# Relevance of Digital Transformation in the Libyan Health System: Implementation of an Electronic Health Record System (EHRS)

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## أهمية التحول الرقمي في النظام الصحي الليبي: تنفيذ نظام السجلات الصحية الإلكترونية

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**Abstract:**

One of the important reasons leading to the low quality of health services in some developing countries such as Libya is the challenges doctors face while diagnosing and treating patients. These challenges include collecting patients' backgrounds as well as the difficulty of cooperating between hospitals and clinics, whether governmental or private. As a result, this study aims to identify the importance of digital transformation in the health sector and propose implementing an electronic health record (EHR) system to raise the quality of health services. Digital transformation provides a new way to deliver high-quality services, improve processes, and meet customers' needs effectively, easily, effortlessly, and in less time. EHR system will centralize patients' information in one database that any authorized doctor can access from any hospital, clinic, or medical centers. Therefore, doctors can know their patients' medical history, including disease, allergies, surgeries, immunizations, and comorbidities, as well as, medications being taken. In addition, information on some diseases can be shared along with patients' experiences and treatment histories to provide as much information as possible to help treat difficult cases.

**Keywords:** Digital Transformation, Libyan Healthcare System, Electronic Health Record EHR.

## الملخص

أحد أهم الأسباب التي تؤدي إلى تدني جودة الخدمات الصحية في بعض الدول النامية مثل ليبيا هو التحديات التي يواجهها الأطباء أثناء تشخيص وعلاج المرضى، وتشمل هذه التحديات معرفة التاريخ الطبي للمرضى، بالإضافة إلى ذلك صعوبة التعاون بين المستشفيات والعيادات سواء الحكومية أو الخاصة، ونتيجة لذلك، تهدف هذه الدراسة إلى التعريف بأهمية التحول الرقمي في القطاع الصحي، كما تقترح تطبيق نظام السجل الصحي الإلكتروني لرفع جودة الخدمات الصحية، حيث يوفر التحول الرقمي طرق حديثة لتقديم خدمات عالية الجودة، وتلبية احتياجات العملاء بفعالية وسهولة ودون عناء وفي وقت أقل، كما يعمل نظام السجلات الصحية الإلكترونية على تجميع معلومات المرضى في قاعدة بيانات واحدة يمكن لأي طبيب مخول الوصول إليها من أي مستشفى أو عيادة أو مركز طبي، وبذلك يمكن للأطباء معرفة التاريخ الطبي لمرضاهم، بما في ذلك الأمراض التي تم التعرض لها في الماضي، والعمليات الجراحية التي أجريت، والتحصينات التي تلقيت، والأدوية التي يتناولونها، وكذلك الحساسية والأمراض المصاحبة لهم، وبالإضافة إلى ذلك يمكن عن طريق نظام السجلات الصحية الإلكترونية مشاركة المعلومات حول بعض الأمراض إلى جانب تجارب المرضى وطرق العلاج لتوفير أكبر قدر ممكن من المعلومات للمساعدة في علاج الحالات الصعبة.

**الكلمات المفتاحية:** التحول الرقمي، النظام الصحي الليبي، السجل الصحي الإلكتروني.

## 1. Introduction

The advancing development in digital technologies and the use of smart devices, the Internet of Things, and artificial intelligence allow organisations to enhance their performance in different industries (Henriette et al. 2016). As a result, digital transformation has become trending in various sectors, including the health sector. generally speaking, an analysis of the health information systems in developing countries showed that some countries are moving towards superior more scalable, and sophisticated health information systems to gather and

use health information (Vital Wave, 2009). In contrast, although the use of technology has been growing dramatically in a vast majority of sectors in Libya, especially marketing, the healthcare sector continues to use paper records to deliver care, manage patient information, and conduct clinical transactions. What's more, although WHO and other international agencies' support for Libya, there is still no nationwide health information system to collect data, control medical supplies, and evaluate health requirements or service capability (WHO, 2022).

