwang et al, 2016).

Despite the many benefits of using PACS, there are challenges in implementing and using this technology; these challenges include the need to change the workflow, costs, and user resistance to technology (Goodarzi et al, 2016; Chang, Hwang, Yen & Lian, 2006; Bramson & Bramson, 2005; Davis FD. (1993). Such challenges can lead to delays in accepting information systems, increased medical errors, and user dissatisfaction (Farzandipour, Sadeqi, Nickfarjam & Tadayon, 2021). User satisfaction with PACS is considered one of the crucial criteria for evaluating the success of its use (Abbasi, Jabali, Khajouei & Tadayon, 2020). Therefore, it is necessary to evaluate any type of information system from the perspective of users. Since specialists and radiologists are the most important users of PACS, it is important to examine their views on the observed pros and cons and obtain their suggestions for improving PACS performance. Understanding is beneficial in both cases since in addition to the benefits of working in an advanced workstation in a digital radiology environment, operators also face its problems and malfunctions. Understanding the technical and organizational background of the PACS digital environment requires an understanding of user satisfaction (van Ooijen, 2021; Cohen, Coleman & Kangethe, 2016).

In Iran, several studies have been conducted on the level of satisfaction with PACS. However, no relevant study in Social Security hospitals was found. Because the Social Security Organization is the second institution, preceded only by the Ministry of Health of Iran, to provide medical services to the insured and has a large share in providing health services (Sepehrdost & Rajabi, 2012) ، identifying and resolving its various technical and systemic problems is important. As a result, the researchers decided to conduct this qualitative study to identify and compare the challenges of using PACS in hospitals affiliated with the Social Security Organization. Other hospitals can use the findings of the present study to overcome challenges and successfully implement PACS.

Method

Participants and methods

Considering the issue under examination and the scope of the present study, interpretive paradigm and qualitative approach were used. Due to the specialized nature of the concept, experts are interviewed in this approach. Based on scientific sources, content analysis was selected to conduct the present study.

According to the aim of the study, the study population consisted of specialists and radiologists. Purposive sampling with maximum variation in terms of expertise was used to select the participants. Inclusion criteria were working in one of the social security hospitals, having at least three years of experience working with PACS in the hospitals, and willingness to participate in the study. According to the aim of the study, the appropriate tool for data collection was interviewing, which was conducted in a semi-structured manner. The interviews were conducted in 2020. Before conducting the interviews, the study objectives and the research team were introduced to the interviewees, and their informed consent was obtained. Interviews were conducted in person. Necessary arrangements were made with the experts before the interviews. The interviews were conducted by the first

author at the time and place chosen by the interviewees. An interview guide was prepared based on the aims of the study to guide the interviews using the opinions of experts and the research team. The duration of each interview was between 30 and 45 minutes. Experts' responses were recorded using a mobile phone. In addition, note-taking was used to record information during the interviews. Immediately after each interview, the recording was heard several times and typed verbatim to revise the questions or add new questions to the interview guide if necessary. The interviews continued until data saturation was achieved, after 13 interviews.

Finally, to perform information analysis, according to Charms (2006), the text coding analysis method was used. Therefore, qualitative content analysis based on Graham and Landman's method was used (Graneheim & Lundman, 2004). First, the interviews were read to analyze the data. Then, after a general overview of the interviews, the transcripts were reviewed many times to extract the initial codes. The initial codes were compared, and similar codes were placed in sub-categories. Then, by constantly comparing the sub-categories and based on their relevance and similarity, each of them was placed within the main categories that included the main themes of the research and had a degree of abstraction. MAXQDA 10 software was used for this aim. Qualitative content analysis based on Graham and Landman's method was used. Lincoln, Guba & Pilotta (1985) evaluative criteria, including reliability, transferability, and verifiability, were used to ensure the reliability of the data (Figure 1).

