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Exploring an E-Health Cloud Computing Adoption in Saudi Arabia: Review Article

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Abstract: Within the ever-changing landscape of health care reform, notably in Saudi Arabia, the combination of e-health and cloud computing has the potential to be a game-changer. The use of cloud computing in electronic health care is expertly navigated within the context of the Saudi Arabian setting by means of this comprehensive assessment research. The objective of this study is to investigate the implementation of an e-health cloud computing system in Saudi Arabia by utilizing literature review from various online data repositories. The purpose of this investigation is to identify the factors that have an impact on cloud computing in the healthcare industry. To establish a solid foundation for policy-makers and stakeholders to leverage in their decision-making processes and to ensure the successful adoption of cloud computing technology in Saudi Arabia, researchers in this study proposed an adoption framework by integrating all of the factors revealed from content analysis, the theoretical background, and the existing framework for technology adoption. All of these factors were incorporated into the framework. In order to understand how the implementation of e-health cloud computing within Saudi Arabia's health care system may be properly optimized, and if additional research and analysis are required.

Keywords: *E-health cloud computing; factors affecting adoption; cloud computing framework; technology adoption theories*

1. Introduction

Cloud computing provides an immense opportunity for the health care system in Saudi Arabia to become more efficient and effective, especially for e-Health solutions [1]. As more entities continue to move to cloud computing for e-health, there is the potential for the entire health sector in Saudi Arabia to transform for the better and meet the growing demand for quality care. Saudi Arabia has been engaged in a multiyear transformation effort to create an efficient health care system that utilizes state-of-the-art health care technologies and IT systems [2]. Saudi Arabia has witnessed significant growth in the implementation of e-Health cloud computing systems in recent years [3].

Integrating e-health into the Saudi health care system is a monumental task with massive potential to improve the lives of countless people across the country. Semwanga et al. [4] noted that the application of e-health in health care organizations can result in improved performance and more accurate data access. To make such advancements, a strategic and well-defined framework for implementation is necessary [5]. The initial goal of integrating e-health technology into Saudi's health care system is to maximize its advantages for the population, which means that cloud computing must be part of the plan. According to Alharbi et al. [5], cloud computing enables the rapid and effective sharing of health care information from one hospital to another or from one country to another. It can also serve to manage resources better, particularly if all the related parties (patients, doctors, insurers) can access patient data stored in the cloud. Furthermore, by leveraging cloud computing, Saudi health care institutions will have access to innovative medical applications, enabling them to adopt digital medical technology such as artificial intelligence, the Internet of Things (IoT), and predictive analytics to manage complex medical tasks and data [6]. Alharbi et al. [5] indicated that a major aspect of the framework for implementation is to set a proper set of laws and regulations.

A new game-changer in Saudi Arabia's healthcare system is electronic health, which is the application of ICT to improve the delivery of medical treatment [6]. The Kingdom's ambitious Vision 2030 agenda, which aims to build a knowledge-based economy and enhance the lives of its citizens, is the main reason for the significant advancements in e-health solutions. Cloud computing, a concept for providing on-demand access to computing resources through the internet, is a major reason why e-health solutions have become so popular in Saudi Arabia. Better patient care, more efficiency, and lower costs are the end outcomes of healthcare practitioners' use of cloud-based technology to securely access and exchange patient data [5].

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1.1. Cloud Computing in the Process of E-Health Adoption in Saudi Arabia

A nationwide electronic health record (EHR) system called the Saudi Health Information Exchange (SEHIE) was built by the Kingdom of Saudi Arabia, which has invested heavily in e-health infrastructure development [7]. Electronic health care is rapidly expanding in Saudi Arabia, with more and more people using telemedicine, RPM, and mobile health apps, among many others. While EHR adoption is growing quickly in Saudi Arabia, it is still relatively low compared to other countries. As an example, by 2022, 30% of Saudis will have used electronic health records (EHR), up from 5% in 2015 [7]. Healthcare in Saudi Arabia stands to benefit from e-health since it offers the possibility of more accessible, faster, and personalized treatment. Patients in far-flung areas or with long-term health conditions can get the care they need through telemedicine, for example [6]. The healthcare business stands to gain even more efficiency from e-health's ability to cut down on paperwork and simplify administrative tasks. Electronic prescribing, for example, may increase medication adherence and decrease the frequency of mistakes [5]. Healthcare costs could be reduced through the use of e-health since it streamlines administrative tasks and does away with the need for on-premises technology and software, take, for example, the possibility of cutting IT spending by half with cloud-based e-health solutions [5]. The use of electronic health records has the potential to revolutionize medical treatment in Saudi Arabia. By investing in e-health infrastructure, developing e-health apps, and encouraging the adoption of e-health, Saudi Arabia may enhance patient care, boost efficiency, and decrease healthcare costs [5]. One of the most important factors facilitating the implementation of EHRs in Saudi Arabia is cloud computing. Comparing cloud-based solutions to conventional on-premises infrastructure, there are several advantages [8, 9]. Rapid scalability is a key feature of cloud-based solutions that allow them to meet the dynamic needs of healthcare providers. It is possible to reduce IT spending with cloud-based solutions since they do not require on-premises software and hardware maintenance [2,5]. With a cloud-based system, all you need is an internet connection, regardless of where you are. Medical professionals can now more easily access patient records and communicate with one another because to this. Cloud service providers use rigorous security measures to protect patient data [1]. Thanks to e-health and cloud computing, Saudi Arabia's healthcare system is seeing a sea change. By embracing e-health solutions and utilizing cloud-based technologies, Saudi Arabia can enhance patient care, boost efficiency, reduce costs, and empower its citizens to take charge of their own health. The Kingdom is poised to become a world leader in healthcare thanks to its continuous investments in cloud computing and electronic health records [5]. According to the findings of a few studies, cloud computing for e-health has the potential to enhance patient care by making it significantly more accessible, fast, and tailored. However, some studies have discovered that cloud-based solutions can also result in the fragmentation of care, an increase in the load of administrative work, and the possibility of privacy problems [2]. Through the elimination of the requirement for on-premises hardware and software, as well as the streamlining of administrative rocedures, e-health cloud computing has the potential to minimize the expenses associated with healthcare. Other studies, on the other hand, have discovered that cloud-based solutions can also incur significant expenses related with the movement of data, training, and ongoing maintenance [2,5].