In addition, the establishment of the Health Information Centre in the Libyan Ministry of Health to collect and report national health data was a useful step (WHO, 2010). Yet, the essential functions of a health information system (HIS) are missing (WHO, 2013), in addition to modern facilities for better HIS functionalities are not available, for instance, computers are not used in most healthcare centres to capture and collect data at the point of service delivery.

Moreover, it has been reported that private healthcare services such as private inpatient clinics, diagnostic centres, laboratories, and pharmacies have been growing significantly in Libya due to insufficient public healthcare services and healthcare professionals leaving for better-paying jobs in the private sector (WHO, 2022). Accordingly, the Healthcare system governance has been facing challenges with collecting basic health information necessitated for evaluation and performance improvement due to the weakness of infrastructure in collecting, recording, and analysing data from different health institutions, public and private (El-Fallah, 2014). Consequently, the Libyan health system has been in bad condition and the top priority of the government is to reinforce it (Eddib and Eddib, 2023). Likewise, most studies agreed that it is essential to gradually replace paper-based records with computer-based ones with friendly user interfaces, and with at least a few training programs (Tomasi et al. 2004; Mangoud and Al-Ruwashed 2002). Besides, an electronic health record system is essential to improve access to patient information with high-quality care; however, it appears that it will not be adopted in the Libyan health system, as physicians remain largely focused on traditional medical practice. Hence, this study sought to clarify the benefits the HER system will bring to the Libyan National service along with the challenges and implementation strategies.

First, the literature review of this study illustrates the background of the Libyan healthcare system. Then, it clarifies the concept of digital transformation and electronic health record system (EHRS), in addition to the benefits and the challenges of the EHR system implementation. After that, the result and discussion section focuses on the main findings of the previous studies and reveals the benefits and challenges of EHR system implementation in the Libyan health system. Furthermore, it contains the strategies proposed to integrate the EHR system into the Libyan health system with minimum challenges. Eventually, the conclusion and recommendations are demonstrated at the end of the paper.

## 1.1. Problem of the study

The Libyan health system has been suffering from the low quality of health services. Additionally, many studies have reported the recurrence of medication mistakes and their negative impact, especially in paediatrics (Shekelle et al. 2006). In addition, health issues such as hypertension, asthma, and heart disease need primary health care and precise clinical decision-making, consequently, that needs a system that supports disease management and clinical decision-making (Tomasi, 2004; Starkey et al. 2000). Therefore, an electronic health Records system is an important component to improve the health sector in Libya as it enables access to more reliable information, richly defines basic health indicators related to the causes of morbidity and mortality, helps in planning and decision-making, achieves high productivity, and saves time and resources(El-Fallah, 2014).

However, in Libya, although the use of technology continues to grow dramatically in a vast majority of sectors, especially marketing, the healthcare sector continues to use paper records to deliver care, manage patient information, and conduct clinical transactions. Thus, this paper aims to demonstrate the benefit of digital transformation, represented in this paper in the integration of an electronic health record system into the Libyan health system. Besides, it desires to investigate challenges that may be encountered in the adoption of an EHR system and provide strategies to overcome them.

## 1.2. Objectives of the Study

This study aimed to:
- Discover the current challenges in the Libyan health system.
- Identify numerous benefit of adopting digital transformation in the health sector.
- Identify prospected challenges that would face the implementation of the digital transformation in developing countries.
- Provide relevant documentation of implementing an electronic health record system; including benefits, challenges, strategy of implementation.

### 1.3. Relevance of the Study

This paper highlighted the role of digital transformation, particularly EHRS in improving the Libyan health sector. Additionally, it demonstrated that health information systems based on electronic health records can dramatically transform the delivery of health care, making it more efficient, safer, and effective. What's more, it concluded that adopting an EHR system in the Libyan health sector will improve the services and efficiency of the work by helping eliminate problems, including :1) misdiagnosis resulting from obtaining insufficient information from the patient, such as comorbidities, past illnesses, operations, and current medications, 2) multiple diagnoses by more than one doctor for the same patient, requesting the same tests more than once, and giving the same medications to the same patient to no avail, 3) the lack of previous experiences or statistics for some diseases because there is no a centralised database of patients' information .