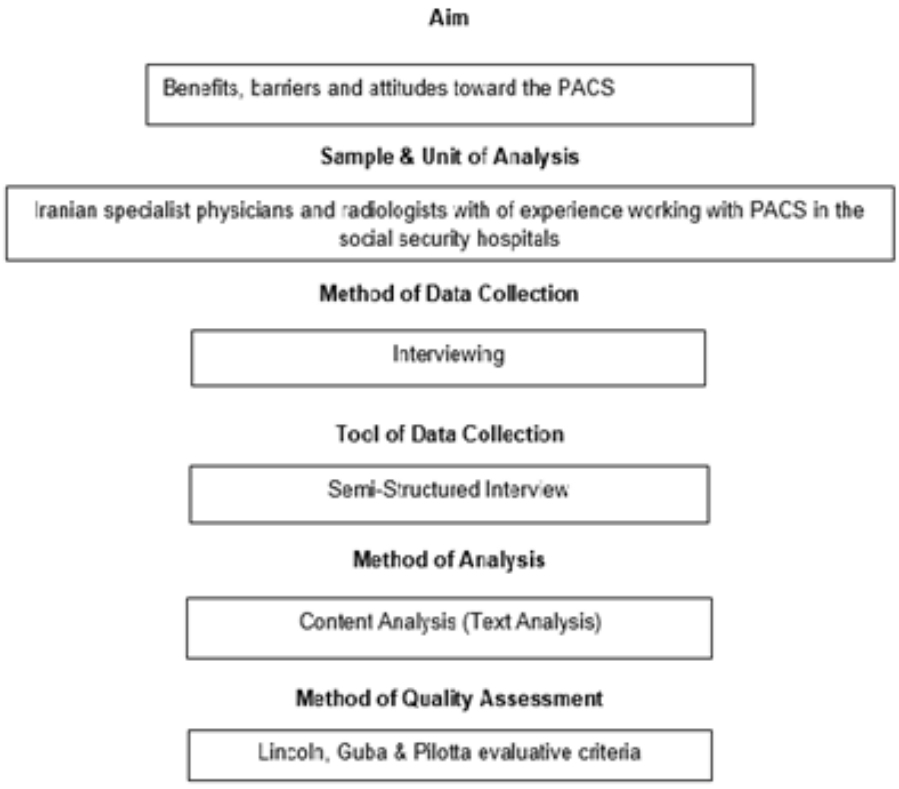

Fig. 1. An overview of the process of a qualitative content analysis.

Ethical considerations

Voluntary participation, full informed consent of participants, the right to withdraw, providing the results (upon request), and observing the ethical principles of the interview, including confidentiality of results and emphasis on information retention, were among the ethical considerations considered by the researchers.

Findings

All participants in the study were male and had five years or more experience of working with PACS. Most of the participants were emergency medicine specialists aged over 50 (Table 1). Of the participants, 77% stated that they recommend the use of PACS to their colleagues in other centers, and 23% had the experience of consulting with doctors outside their center through PACS and were satisfied with this experience.

Table 1: Demographic information of the interviewees

Variable		Frequency	percent
Age	55-50	7	53.84
	60-55	5	38.46
	>60	1	7.69
Specialty	Radiology	3	23.07
	Emergency Medicine	5	38.46
	Orthopedics	2	15.38
	Neurosurgeon	3	23.07
Experience with PACS	<15	1	7.69
	20-15	3	23.07
	25-20	4	30.77
	30-25	5	38.46

The benefits of PACS were first reviewed and coded. After the removal and integration in different stages of the analysis, the codes were finally classified into two categories: hospital and physician. Given that the benefits mentioned were mainly related to PACS benefits for the hospital as well as benefits for physicians, these two categories were considered. Each category was divided into several sub-categories depending on the category (Table 2).

Hospital

This category was divided into four sub-categories: improving hospital management, reducing medical errors, system integration, and cost savings, all of which were mentioned by all participants. Below, some of the mentions are quoted as examples.