Moreover, technological and structural readiness should be determined to understand the preparedness of each health care institution for integrating e-health services. This process should identify the strengths and weaknesses of each institution, as well as potential challenges and requirements. The successful integration of e-health technology into the Saudi health care system will likely involve establishing both infrastructure and well-defined policies. To ensure this, all stakeholders must work together to ensure the smooth and effective deployment of cloud computing technologies, legal regulations, and organizational readiness. Such an initiative can significantly contribute to the health and welfare of the Saudi population. Currently, we offer an overview of cloud computing adoption in the health care sector, highlighting the unique difficulties and factors. According to the broad objectives, this study specifically aims to accomplish the following objectives:

- Explore the adoption of an e-Health cloud computing system in the Saudi Arabian health care sector.
- Identify the factors necessary for the successful adoption of cloud computing in the Saudi Arabian health care sector.

1.2. Organization of the paper

This paper is organized as follows: Section 2 presents the methodological farmwork; Section 3 presents preliminaries and literature review; Section 4 presents research challenges; Section 5 presents theoretical background for technology adoption; Section 6 discusses the findings and Section 7 concludes the paper

2. Methodological Framework

This research undertook a comprehensive analysis of academic literature, official papers, and online data repositories in order to present a comprehensive picture of the current state of e-health and cloud computing in Saudi

Arabia. Following are some of the factors that were used to determine the selection of sources:

• Regarding the subject of e-health and cloud computing in Saudi Arabia, the source ought to be directly pertinent to the discussion at hand.

• It is essential that the source be legitimate, with a renowned author or institution being the provider of the information.

• The source should be up-to-date, reflecting the most recent advancements in e-health and cloud computing in Saudi Arabia.

For the purpose of ensuring that the literature evaluation is exhaustive and covers all pertinent studies on the subject of e-health cloud computing adoption, we have taken the necessary precautions. We have looked at various online available repository. It is critical to conduct a thorough literature study before starting the facts series, which involves exploring several instructional databases, books, publications, and different pertinent sources. The literature overview aims to pinpoint the elements that substantially impact the world of e-health's adoption of cloud computing. This study looks at evaluations of earlier research from online resources. Related articles have been discovered using keywords such as cloud computing, e-health cloud computing, adoption, factors affecting adoption, technology adoption theories, cloud computing framework, and mixtures of those key phrasesFor the purpose of ensuring that the literature evaluation is exhaustive and covers all pertinent studies on the subject of e-health cloud computing adoption, we have taken the necessary precautions. We have looked at various online available repository. It is critical to conduct a thorough literature study before starting the facts series, which involves exploring several instructional databases, books, publications, and different pertinent sources. The literature overview aims to pinpoint the elements that substantially impact the world of e-health's adoption of cloud computing. This study looks at evaluations of earlier research from online resources. Related articles have been discovered using keywords such as cloud computing, e-health cloud computing, adoption, factors affecting adoption, technology adoption theories, cloud computing framework, and mixtures of those key phrases.The papers, technical reports, and other pieces of literature that were found by the search phrase were chosen for the data collection based on the following criteria:

• Publications that describe e-Health cloud computing.

• Publications that describe the critical success factors in the adoption of e-health cloud computing.

Which pieces of literature returned by the search query will be omitted was decided using the following criteria:

• Publications that are not relevant to the research objectives.

• Publications that do not describe factors in the computing adoption process.

The results of the search show that 851 documents about cloud computing for e-health were produced. Despite the search method making a vast amount of data accessible, the researcher used the data cleaning process to eliminate all duplicates. The researcher was left with 340 articles after removing redundant sources. To check that the sources matched the relevant inclusion criteria, an analysis of the abstracts and titles was also performed. Regarding the research designs and technique, the final elimination took place. Because they did not match the criteria for inclusion, a total of 215 items were eliminated. Using population, intervention, and outcome criteria, more publications were removed. Ultimately, only 56 publications were used in the investigation. Figure 1 of the study flowchart illustrates the search process.

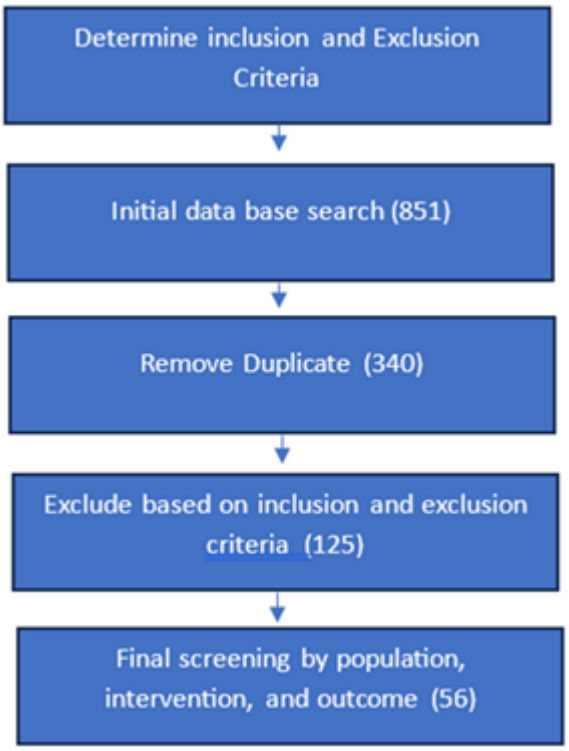


Fig. 1. Search process flowchart.