Likewise, this research paper contributes to studies of the field of healthcare in Libya and provides a review of the use of the EHR system in the healthcare sector to improve the Libyan health system.

### 1.4. Research Methodology

The aim of the study was to evaluate the Libyan health system, particularly in the absence of an electronic health record system, and to identify the advantages and challenges of implementing EHR systems. To conduct the study, the researchers reviewed peer-reviewed articles, books, dissertations, reports, and various websites (governmental, organizational, and educational) that were published between 2000 and 2024. The study focused on healthcare systems, health information systems, the Libyan health system, digital transformation, and electronic health records. Any sources that did not contribute to the study were excluded.

### 1.5. Limitation

Although researchers always strive to minimize unavoidable limitations and constraints while conducting their research, they inevitably face difficulties and obstacles that may affect their quality. One of the difficulties, which affected the methodology of this study, was that this study was conducted by one researcher with limited resources and time. In addition, there was a scarcity of recent studies related to the Libyan healthcare system at the time of this study. However, this review was focused on providing decision-makers with as much available evidence as possible about the efficiency of EHR systems. Another important limitation is the lack of a field study to collect the stakeholders' views. Yet, the studies mentioned in the literature review relieve the significance of this limitation as they used qualitative and quantitative methods in their research.

### 2. Literature review

This review of literature summarised background of healthcare system in Libya and its weakness, and synthesized some research evidence of the impact of electronic health records on the quality and efficiency of providing healthcare services. Moreover, it aimed to identify the concept of digital transformation and to clarify its benefits and challenges in healthcare system.

### 2.1. Healthcare system in Libya

Libya is an Arab country located in the north of Africa and lies on the coast of the Mediterranean Sea and it is the fourth largest country in Africa (WHO, 2007). Additionally, the total population of Libya was 6,931,000 in 2020 (WHO, 2021).

The Libyan health system is a mix of public and private healthcare services. Additionally, the Libyan Ministry of Health is the main provider of the Libyan National Health Service (LNHS) and all its services are free of charge for all citizens in Libya (El-Fallah, 2014). Moreover, the implementation of healthcare services is operated on three levels: the first level is primary healthcare centres, and polyclinics, the second level is secondary healthcare services, which are provided to those directed from the foremost level in general hospitals. While the third level involves of advanced healthcare services delivered via specialized hospitals to those referred from the secondary level (WHO, 2007; El-Fallah, 2014). Furthermore, Libyan Private Health Service (LPHS) runs a widespread and growing health services network. (El-Fallah, 2014).



**Figure 1** Three levels of the Libyan healthcare delivery system.

What's more, there is good implementation of immunization programs by the National Centre for Disease Control (NCDC) to control and prevent both communicable and non-communicable diseases. Additionally, it has been demonstrated that Libya is among the best in the Mena province in terms of the main health indicators, which are the decline in the incidence of communicable disease, the rise in life expectancy, and the reduction in mortality rates (WHO, 2007; El-Fallah, 2014).

Although healthcare services are widely available free of charge in Libya, unfortunately, they have weaknesses and complications, some of which are illustrated in the next section, making Libyans prefer to buy healthcare services from the LPHS and travel for treatment abroad (El-Fallah, 2014).

### 2.1.1. Weaknesses and Challenges of healthcare system in Libya

It has been cited that Libya spends less on healthcare services compared with other MENA countries (El-Fallah, 2014). Likewise, the Libyan healthcare system has suffered from neglect, deficient funding, a lack of development, as well as corruption for a long time (El Oakley, 2013). Additionally, as the Libyan National Health Service is available to all citizens without charge, insufficient funding and consequently inadequacies in the healthcare system can deteriorate the quality of services. This can end up doing more harm than good, and put individuals at risk of financial burdens related to illness when they have to pay out-of-pocket for services.