"…As far as I am concerned, the quality of the images was at the level of world standards" (P3)

"Speed. Time was reduced for both the staff and patients. Work quality also increased. Generally, it has saved resources and helped our human resources. Besides, human error, which was the worst aspect of the previous systems, was prevented in this system." (P1)

"It was very good. Fast internet access, like at home. It is a good idea. Another important issue was the economics of treatment. I always had problems with the printer. The quality was not good. The image quality was ruined in poor storage conditions. We also had to buy big envelopes." (P3)

"It helped treatment and diagnosis. Printing costs were reduced. The commute of doctors and patients was also reduced. Work can be done faster. Emergency physicians (general practitioners) can make diagnoses, and if a case is suspicious, the specialists are immediately notified, and they can give a definite answer through the device closest to them, such as a phone or PC." (P9)

"Instant access to patients' radiographs (scans), better image qualities, elimination of stereotypes Radiology, easier archiving, cost saving, better image quality." (P10)

Physician

These benefits were also emphasized by most of the participants. They argued that PACS had benefits for them, the most important of which were human factors, systemic benefits, system integration, time saving, information availability, improving the data management process, improving medical diagnosis and quality of care, and reducing medical errors. Among these benefits improving medical diagnosis and quality of care, and time saving were emphasized by all specialists. In the following, the comments of some of the participants are presented.

"It improved image quality and the possibility of a more accurate examination of the patient's safety and accelerated diagnosis and treatment." (P2)

"It accelerated the diagnosis and treatment of patients because we can change the density, zoom in, rotate, make it three-dimensional, and change the resolution." (P7)

"The important thing is that, for example, a doctor wants to write 360 reports. It would be so time-consuming if he takes the ones he wants out of an envelope and writes the reports, but with this system, he looks at the photos one by one at the press of a button. Besides, with technology, it is much easier to set the light, zoom in, zoom out, change the angle, and adjust the contrast for a better diagnosis and report." (P3)

"We can follow the patient's images and treatment from home on our phone, consult by calling the hospital emergency, and view the images. This shows how helpful this system was." (P11)

One of the physicians stated, "It helped us not to waste time and get better results. This means that we compensated for the time that the patient was losing" (P1).

Furthermore, other physicians believed that online access to a specialist had improved the quality of patient care.

"Availability. When they come across a suspected case, they immediately call me, and I can see the images and comment wherever I am, even on the street, so high-quality patient care can begin immediately without wasting time" (P13). Another said, "Impact on patient affairs and access to patients' radiographic records in different places" (P12).

Table 2: PACS benefits according to the specialists

No	Initial code	Sub Category	Category
1	Improvement of the performance and efficiency of clinical care processes	Improving hospital management	Hospital
2	Improvement of job satisfaction		
3	Improvement of employees' interaction and relationships		
4	Improvement of organizational communication and collaboration between physicians		
5	Improvement of the connection with physicians from other hospitals		
6	Improvement of remote radiology services		
7	Improvement of research applications		
8	Improvement of educational applications		
9	Quicker access to information, images, and reports		
10	Improvement of data transfer capability		
11	Quicker diagnosis and treatment of patients		
12	Reduction of average hospitalization time		
13	Increased quality of support services		
14	Easier archiving		
15	Eliminating papers and protecting the environment		
16	Reduction of the number of lost images	Reduce medical errors	
17	Reduction in giving wrong images to the patients		
18	Reduction of medical errors		
19	Compatibility with the system of other centers due to compliance with international standards	System integration	
20	Standard hardware		
21	Integration with the hospital information system		
22	Reduced need for physical storage space for radiographs	Cost savings	
23	Decrease in the use of papers		
24	Reduction in the costs of film, ink, and image printing		
25	Reduction in the number of tests and examinations		
26	Reduction of repetitive tests and examinations		
27	Reduction of workforce		
28	Reduction in the costs of on-call physicians		
29	Reduction of the costs of a radiologist's presence in the hospital, during non-office hours		
30	Reduction in commuting costs of specialists and radiologists		
31	Improvement of job satisfaction	Human Factors	physician
32	Improvement of interaction and relationships between medical staff		
33	Improvement of morale due to reduced work pressure		
34	User-friendly software	Systemic benefits	
35	Easy software training		
36	Easy use of the system		
37	Software compatibility with user needs		
38	Improved image resolution		
39	Improved information quality		
40	Improved system quality		
41	Improved support services quality		
42	Ability to integrate with other software	System integration	