3. Preliminaries and Literature Review

This section explores the history surrounding e-health cloud computing in general, offering an in-depth understanding of adoption rates. It also explores theories for successful e-health cloud computing while also providing potential frameworks best suited to Saudi Arabia's unique e-Health care domain.

The theoretical foundation for the implementation of cloud computing in e-health is robust and pertinent, drawing

upon well-established ideas and models from a variety of domains, such as the acceptance of technology, the dissemination of innovation, and the transformation of organizations. In especially with regard to healthcare organizations, these theories offer a framework that may be utilized to get an understanding of the elements that influence the adoption of new technology [9].

3.1. Preliminaries

Because engineers and academics have varied interests, there is no universally accepted definition of cloud computing. The US National Institute of Standards and Technology's (NIST) definition of cloud computing is the most popular. Cloud computing allows users to quickly access a shared pool of computing resources such as networks, servers, storage, applications, and services. These resources can be quickly provisioned and released with little management effort or interaction with service providers, as stated by NIST [8]. Cloud computing is characterized by features such as self-service on demand, network accessibility, pooling of resources, quick elasticity, and measured service [8].There are three distinct ways that cloud computing services can be provided. Users can access application software using software as a service (SaaS) and pay for it as they go [9]. It launches a single instance of the program and makes it accessible to numerous users. Operating systems, language execution environments, databases, and web servers are the major components of a platform as a service (PaaS) development environment [10]. Virtualization, storage, networking, and servers are all part of the computing resources made available to users through infrastructure as a service (IaaS) [8].

3.1.1. Cloud Computing Software as Services

SaaS represents a paradigm shift in software delivery, as the service provider hosts the software on their cloud infrastructure and enables end users to access it via a web browser [11]. SaaS has the potential to significantly reduce the time and effort required to acquire cloud computing services. Reference [12] highlighted the many processes that SaaS eliminates, including administrative approvals for hardware and software procurement and technical development, deployment, and testing. However, security concerns pose a major obstacle for many businesses considering adopting SaaS. Ferreira et al. [13] noted that these concerns include data location, access, segregation, and integrity. Adopting a SaaS solution necessitates carefully considering and managing these security and policy concerns. The challenges involved in integrating SaaS applications with cloud-based or on-premise applications have been a topic of concern due to the lack of a standardized Application Programming Interface (API) [12]. This has posed a significant hurdle to the efficient functioning of these applications. However, researchers have identified solutions to overcome these challenges. Organizations seeking to adopt SaaS or other cloud computing solutions must understand the service level agreements (SLAs) that they must accept and monitor [11]. This knowledge will enable them to establish best practices and optimally utilize cloud computing solutions. Despite this, the SaaS model offers clear advantages in regard to pricing. Unlike other cloud computing models such as PaaS and IaaS, SaaS offers simple and straightforward pricing schemes, whereby the cloud consumer pays per month and/or per user [11].

3.1.2. Cloud Computing Platform as Services

Cloud computing platforms as services refer to a suite of tools ranging from libraries and infographics essential for building and deploying exciting applications [14]. These platforms feature abstraction layers that enable application development without concerns about background hardware or software infrastructure support. Cloud computing has numerous app deployment and creation advantages, as it allows developers to focus more on innovation than on infrastructure management [15]. Platforms such as these are incredibly scalable—operating nearly in tandem with business needs—while significantly slicing costs related to deploying apps. However, using these services is not without its drawbacks, one of which is the inability to customize the underlying infrastructure properly considering it is subject to third-party control, ultimately compromising app uniqueness [16].

3.1.3. Cloud Computing Infrastructure as Service

Infrastructure as a service is now commonly adopted by businesses worldwide using this virtualized network resource allocation system that comprises computing power, storage capacity and network access [17]. The most effective way to manage existing IT systems' entire lifecycle is to scale resources up and down effectively using IaaS [18]. Virtualization technology empowers businesses to allocate computing resources based on their needs, leading to optimum hardware utilization levels and more flexible IT operations. AWS, Google Cloud, Microsoft Azure & IBM Cloud provide IaaS services uniquely designed with features/benefits such as AWS's reliability and robustness in its cloud infrastructure management [19]. Table 1 illustrates the main differences between the three model services of cloud computing.

Table 1: Summary of differences between cloud service types and features

Feature	***Public Cloud***	***Private Cloud***	***Hybrid Cloud***
Deployment	Off-premises	On-premises or off-premises	Combination of public and private cloud
Infrastructure	Shared with other users	Dedicated to a single organization	Shared and dedicated resources
Cost	Pay-as-you-go	Higher upfront costs, but lower long-term costs	Depends on the specific configuration
Scalability	Highly scalable	Less scalable than public cloud	Scalable, but may require more planning and coordination
Security	Shared responsibility between provider and customer	Full control over security	Shared and dedicated security measures
Control	Limited control over infrastructure and software	Full control over infrastructure and software	Shared and dedicated control
Suitability	For organizations that need flexibility, scalability, and cost-efficiency	For organizations that have strict data privacy and security requirements	For organizations that need a combination of flexibility, scalability, and control

3.2. cloud Computing in the Saudi Health care Context

Studies have explored the implementation of cloud computing in the health care sector of Saudi Arabia. Specifically, King Abdulaziz City for Science and Technology (KACST) implemented cloud computing to support the Saudi Genome Project (2015), and Azzedin et al. [20] created the Disease Outbreak Notification System (DONS). However, these studies solely focused on the technical implementation of cloud computing, neglecting the factors that contribute to its adoption within the health care organizations of Saudi Arabia. As a result, the research gap becomes evident, wherein the implementation of electronic services in health care lags behind that in other sectors, such as banking and industry [21], [22].