What's more, a study conducted by El-Fallah (2014) highlighted the most significant weaknesses and problems in both LNHS and LPHS hospitals that led to patients' loss of trust and their perceptions of the poor quality of Libyan hospitals. These weaknesses and problems are summarised below:

- The frequent occurrence of medical errors in diagnosis, treatment, or surgery that are sometimes severe and kill patients. Medical error can be a result of the service providers' inexpertness or medical personnel neglect, which might be a doctor's error, negligence in operations, sterilisation, and paying attention to patients.
- The healthcare system governance's lack of responsibility for monitoring, investigation, and controlling of medical errors.
- There is no care of following up on patients' states after treatment.
- The mismanagement in LNHS hospitals including; the failures of officials, hospital managers, administrators, and heads of medical services to perform their duties. Likewise, the absence of regular monitoring over the progress of work and control over human resources for health lead to neglect to follow the rules of work and, therefore, causes the poor quality of healthcare services
- The inaccuracy of healthcare delivery schedules and obvious neglect of patients are the most significant reasons for the long waiting time for patients in hospitals, or outpatient departments, or in getting access to a bed or surgical operation.
- There is no standard mechanism or form in hospitals, polyclinics, etc. for collecting health information on a patient's health status. In addition, in most cases, each health centre has its own set of forms that are not shared with other centres and the same disease might have different descriptions.
- An absence of collecting data, writing reports, and conducting studies in different healthcare scopes that are required for capturing, the quality of healthcare services, population's health status, disease spread, etc.
- The problem of favouritism, which means that patients who have friends or relatives in a hospital, will acquire a better service. Accordingly, patients are more likely to have negative feedback towards human resources for health and dissatisfaction with services. (El-Fallah, 2014)
- Most doctors concern about the material and divide their time between LNHS and LPHS. Besides, some doctors do not work efficiently and even do not have enough time for patients in the LNHS and attempt to redirect them to the LPHS. This has made it increasingly difficult for low-income households to access required and specialized healthcare services (WHO, 2022).

What's more, paper-based information systems are usually fragmented, and highly difficult to obtain specific information from them (Vital Wave, 2009), especially in the case of conducting a statistical study of a disease, for instance. Additionally, Libya lacks a system to monitor vaccine supplies, which can lead to vaccination shortages and disrupt immunization schedules, putting children at risk of life-threatening diseases (WHO, 2022).

### 2.1.2. Health Information System in Libyan health system

The establishment of the Health Information Centre in the Ministry of Health to collect and report national health data was a useful step (WHO, 2010), however, the essential functions of a health information system (HIS) are missing (WHO, 2013). In addition, different regions in the country have implemented makeshift information systems but they lack integration into a unified reporting system and concentrate on data collection rather than analysis (WHO, 2022). That makes them inoperative systems at all levels (El-Fallah, 2014). Besides, handwritten notes are weak, paper patient files are remarkably fundamental, and accurate data are unavailable. Additionally, the quality of analysing data collected at the national level is extremely basic (El-Fallah, 2014). Furthermore, to

unorganized records in hospitals, it is rare to find a complete patient file, or a form filled out completely. Similarly, the scarcity of proper organization of health information makes it difficult to get the required information or to rely on them as a reference for research (El-Fallah, 2014).

Moreover, health information documentation processes in Libya's healthcare system have been criticized because they use traditional and manual techniques (El-Fallah, 2014). Additionally, the weakness of the HIS has negatively affected the evaluation of a patient's health status and wasted time and resources (El-Fallah, 2014). Likewise, the documented information has lacked the scientific basis required for global documentation and classification, thus reducing its significance (El-Fallah, 2014).

What's more, 2022 was the end of Libya's five-year goal to strengthen its Health Information System by launching the District Health Information System 2 (DHIS2) over the country to collect, and analyse data, integrating standalone programs with the system, and using the generated data to improve evidence-based policies and formulate effective action plans(WHO, 2022). DHIS2 is provided free of charge as a worldwide public good (WHO, 2022). WHO, UNICEF, and other agencies including the International Rescue Committee (IRC), IOM, GIZ, UNFPA, and International Medical Corps (IMC) made efforts to help Libya reach its goal, however, the goal was only partly achieved. Even though most of the municipalities in Libya have received training on how to use the DHIS2, the reporting was insufficient. Furthermore, the efforts to align stand-alone programs with DHIS2 have halted, and the incorporation of Libya's civil registration and vital statistics system into the DHIS2 has also been delayed until 2023 (WHO, 2022).