43	Workflow acceleration	time saving	
44	Faster image processing		
45	Faster image transfer		
46	Reduction of the turnaround time of reports		
47	Reduction in image search time		
48	Reduction of delays in patient care		
49	Reduction of delays in writing reports		
50	Quicker access from outside the workplace		
51	Quicker diagnosis and treatment of patients		
52	Quicker decision-making for emergency physicians		
53	Reduction of commute		
54	Accessibility from outside the workplace	Availability of information	
55	Instant access to images and reports		
56	Ability to track images on a mobile phone		
57	Improvement of inter-organizational communication and cooperation with physicians outside the hospital		
58	Easy data management by deleting identical images	Improve the data management process	
59	Reduction of duplicate images in patient records		
60	Aggregation of examinations and patient data		
61	Ability to access the patient's previous results		
62	More accurate diagnosis of diseases, due to advanced analysis and observation	Improve medical diagnosis and quality of care	
63	Changes made to images for easier analysis and review		
64	Provision of a wide range of tools for a better display of images		
65	Ability to change the density, resolution, contrast, zoom, and image dimensions		
66	Storing standard 2D images alongside 3D images		
67	Possibility of reviewing radiology history of patients and the process of disease change and comparing the results with different studies		
68	Reduction in the number of lost images	Reduce medical errors	
69	Quicker access to images and reports		
70	Easy recognition and correction of errors		
71	Preventing medical errors		
72	Preventing giving radiographs to the wrong patients		

In the present study, in addition to investigating the benefits of PACS from the perspective of experts, the problems related to this system and solutions to these problems were investigated. According to experts, PACS problems are divided into three main categories: inadequate infrastructure, human factors, and financial problems and costs. Moreover, each of these categories has some sub-categories (Table 3).

Inadequate infrastructure

The category of inadequate infrastructure was divided into five sub-categories: technical, image storage capacity, lack of permanent information support, external communication, and organizational issues. Each of the participants mentioned issues and problems, depending on their expertise. Some of the participants' comments are mentioned below. Most of the participants mentioned and complained about system and internet disconnection and a slow internet connection.

"System memory must be cleared from time to time and images are erased." (P7)

"Patients' names are written with different spellings in different documents. For example, one spelling in CT and another spelling in the MRI unit makes patient documents hard to find. Spellings are incorrect. This leads to human error." (P4)

"The problem is that they have turned the paraclinic into a photoshoot studio. There is no report with the images. None of our colleagues in our field looks at the reports. This is a legal issue. For example, when I order an MRI, images are brought without a report, but images must have a report whether I read the report or not. Legally there must be a report. The report has legal value and is part of the job. In any case, this is not a photoshoot studio." (P9)

"The problem is that this system is practical only if the patients want the images for the inside of the center and everyone has access to it, but if the patients want to take the images outside the hospital, it causes problems for the patients because of more difficult access." (P7)

Human factors

The category of human factors was divided into two sub-categories of attitude and training. Lack of training and inadequate training were mentioned by most of the participants. They stated that they learned to use the software while working with it, and there was no training before or after the implementation of PACS. Some of the specialists' claims are mentioned as examples:

> *"I worked out the icons and buttons myself. There was no training course. Training is very important." (P3) & (P7)*

> *"Lack of time and training, as well as lack of feedback from the users were among the challenges" (P2)*
> *"It was a good plan, but I think for us, orthopedic doctors, it is time-consuming." (P8)*

Financial problems and costs

Financial problems and costs are related to the initial and peripheral costs of developing and maintaining PACS. This issue was mentioned less frequently by the participants compared with other categories since most of the specialists believed that using PACS would save costs. Specialist 9 argued, "This may replace films or appears to save costs, but no. I strongly doubt it. We do not take infrastructure costs, maintenance, and support into account. Writing plans. We compare a radiograph to a CD and say that CDs cost less, and then call it saving" (P9).