The Saudi Arabian health care sector is facing the challenge of understanding the potential benefits and challenges of adopting cloud computing systems. This nation's dispensation of health care services poses a formidable challenge for the Saudi government owing to its expansive geographical expanse and many rural areas [23]. Moreover, it is noteworthy that health care services are offered free of charge to all Saudi nationals as a customary practice [24]. The population of Saudi Arabia stands at 32.2 million individuals [25], and their distribution across a vast land area of 2 million km2 [26] leads to a lack of uniformity. This, in turn, engenders the fragmentation of health care systems within the country [22], necessitating additional financial resources to maintain superior health care services. Furthermore, it is imperative to recognize that the sociocultural milieu prevalent in Saudi Arabia cannot be underestimated, and Saudi Arabia's strict gender segregation has profound implications for implementing cloud computing, particularly within the health care sector. The application of gender segregation in workplaces necessitates the establishment of separate cloud infrastructures and access controls to adhere to cultural norms [27]. Consequently, this gender-based segregation affects cloud computing in several ways. First, gender segregation often leads to limited access to resources and infrastructure necessary to effectively deploy cloud computing solutions in health care organizations. The separation of facilities and work environments for men and women can result in challenges when managing and implementing cloud-based systems. Second, gender segregation may result in a smaller pool of skilled professionals available for cloud computing initiatives, thus hindering development, implementation, and management [28]. If certain technical roles are restricted to women or opportunities for professional growth are denied, the expertise available for cloud computing projects decreases.

Furthermore, in a gender-segregated environment, communication barriers may emerge, necessitating additional approvals or restricting communication between male and female professionals [28]. This can hinder collaboration and teamwork, thus impacting decision-making and problem-solving processes crucial for the success of cloud computing implementation.

The lack of data on present conditions affecting E-health cloud-computing adoption rates poses an obstacle when developing a framework encompassing all necessary criteria and context-specific requirements [29]. However,

given the present circumstances, a lack of information regarding essential factors, including cultural-social factors, technical complexities, regulations and policies, leaves devising adequate strategies problematic. To address this issue of whether to develop contextualized frameworks, further exploration focusing on e-health cloud computing adoption in Saudi Arabia is needed. Methodologies should center around assessing levels of awareness concerning available information and taking into account specific challenges encountered throughout the adaptation process [6].

4. Research challenges

4.1. Compatibility

Compatibility refers to how well a technology can fit in with its users' needs, values, and existing experiences [29]. Research conducted by Meri et al. [30] has suggested that one of the key aspects of the successful adoption of e-health in cloud computing is ensuring compatibility with existing health information systems and practices. Several studies have assessed the role of compatibility in e-health in cloud computing. Faloye et al. [31] suggested that there is a need to increase the level of compatibility between existing health care systems and cloud computing technology. Moreover, Calegari and Fettermann [32] found that e-health solutions that are tailored to individual patient preferences can facilitate faster adoption because it is necessary to ensure that existing health care systems can be integrated with new e-health technologies and that user preferences are considered [33].

4.2. Relative advantage

A large body of literature has examined the relative merits of e-health in cloud computing and its effects on adoption. First, because health care data is accessible in real-time through e-health in cloud computing, wait times are drastically reduced, accuracy is improved, and the likelihood of errors is decreased [34]. According to Alharbi et al. [34], one of the biggest benefits of e-health on the cloud is the ability to access data in real-time. Reason being, it cuts down on the time medical staff spends physically processing paperwork or entering data into several systems while also increasing accuracy. One of the most significant benefits of e-health in cloud computing is the enhancement of health care service quality [35]. Cloud computing allows medical professionals to access accurate patient records and base their judgments on them. Furthermore, healthcare providers can spend more time delivering direct patient care because these data are more easily accessible [36]. Medical professionals can better serve their patients when they have access to up-to-date, reliable information on their health. Medical treatment systems also benefit greatly from the efficiency gains brought forth by cloud computing. Franca et al. [37] showed that the administration and organization of patient care operations are helped by using efficiency measures, such as automated workflows. The use of cloud computing also helps bring down healthcare costs [6]. Cloud computing has helped bring down healthcare costs by making data storage and processing more efficient and doing away with paper-based solutions. Cloud computing also enhances healthcare providers' capacity to collaborate and communicate with one another [38]. According to Adler-Milstein et al. [39], secure messaging and data-sharing platforms facilitate better communication and collaboration among healthcare providers, leading to more consistent and high-quality patient care.

4.3. Security and privacy

Electronic health records and cloud computing are becoming more popular due to the healthcare industry's growing dependence on technology [40]. Protecting the privacy of patients' medical records is of the utmost importance, and this raises concerns about data security and privacy, according to Chenthara et al. [40]. Concerns about data privacy and security have a direct impact on the uptake of e-health in the cloud, according to the research. When dealing with sensitive medical information, it is important to keep patient privacy in mind, according to Chomutare et al.There are opportunities to develop more secure systems for storing and communicating health care data, but privacy and security are major variables influencing the use of e-health in cloud computing [35]. As an example, new possibilities for improving the privacy and security of cloud-stored data have emerged thanks to technical advancements like blockchain, as pointed out by Sivan and Zukarnain [35]. Health care businesses can gain more control and access to data through improvements in authorization, user authentication, and identity and access management. This will create a safe and private environment for cloud-based e-health apps [41].