By the end of 2023, Libya had installed the first electronic vaccination administration system called Tahseen at 627 out of 700 vaccination locations across Libya by supporting UNICEF (UNICEF, 2024). Libya's National Centre for Disease Control (NCDC) presented the Tahseen platform in October 2021 as part of its campaign for immunizing with the anti-COVID-19 jab (LibyaHerald, 2023). Likewise, UNICEF clarified that Tahseen was created to improve the performance of the Immunization Programme by providing a convenient way to accurately track people's immunization status as individuals' immunization schedules will be observed electronically, and the history of their immunization will be kept in the system (LibyaHerald 2023; UNICEF, 2023).

To summarise, there must be a focus on maximizing the quality and value of healthcare in Libya countries by improving health systems as much as possible. Successful improvement of health systems will need reliable, relevant, precise, and timely information, which can be provided by an electronic health information system EHIS (Vital Wave, 2009).

## 2.2. Digital transformation

The concept of digital transformation has emerged with the appearance of digital technologies (Sayabek et al. 2020) and has become an important part of everyone's life. Digital transformation has been defined as the digital technology integration into a business resulting in changes in the way it operates (Liu et al. 2011). Digital transformation is also defined as employing information and communication technology within institutions, whether governmental or private, with the aim of developing institutional performance and services (Appleby et al. 2021), improving operational efficiency, and increasing effectiveness and productivity. Additionally, it facilitates linking institutions to each other whether governmental or private to ensure providing a reliable and coherent source of information. As well as, it helps organize and accelerate workflows within departments in an institution or within institutions in a sector, facilitating access to different services and information with saving time and effort. Moreover, different sectors gain benefits from digital transformation as it brings information together to work more efficiently as well as it takes advantage of advanced technologies, such as machine learning (ML) and artificial intelligence (AI) in a way that was not possible before.

Furthermore, digital transformation significantly simplifies procedures of services provided to users and gives opportunities to provide innovative services, which in turn contribute to improving customer satisfaction and acceptance of the organization's services. Besides, it helps decision-makers in institutions to monitor performance, improve the quality of services, and define goals and strategies.

## 2.2.1. Digital transformation in healthcare sector

In the healthcare sector, digital transformation has been defined as delivering care in a new way that advances processes and provides the patients' well-being (Appleby et al. 2021). The healthcare sector is one of the most important sectors, thus, it demands higher efficiency, consistency, quality, safety, and value. According to Shekelle et al. (2006) to achieve these demands, it is widely recommended to build an electronic health information system connected with electronic health records (EHR) that documents citizens' health information and each patient's diagnosis and treatment process. They also added that a typical EHR system enables capturing patient information and allows physicians to access it for disease management and medical decision-making.

### 2.2.2. Electronic health Record System (EHRS)

It has been cited that the phrase 'health record' comprises all records related to delivering care to individuals including diagnosis, treatment, and other healthcare activities (NHS, 2024). An electronic health record EHR, which is also called an electronic medical record and personal health record, can be defined as an element of health information technology that enables the recording of patient medical information electronically with the ability to access and view it (Wang et al. 2003; Ehrenstein et al. 2019). EHR is also defined as any digital document, kept online, on a local network, or on a device, containing information on a person's health (CSP, 2020). Another definition of EHR is that it is a file consisting of data regarding health and has been created by or on behalf of a health-proficient (NHS, 2024).