Table 3: PACS problems from the perspective of the specialists

No	Initial code	Sub Category	Category
1	Internet disconnection	Technical	Insufficient infrastructure
2	low bandwidth and slow internet connection		
3	Power outage		
4	Frequent system failures		
5	System crashes		
6	Inadequate support		
7	Difficult search in the software due to different spelling of patients' names		
8	Images without reports		
9	Time consumed typing the reports		
10	Difficulty in typing the reports		
11	The need to see the patient again due to the lack of history in the system		
12	The low storage volume of server space and storage space	Image storage capacity	
13	Periodic deletion of images due to lack of system memory		
14	The possibility to delete previous images	Lack of permanent support for information	
15	Incompatibility of the system with the system abroad for consultation	External communication organization	
16	Difficult access from outside the hospital		
17	Using CDs to communicate outside the hospital		
18	Incompatibility between hospital requirements and PACS	Organizational	
19	Incompatibility between PACS and HIS		
20	Wasting time	Attitude	Human factors
21	Cumbersome process		
22	Uselessness		
23	Creating additional commitment for the medical staff		
24	Increasing the workload		
25	Loss of patient examination time		
26	Not receiving feedback from the user		
27	Inadequate training	Education	
28	Purchasing PACS hardware equipment	Initial costs	Financial problems and costs
29	Purchasing PACS software		
30	Training the users		
31	CD		
32	Support	Ancillary costs	
33	Maintenance		
34	Equipment depreciation		
35	System update		
36	Server maintenance and development		
37	Archive maintenance		

Some recommendations were also proposed to improve PACS (Table 4). Regarding infrastructure issues, the greatest emphasis was on the use of high-speed, high-bandwidth Internet. Moreover, buying equipment such as Dictaphones, high-quality monitors, and internal software was recommended. Some of the participants' comments are mentioned below:

"No, this software is good. But the problem is that we should type in the reports. We need Dictaphones to type whatever we say. I don't know why they don't buy these. I don't have time to type all the reports. Dictaphones are so convenient and can type all the details that I say. In this case, there is no need for a secretary. Even now, secretaries don't type everything." (P13)

"If a domestic company makes an offer I'll accept it because support is provided in other countries but for us support is an issue. This is also the case in foreign programs because patients' files are classified documents, so it is better if the program is a domestic." (P3)

Most of the specialists insisted on using cyberspace to communicate securely with outside the hospital. In

addition, the use of CDs and flash memories to communicate with outside the hospital was also suggested.

"Because of the structural problems that we have, there's internet problems, and archiving support for these photos will be difficult. It is recommended that a CD be given." (P1)

Regarding the issue of insufficient image storage space, some recommendations were made, the most important of which were using cloud storage to store images, which helps to improve communication with those outside the hospital.

> *"I recommended that we use virtual space instead of buying hard drives and actually use cloud storage. Virtual space has hard drives that provide good support. It is always guaranteed. But keeping these drives in my room is not safe. I insist on buying virtual space in the form of a cloud service that is safe enough. The cost of maintaining these cloud servers is far less than the cost of purchasing and storing them internally on a hard drive" (P3).*

The most important solutions for improving the challenges related to human factors were proper and complete in-service software training while evaluating and updating the system according to user needs. However, one of the experts believed that to solve the problem, we should return to using the traditional method and radiographs.