4.4. Technical Complexity

More and more research suggests that the specific technical expertise needed to effectively adopt and maintain technology makes it extremely challenging for health care organizations to satisfy their health care needs through technology leveraging [36]. According to studies looking at how technical complexity affects cloud computing e-health, healthcare companies don't have what it takes to make good use of the technology [30].Furthermore, studies on cloud computing for e-health have shown that the level of technical complexity might differ from one company to the next [38]. For instance, when it comes to e-health in the cloud, firms that already have an IT infrastructure might not need as many technical resources as those who don't. Technical complexity can also be influenced by the organization's unique aims and priorities, in addition to the resources at their disposal [31].

4.5. Regulations and policies

The health care business is rapidly adopting cloud computing for e-health purposes. This is because it could provide major advantages in terms of cost, accessibility, and data management, all of which are important considerations. Still, businesses can't enjoy these perks without following stringent rules and laws on data, privacy, and security protection [42]. Cloud computing laws and regulations pertaining to e-health should address all relevant aspects of the healthcare system, say Kaur et al. [42]. Among these considerations are the many issues with ethics, law, regulation, and safety. Protecting the privacy and security of patients' information and ensuring their consent before using it are two of the primary goals of health information legislation and regulations like HIPAA and the EU's General Data Protection Regulation (GDPR) [43]. Given the complexity and dynamic nature of these requirements, it is imperative that organizations consistently demonstrate compliance.

4.6. Cost Effectiveness

One major obstacle to using e-health cloud computing, according to research by Alkurdi [29], is the associated costs. Before committing to cloud computing, healthcare organizations should calculate the whole cost, which includes not just the initial investment but also ongoing expenses for things like software, hardware, network infrastructure, and security. In the healthcare industry, for example, a shortage of qualified information technology workers can drive up indirect costs, according to research by Meri et al. [30]. There are a number of tactics that healthcare companies can employ to lessen the financial impact of e-health cloud computing, which is a major barrier to adoption [38].

4.7. Infrastructure

According to the findings of a study that was carried out by Alkurdi [29], the expense of implementing cloud computing for e-health is a significant hurdle. The whole cost of installing and sustaining cloud technology is something that health care businesses need to take into consideration. This includes the cost of procuring hardware, software, network infrastructure, and security. A shortage of experienced information technology personnel, for example, can lead to increased indirect costs in health care organizations, according to the findings of a study that was carried out by Meri and colleagues [30]. Despite the fact that cost is an important issue that influences the adoption of cloud computing for e-health, there are a number of ways that health care organizations may take to reduce the impact of these expenses [38].

4.8. Cultural and societal factors

In the process of implementing cloud computing for e-health, cultural and societal issues are extremely important [32]. Individuals who receive medical care and those who give medical care have distinct interests and values, which influence their propensity to adopt cloud-based electronic health record systems. According to the findings of a study conducted by Alharbi and colleagues [34], patients were more likely to feel comfortable using e-health cloud computing if they evaluated the system to be user-friendly and helpful. On the other hand, people were less inclined to accept the e-health cloud system if they had concerns about their privacy, if they did not trust the technology, or if they did not trust the particular health care provider. On the other hand, health care professionals were more likely to use cloud-based electronic health record systems if they judged these systems to be efficient and successful in improving patient outcomes [30].

5. Theoretical Background for Technology Adoption

Healthcare businesses can benefit from the E-health Cloud Computing Adoption Framework's comprehensive and methodical approach to e-health solution implementation in the cloud. Several theoretical frameworks served as inspiration for the framework's structure and components. Many factors impact the adoption of new technology, especially in healthcare companies. These frameworks provide understanding into these difficulties [25].

For healthcare companies looking to successfully implement cloud-based e-health technologies, the E-health Cloud Computing Adoption Framework offers a thorough and systematic approach. A variety of theoretical models serve as inspiration for the framework, which influences both its overall design and its individual components. Particularly relevant to healthcare companies, these models illuminate the multitude of elements that influence the adoption of new technologies [18].

5.1. Unified Theory of Acceptance and Use of Technology (UTAUT)

Information and communication technology (ICT) systems, including cloud computing or e-health systems, have gained widespread popularity over the years, necessitating an effective theoretical framework such as the Unified Theory of Acceptance and Use of Technology (UTAUT) to understand how and why people adopt new technologies [45]. According to UTAUT, four essential ideas power adoption decisions: performance expectancy, effort expectancy, social influence, and facilitating conditions [46]. Performance expectation refers to an individual's belief that adopting cutting-edge technologies will enhance their ability to meet specific goals or perform better [46]. Effort expectation highlights the user-friendliness aspect of a designated ICT system. Social influence underscores how opinions and beliefs influence

ICT adoption. Finally, facilitating conditions reflect whether practical support such as training programs or technical assistance is readily available for users navigating newly adopted digital systems [46].

Undoubtedly, one of UTAUT's standout features is its comprehensive nature, which enables it to illuminate multiple potential motivators behind moves toward increased digital technology incorporation in personality contexts at once while also accounting for big picture factors such as wider societal trends, offering versatility and multiple approaches available for users when evaluating specific advancements that are most useful [47]. It facilitates the recognition of key elements influencing technology uptake within individuals' daily practice routines [45]. According to Tamilmani et al. [45], this helps policy-makers determine ideal corrective measures if needed or tools for encouraging positive user attainment milestones.