Moreover, EHR is an electronic record of a patient's medical chronology provided over time and includes the complete clinical data relevant to that patient (CMS, 2024). Accordingly, with EHR patients do not need to recall their medical history, medication, and previous medical diagnoses because clinicians can access and view all of them (CSP, 2020). Furthermore, studies illustrated the capability of EHRs to improve the quality of health information systems (Shekelle et al. 2006), especially when the EHRs store data with high accuracy, and make those data quickly and easily accessible when required.
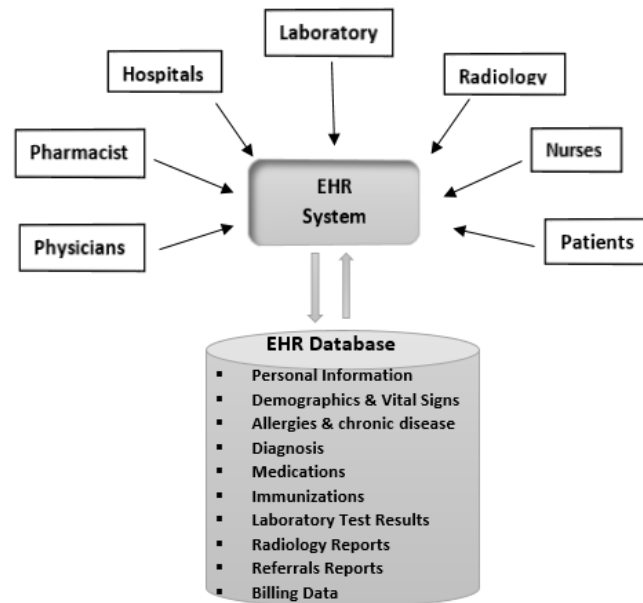


**Figure 2** EHR system, database and users.

The EHR system must provide a set of functionalities including, at least, storing patients' information in a structured database with the ability to manage and display this information (Aspden et al. 2004). Additionally, the patient's information can include medical history, diagnoses, medications, immunization schedule, laboratory test results, and radiology reports and images, as well as, other related personal information including demographics, vital signs, smoking status, and allergies (Ehrenstein et al. 2019; Chakraborty and Rathi 2021; CMS, 2024). Other additional functions that an EHR system can facilitate are the automatic generation of reminders for patients' appointments, regular check-ups, and immunization time, communicating electronically, exchanging health information, and other medical services. Moreover, analysing patients and disease information and generating electronic charts are features of EHR that can provide productivity in creating health reports, maintaining clinical decisions and administrative processes, and reporting population health (Aspden et al. 2004).

The advanced electronic health record systems enable collaborative working cross-organisation by linking patients, clinics, hospitals, laboratories, medical imaging centres, and pharmacies over the Internet in a secure and standardized way (Ambinder, 2005). Consequently, other healthcare professionals, such as nurses or physical therapists, can legally access or type information into a patient's medical record for direct care aims (NHS, 2024). In addition, EHR can be utilised for clinical, nonclinical, and managerial purposes, as well as other pursuits related to healthcare (NHS, 2024).

### 2.2.2.1. Benefit of EHRS implementation

Information technology is offering evidence-based importance to support the health sector globally (Anwar and Shamim, 2011). Similarly, the use of health information systems is important for the boost of the healthcare sector in developing countries. Additionally, the majority of respondents in Aburawi et al.'s study (2016) approved of the importance of modern health information systems in providing a well-functioning health system, supplying accurate data that is essential in evidence-based development plans, and supporting medical professionals in

distant areas to deliver good healthcare services. This section of the study also illustrates a range of advantages that the EHR system provides to improve the quality of healthcare and the performance of medical services.

First of all, compared with paper-based health systems, the EHR system is more accurate (Tomasi et al. 2004; Hassey et al. 2001), easier and quicker in finding and retrieving patient data (Ambinder 2005; Tomasi et al. 2004; Wager et al. 2000), and better manager of health records due to that the entire patient information is centralized in one database. In addition, there were positive experiences of implementing such systems including increasing adherence of physicians to standardized treatment plans (Papshev and Peterson 2001; Starkey et al. 2000), easier regulation of ordering health care and diagnosis, and decreasing variability in clinical diagnosis (Tomasi 2004).