> *"In-service training increases the quality of the work." (P1)*
>
> *"The system needs continuous and regular evaluation, troubleshooting from the users' point of view, upgrades, and fixing current problems" (P2).*
>
> *"We should take care of whatever we have, and this plan is no exception. This plan and the equipment should be updated. These savings are because of this system, so this must be considered. Infrastructure and training courses should be provided for all colleagues as well as for physicians, including radiologists." (P3)*
>
> *"I don't think it is necessary to implement this system in our centers. We shouldn't do what is done in other countries just to say we have such a system. Because of our internet problems we should use radiographs." (P9)*

It was recommended that PACS be adapted to existing systems in other hospitals in the country and abroad and that a social security contract or Ministry of Health contract be signed with overseas radiologists to reduce legal issues.

> *"Remote working is common all over the world. If there are few radiologists in a center, the center can contract other places that have radiologists and are also equipped with PACS. These radiologists can write reports and get paid. Radiology reports should also be responsible ... so it is good that the organization or ministry contracts radiologists abroad based on PACS" (P1).*

Table 4: Specialists' solutions to improve PACS performance

No	Initial code	Sub Category	Category
1	Strong server	Technical	Infrastructure
2	High-speed national internet		
3	Secure network with appropriate bandwidth		
4	Using software with an domestic source to ensure the security of patients' information		
5	Search for patients based on their ID, instead of their names		
6	Dictaphone for typing reports		
7	Increasing the number of high-quality monitors		
8	Saving the images in the buffer memory in the emergency for faster recovery		
9	Cloud storage and virtual space		
10	Compressing images with software while maintaining their quality		
11	System update and upgrade		
12	Constant upgrading of equipment		
13	Continuous and regular evaluation of the system from the users' point of view		
14	Investing in upgrading PACS infrastructures outside the hospital		
15	Using cyberspace to communicate with outside the center	Communication with the outside hospital	
16	Intranet to access information and images outside the hospital		
17	Using flash memories to communicate with outside the center		
18	Using CDs to communicate with outside the center		
19	Establishing access to the system for the physicians outside the center		
20	Long-term storage of important and special images	Storage	
21	Permanent storage of images		
22	Deleting older images		
23	Saving reports alongside images		
24	Instant access to images in the first 24 hours for faster recovery		
25	Instant access to images in the first 48 hours and then transferring them to the server		
26	Online access to images via cloud storage		
27	Adaptability of PACS with systems available in other hospitals in the country and abroad	Legal	
28	Signing contracts between social security or the ministry of health and overseas radiologists		
29	In-service training	Education	human factors
30	Using the traditional method of radiographs	Attitude	
31	System assessment and update based on user need		

In the end, the specialists were asked to give the PACS used in the hospital a score out of 20. The mean score was 17.4. Furthermore, the participants were asked an open-ended question on the duration of image storage in the system. Most of the participants agreed with keeping them for at least five years.

Discussion

The present study aimed to investigate PACS in social security hospitals. A qualitative research method was applied to conduct the study to achieve an in-depth understanding of the participants' experiences. According to the results, the benefits were divided into three categories of PACS benefits for hospitals, physicians, and patients. According to all of the specialists, the most important benefits of PACS were quick access to information, images, and reports and improved data transfer capability. These benefits lead to faster diagnosis and treatment of the patient. This result is in line with the previous studies (Hasani, Hosseini & Sheikhtaheri, 2020; Al-Kahtani et al, 2021; Ivanov, Gueorguiev, Georgieva & Nenova, 2020; Abodahab, Tharwat, Alserafi & Fawzy, 2020).. Furthermore, according to the specialists, PACS can improve productivity, efficiency, and quality of care by optimizing image quality and accessibility. This finding had been confirmed in previous studies (Alalawi, Eid & Albarrak, 2016; Buabbas, Al-Shamali, Sharma, Haidar & Al-Shawaf, 2016; Aldosari, Saddik & Al Kadi, 2018).