5.2. 5.2 Diffusion of Innovations Theory

The Diffusion of Innovations Theory holds a vital position as a framework used widely in discerning how innovative methods are adopted across industries, including health care [48]. This theory suggests that when adopting newer technologies, the relative advantage, compatibility, complexity, and trialability alongside observability elements as factors must be considered. Relative advantage refers to how the new technology is viewed versus its predecessor. In e-health systems and cloud computing, users view these technologies as superior to traditional health care methods by increasing efficiency while safeguarding patient data [49]. Compatibility indicates how much technical tools align with the values and experiences of their users [34]. Complexity signifies how hard it seems to adopt a new technology being perceived as problematic in understanding or using it initially, as confusing elements are factored as in [29]. Trialability involves evaluating an innovation before committing fully to assess its impact thoroughly and making informed decisions accordingly [48]. In health care technology adoption, observability refers to how apparent its benefits are for others [48]. To help guide the understanding of how new technologies in health care are adopted successfully requires a framework such as diffusion of innovations theory. Table 2 shows a summary of the two theories mentioned above.

Table 2: Summary of technology adoption theories

Unified Theory of Acceptance and Use of Technology	Diffusion of Innovations
• Performance expectancy	• Relative advantage
• Effort expectancy	• Compatibility
• Social influence	• Complexity
• Facilitating conditions	• Trialability
	• Observability

5.3. Framework for Cloud Computing Adoption

Healthcare businesses can benefit from the E-health Cloud Computing Adoption Framework's comprehensive and methodical approach to e-health solution implementation in the cloud. The fields of organizational change, innovation dispersion, and technology adoption provide the solid groundwork for the framework. Starting with the preliminary evaluation and planning stages and continuing through the implementation, evaluation, and continuous improvement phases, it handles all the main components of the adoption process [16].

Each part of the E-health Cloud Computing Adoption Framework is heavily dependent on and linked to every other part. To ensure a successful adoption, a comprehensive approach is needed, one that considers every step of the process, from preliminary review and planning to ongoing optimization and assessment. The following frameworks provide an organized and educated decision-making process for companies to ensure effective adoption, alignment with organizational goals, and adaptation of cloud-based e-health solutions to meet the evolving demands of healthcare delivery.

5.3.1. HIPAA Framework

With the ultimate objective of preserving patient privacy, maintaining health care data security, and enforcing solid data governance, the Health Insurance Portability and Accountability Act (HIPAA) on the cloud serves as a key framework in the promotion of secure cloud computing practices in the health care sector. There are a variety of essential procedures and prerequisites that are essential to the operation of this framework. These include restricting data access to particular users, ensuring data security through encryption, providing persons with the right to request data, and allowing investigations into potential data breaches [50]. As an additional point of interest, it highlights the need of utilizing advanced data security mechanisms such as two-factor authentication, data encryption, and storage systems such as the cloud key

management system (CKMS) in order to secure the confidentiality and integrity of health care information [51]. Indeed, recent research conducted by Al-Marsy et al. [52] highlights the significance of HIPAA on the cloud in their evaluation of the advantages and disadvantages associated with it. This evaluation was based on the findings of interviews with stakeholders in the health care business in the United States. In general, this framework is essential for strengthening confidence and transparency in the management of sensitive patient information in cloud computing activities within the health care industry.

5.3.2. HIMSS cloud computing adoption model (CCAM)

For the purpose of assisting health care organizations in assessing the level of cloud adoption that they are now experiencing, the Healthcare Information and Management Systems Society (HIMSS) established the cloud computing adoption model (CCAM) [53]. The CCAM framework is comprised of many stages of cloud adoption, which academics employ in order to evaluate the level of maturity that health care organizations have reached in their journey toward cloud computing. When it comes to analyzing the level of progress that health care organizations have made in adopting cloud computing, the Cloud Computing Assessment Model (CCAM) has shown to be an invaluable instrument [54]. This is because it offers useful insights into an organization's readiness to implement cloud-based solutions.

5.3.3. The Five Rights Framework

The purpose of this paradigm is to emphasize how important it is to make sure that all five rights—right information, user, process, place, and time—are respected [55]. The use of the Five Rights Framework brings to light the relevance of cloud systems that have been correctly implemented in the health care industry, hence paving the way for health care services that are of higher quality and more efficient [56].In the previous part, the framework for cloud computing adoption in the health care sector was presented. This framework was designed to provide assistance to health care companies in Saudi Arabia as they move toward adopting cloud computing. An overview of the frameworks may be seen in Table 3.

Table 3: Summary of cloud computing adoption frameworks

Framework	Main goal	Limitations
HIPAA	Protecting patient privacy, ensuring the security	• Outdated nature of HIPAA regulations
CCAM	Evaluating the level of progress made by health care organizations in adopting cloud computing	• Focuses on assessing technological aspects of cloud adoption • Neglect the organizational, and cultural factors
Five Rights	Emphasizing the importance of all Five Rights: right information, user, process, location, and time	• Lacks specificity in certain technical aspects of cloud computing in health care

6. . Findings and Discussion

6.1. E-Health Cloud Computing Adopting Factors

Upon evaluating previous literature on cloud computing, the authors found that the factors for the adoption of cloud computing can be categorized into three groups. A clear representation of the three groups of factors is depicted in Figure 2, which includes the general cloud computing adoption factors (GCCAF) and specific cloud computing adoption factors (SCCAF) that are applicable to the context of Saudi Arabia and common cloud computing adoption factors (CCCAF). The analysis reveals a set of common factors present in both the general and specific groups, along with factors that are exclusive to the adoption of cloud computing in Saudi Arabia. Such an assessment of cloud computing adoption factors can significantly aid in guiding policy-makers and stakeholders on appropriate approaches toward adopting cloud computing technology in Saudi Arabia. It provides insight into the common factors that affect cloud computing adoption in different regions and a detailed understanding of the specific factors exclusive to the country. Such a nuanced understanding of the cloud computing adoption factors is essential to ensure that any strategies adopted align with the specific requirements and conditions of the country. This further reinforces the need to address and accommodate country-specific factors when considering the implementation of cloud computing. This comprehensive analysis establishes a solid foundation for policy-makers and stakeholders to leverage in their decision-making processes and ensure the successful

adoption of cloud computing technology in Saudi Arabia.



Fig 2. Cloud computing adoption factors

6.2. Framework for Cloud Computing Adoption

From previous literature analysis we can observe that the available frameworks take into account critical aspects of the system: its relative advantage, compatibility, complexity, trialability, and observability. Be sure that cloud-based e-health solutions are compatible with current systems and workflows, not too complicated, easy to test, and somewhat beneficial for them to be viewed as having these traits. Perceived utility and simplicity of use are two key aspects impacting the adoption of new technology. In response to these worries, the frameworks ensure that e-health solutions hosted in the cloud are both easy to use and generally seen as beneficial in enhancing patient care [27].

Leadership support, resource availability, employee buy-in, effective communication, and change champions are among elements that are considered in these frameworks. Involvement of employees in decision-making and implementation, effective communication of the benefits and expectations of cloud-based solutions, allocation of resources for training, support, and infrastructure upgrades, and strong support from senior management are all crucial to achieve this goal. Incorporating various findings from the review of existing literature, the frameworks provide an all-encompassing, evidence-based approach to cloud-based e-health [5,16]

Top-down buy-in, change champions, efficient communication, staff buy-in, and resource availability are all factors that the framework takes into account. Successful implementation of cloud-based solutions requires strong support from senior management, the identification and empowerment of change champions, clear and effective communication of the benefits and expectations of these solutions, employee participation in decision-making and implementation, and the allocation of appropriate resources for training, support, and infrastructure upgrades [5].

Healthcare organizations can benefit from the E-health Cloud Computing Adoption Framework's methodical and knowledgeable approach to implementing cloud-based e-health solutions. The goal of the framework is to ensure that cloud computing is widely used and that its advantages are fully utilized to improve healthcare delivery. To achieve this, we will include the results of the literature review, draw on well-established frameworks, and follow industry best practices [4].

The E-health Cloud Computing Adoption Framework offers a structured and knowledgeable approach to assist healthcare organizations in embracing cloud-based e-health technologies. The framework's stated goal is to improve healthcare delivery by maximizing the benefits of cloud computing and easing its implementation. We will accomplish this by drawing on established theoretical frameworks, applying best practices, and incorporating findings from the literature review [17].

The regulatory frameworks and other intricacies of cloud computing integration in Saudi Arabian healthcare have so far escaped the attention of existing research [1]. It has become clear from reviewing the current cloud computing adoption frameworks that they do have some shortcomings. The current models and frameworks largely ignore other important factors in favor of focusing on the tactical and operational levels. There may be substantial cultural and organizational differences in the way different nations execute IT projects, even though most frameworks focus on the technological aspects of cloud computing [38]. If we want to learn more about cloud computing adoption, we need to look at how these aspects affect various industries and nations. Previous studies have shown that different contexts have varied impacts of organizational and environmental elements on cloud computing adoption. However, most frameworks are too broad and don't target particular industries like healthcare. This presents a problem since different nations may have diverse business climates that must be addressed individually. Cloud computing adoption might be greatly improved if additional research were to be undertaken to develop a suitable framework that accounts for cultural and organizational diversity [15]. In order to create a systematic representation of the specific variables required for cloud computing adoption in Saudi Arabia's e-health industry, the authors propose an adoption framework that would effectively combine all important factors uncovered throughout the lengthy literature review. With this approach, we hope to propel policy concerning the use of cloud computing in e-health and provide critical direction to important decision-makers. In order to help individuals, organizations, and policy-makers make informed decisions, this proposed framework aims to provide an orderly and effective solution by incorporating all relevant facts and elements. Consequently, this new paradigm for e-

health cloud computing adoption will simplify and expedite the deployment of cloud computing while successfully addressing the unique issues encountered by Saudi Arabia.

This framework combines the DOI and UTAUT theories. According to DOI, the authors split the decision factors into four categories: relative advantage, compatibility, complexity trialability and observability elements that must be considered [48]. According to UTAUT, there are four essential ideas that power adoption decisions: performance expectancy, effort expectancy, social influence, and facilitating conditions [46]. In this framework, additional factors specific to cloud computing, such as data security, can be considered, and the authors integrate this framework with the available frameworks in the literature, including HIPAA, CCAM, and the Five Rights Framework. The proposed framework for adopting cloud computing is explained in Figure 3.

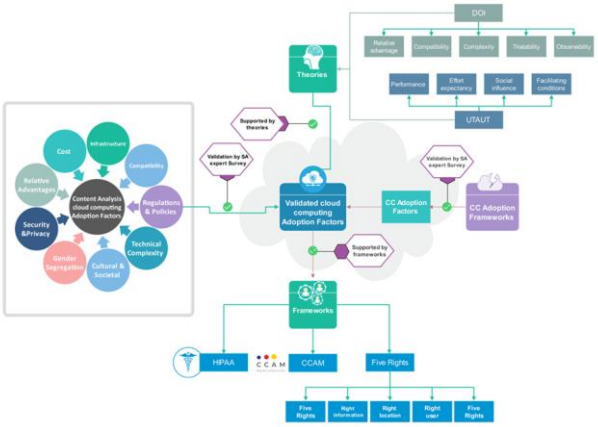


Fig 3: Cloud computing adoption framework

Healthcare delivery, patient outcomes, and resource utilization could all see major improvements with the introduction of cloud computing for e-health in Saudi Arabia [20, 21]. Many policy considerations must be taken into account, however, to ensure a smooth rollout and broad acceptance. Protecting private patient information kept in electronic health record systems hosted in the cloud requires the implementation of data privacy and security regulations[21]. The promotion of open application programming interfaces (APIs) and standardized data formats is crucial to ensure a smooth integration of cloud-based e-health systems with the current healthcare infrastructure. As a result, there will be less friction in the transfer of data and more interoperability among different healthcare providers. Healthcare personnel should be equipped with the ability to effectively utilize cloud-based e-health tools and technologies through extensive digital literacy and training programs[21].