According to the results of the present study, PACS can save time and benefit specialists, radiologists, and patients. These results were in line with other reviewed studies (Kovacs, Cho, Burchett & Trambert, 2019; Shields, 2010; Lepanto, Paré, Aubry, Robillard & Lesage, 2006).

Another benefit stated by most of the experts was the reduction in costs. However, a small number of the specialists did not agree on cost reduction. This finding was in line with the results of the studies conducted by Abbasi et al. Kovacs et al., and Abodahab et al. but was not in line with the results of the study conducted by Ivanov, Gueorguiev, Georgieva & Nenova (2020); Abbasi, Jabali, Khajouei & Tadayon (2020); Kovacs, Cho, Burchett & Trambert (2019); Abodahab, Tharwat, Alserafi & Fawzy (2020). PACS technology has direct and indirect costs and precievable and inprecievable benefits, which economists need to consider in cost-benefit analyse (Hilsenrath et al, 1991; Straub & Gur, 1990).

Disadvantages and obstacles to using a system have a negative impact on users and prevent proper use of the system. The most important obstacle mentioned in the present study was internet disconnection and its low speed and frequent system failures, which lead to disruptions in the use of PACS. These disruptions have negatively affected user and patient satisfaction, leading to a decrease in the quality of care. This limitation was also mentioned in the studies conducted by Al-Kahtani et al. and Farzandipour et al. The participants of those studies complained about slow internet connection and system disconnections (Al-Kahtani et al, 2021; Farzandipour, Sadeqi, Nickfarjam & Tadayon, 2021). Moreover, the results of another study indicated that inadequate training and infrastructure imposed the use of PACS on users (Konstantinidis & Apostolakis, 2020). Data transfer in PACS requires a secure high-speed, and high-volume Internet (Eichelberg, Kleber & Kämmerer, 2020). Therefore, the authorities need to pay more attention to this important and basic infrastructure for PACS (Strintzis, 1998).

Lack of training or inadequate training in PACS use was also a limitation that most participants proposed as a challenge in implementing PACS. This limitation was also mentioned in a study conducted in Saudi Arabia in 2016 as one of the most significant limitations in the proper use of PACS (Alalawi, Eid & Albarrak, 2016). Additionally, the results of the study conducted by Bahador et al. in Shiraz hospitals indicated that more than half of the users were dissatisfied with PACS training (Bahador, Sharifian & Farmani, 2017).

Since end-users are the most important stakeholders of PACS technology, attention must be given to training both before implementation and while working with PACS to achieve the set goals. This was also recommended in other studies (Konstantinidis & Apostolakis, 2020; Bahador, Sharifian & Farmani, 2017; Alalawi, Eid & Albarrak, 2016).

Another limitation that most of the participants pointed out was inadequate image storage capacity and low capacity of the server, which led to the removal of previous images and, therefore, reduced the quality of decision-making based on complete information. To overcome this limitation, experts proposed using servers with higher capacity, using cloud storage, and compressing and reducing the volume of medical images while maintaining their quality. Experts also made these recommendations in other studies (Dragan & Ivetic, 2009; van Ooijen, Ten & Oudkerk, 2005; Armbrust, 2009; Pasquali & Alberich, 2020; Tadros et al, 2021; Chao et al, 1995; Buabbas et al, 2016).

Conclusion

The key to the successful implementation of any type of health information technology is the acceptance of end-users, especially physicians. Their acceptance is influenced by the perceived advantages and disadvantages of the system and its application. Developing the benefits of a system and overcoming its limitations and challenges is influential in users' acceptance and achieving the set goals of that system. The results of the present study and its theoretical model can help policymakers and planners improve the system, the infrastructure, and the strategic planning for the effective implementation of PACS in patient care.

Limitations

The present study was conducted from the perspective of specialists and radiologists, who were PACS users in the hospital. The system should be evaluated from the perspective of patients as well as hospital managers in future studies to confirm the benefits of PACS and conduct a more detailed investigation of its problems.

Ethics Code

This study lacks an ethical code.

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