It is important to inform patients about the benefits and risks of cloud-based electronic health services through patient education programs. Promoting patient engagement in decision-making, keeping lines of communication open to resolve concerns, and building trust in the stated technology are all important. It is recommended that cloud-based e-health services be subject to a transparent and all-encompassing regulatory framework[7,21].

6.3. Strategies to overcome challenges in integrating cloud-based e-health technologies

One concern with healthcare data kept on the cloud is the potential for data breaches and illegal access, given the sensitive nature of the data. To resolve these issues, strict data governance policies, strong security measures, and full compliance with data protection regulations must be put in place. Ensuring seamless communication between disparate systems and integrating cloud-based e-health technologies with the existing healthcare infrastructure can be challenging. Data interchange can only take place with the help of open APIs, standardized data formats, and reliable communication protocols [40].

The ability of healthcare staff to effectively utilize e-health tools and technologies hosted in the cloud depends on their level of digital literacy and technological proficiency. It is critical to offer them thorough training programs and ongoing support so they can exploit these technologies efficiently. Concerns about data privacy and security in the cloud are understandable among patients. Patient education initiatives, effective communication strategies, and involvement in decision-making processes can all help foster trust and encourage adoption [41].

Adoption may be hindered and uncertainty may arise due to the ever-changing legal and regulatory environment surrounding cloud-based e-health services. Helpful regulatory environments are the result of concerted effort by government agencies, technology suppliers, and healthcare providers, as well as the establishment of transparent data governance systems and well-defined legal frameworks. Improving current infrastructure and expanding internet connectivity nationwide are critical measures that should be undertaken to promote broad adoption [21,40].

Electronic health records (E-health) and cloud computing have emerged as essential tools in the fast changing environment of the healthcare industry today [52]. These solutions have the potential to improve patient care, enhance efficiency, and reduce costs. Healthcare practitioners are able to access and exchange patient data in a secure manner, provide remote monitoring and care, and develop breakthrough new treatments and cures when they use the potential of cloud-based technologies [2,5,34]. Because we are stakeholders in the healthcare industry, it is absolutely necessary for us to take into consideration the findings about cloud computing and e-health when we are making decisions. Through the adoption of these

technologies, we will be able to collaborate in order to improve the quality of care that is provided to patients, increase the efficiency of our healthcare system, and decrease operating expenses. By cooperating with one another, we will be able to harness the power of cloud computing and electronic health records to revolutionize the healthcare business and make medical treatment more accessible to patients all over the world [5.34].

7. Conclusion

Generally, the integration of cloud computing within Saudi Arabia's health care system offers significant advantages that require further exploration and investigation to determine how its adoption can be fully optimized.

The current body of literature reveals that there is a need for further exploration regarding the adoption of cloud computing in Saudi Arabia, particularly in the health care sector. Researchers have suggested that the investigation should take into account the various cultural, social, and technical factors, as well as the method of financing. Differences in health care environments across different countries highlight the need for a context-specific approach when analyzing health care systems. Moreover, cultural differences play an important role in the adoption of IT in health care systems around the world. Therefore, each country's health care system must be studied as an individual case, taking into account its unique characteristics and contextual factors.

The development and implementation of robust security mechanisms and data governance principles in cloud-based e-health systems are a matter that requires additional investigation. This is necessary in order to safeguard sensitive patient information. Among these are the investigation of sophisticated encryption methods, access control mechanisms, and tactics for preventing the loss of data. This article infers that implementing strict security measures is required to protect patient information and ensure data privacy since healthcare data is sensitive. To ensure compliance with data protection obligations, solid legislative frameworks and clear data governance norms must be put in place.

More over the most important thing is to make sure that different systems can talk to each other without any problems and to incorporate cloud-based electronic health care systems with the current healthcare infrastructure. The use of open APIs, standardized data formats, and strong communication protocols is essential for a seamless data interchange.

Healthcare professionals must improve their digital literacy if they are to make effective use of e-health tools and technology hosted on the cloud. It is critical to establish thorough training programs to equip healthcare providers with the necessary abilities to operate and navigate these systems effectively.

8. Future work

The development of standardized data formats, open application programming interfaces (APIs), and strong communication protocols is a research project that is required in order to support the seamless integration of cloud-based e-health systems with the existing healthcare infrastructure. Consequently, this would make it possible to share data without any interruptions and will enhance interoperability across various healthcare providers.

It is necessary to conduct research in order to determine the present levels of digital literacy among healthcare workers in Saudi Arabia taking in account the cultural and organizational differences and to evaluate the areas in which they require additional training. The development of focused training programs that will equip them with the essential skills to effectively employ cloud-based e-health tools and technology will be facilitated as a result of this.

Research is required in order to gain an understanding of the attitudes and concerns of patients with regard to the utilization of cloud-based electronic health services. This information will be used to inform the development of effective patient education campaigns and engagement tactics, with the goal of fostering trust and actively encouraging adoption.

As a result of addressing these study areas, Saudi Arabia will be able to acquire a more in-depth understanding of the factors that influence the adoption of e-health cloud computing and develop strategies to optimize its deployment and maximize its benefits for the healthcare sector and the overall well-being of the people.

Conflicts of Interest:

The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analysis, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

Author Contributions:

Ebtesam Abdulrahman Jibreel prepared the manuscript. Muhamad Shahbani Abu Bakar, Maslinda Mohd Nadzir , and Ali Hassan Alhaiti reviewed the manuscript. All authors reviewed and approved the final version of the manuscript.

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