Moreover, many studies have shown the impact of using EHR systems on the completeness and quality of medical documentation (Shekelle et al. 2006) as it records important elements, such as medical history, physical examination of a patient, and after-care instructions. Similarly, it documents the results of episodes of patient care occurring between a service provider (physician, nurse, and others) and a patient. Consequently, this will decrease medical errors, as every medical procedure is documented with time and reason (Ambinder, 2005). Furthermore, it effectively helps manage medication dosages, as well as, it can provide recommendations for the proper use of some medicines such as antibiotics. It is also believed that the EHR system is an essential tool in decreasing the rate of medical negligence and errors occurring in medication and vaccination, especially in paediatrics (Ambinder, 2005; Shekelle et al. 2006; El-Fallah, 2014; CSP, 2020). Additionally, EHR can provide accessibility to medical information needed for patient care, management, education, and research purposes (Ambinder, 2005). Besides, it provides opportunities for cross-sectoral collaboration and the possibility of effective interventions (WHO, 2010, 2013) and sharing health records (HRs) between professionals (Ambinder, 2005; CSP, 2020).

The timely availability of accurate patient information provided by their medical records will enable clinicians to make better decisions for better care and reduce medical errors, repetition of tests, delays in treatment, and discrepancies in diagnosis (Ambinder, 2005; CMS, 2023). Similarly, that supports disease monitoring, prevention strategies, and health facility performance tracking (WHO, 2022). In addition, simultaneous access to EHRs simplifies the doctors' workflow (CMS, 2023) and therefore, saves time (Ambinder, 2005; CSP, 2020).

Computerizing immunization schedules and integrating them with the EHR system will facilitate strict monitoring of required immunizations and emphasize adherence to them, especially if a reminder system is used, which cannot be done with manual immunization books. Besides, using computerized immunization schedules will reduce the challenge that lies in errors occurring in immunization. Furthermore, the support of EHRs has appeared largely in supporting patients with chronic diseases (Foster 2012)

One of the most significant advantages of an EHR system is that the entire patient information is stored in centralised database so there are no worries about losing paper with necessary patient information or trying to pursue reports from different laboratories. The system can reduce the time of receiving radiology or laboratory results, especially in emergency cases. The system can prevent the recurrent of ordering the same laboratory test or radiology test, and restrict adherence to the formulary.

### 2.2.2.2. Challenges of EHRS implementation

Despite the benefits that digital transformation provides to various sectors, organizations still confront challenges in implementing it (Sayabek et al. 2020; Schuchmann and Seufert 2015; Fitzgerald et al. 2013). Besides, health sectors in developing countries have faced numerous challenges in implementing an electronic health record system (Anwar and Shamim, 2011). Some challenges were briefly discussed and included below.

- Threats of cybersecurity are one of the greatest challenges health systems will face and must be considered due to the large amount of personal and sensitive patient data. As a result, the security and privacy of patient data are at the top of health systems' priorities (Shekelle et al. 2006; Appleby et al. 2021).
- Technical complexities (Anwar and Shamim, 2011) and the requirement of a high-performance system dealing with big data are challenges to overcome.
- Insufficient technology experts and lack of electronic readiness of medical staff are other identified barriers (*Ibid*, 2011). Similarly, the lack of computer skills and the difficulty of using EHR among healthcare workers, therefore, training is required (Souther, 2001; Shekelle et al. 2006).
- The lack of documentation of patient data and the consideration of information confidentiality and respect for patient privacy (Blignaut et al. 2001; Williamson et al. 2001).
- The lack of infrastructure (Anwar and Shamim, 2011). In addition, the required time of implementation (Shekelle et al. 2006).
- Financial support for digital transformation initiatives is one of the biggest challenges to overcome. According to 90 interviewed physicians and managers of electronic medical records in 30 organizations, key challenges to EHR utilization were the high cost of finance and physician time (Miller and Sim, 2004 cited at Shekelle et al. 2006; Anwar and Shamim, 2011), in addition to barriers of the expensive and weak access to the internet (Shekelle et al. 2006). Furthermore, The implementation cost of an EHR system is hard to underestimate and significantly varies depending on factors including the healthcare organization scale and

the level of existing infrastructure of information technology as well as the required functionality of the HER system (*Ibid*, 2006). Therefore, the investment in developing countries will be significant and require a well-planned strategy on the side of their ministries of health due to challenges in information and communication technology infrastructure and its relation to their economic progress (Foster, 2012). What's more, the cost of implementing an EHR System includes the cost of hardware and software, (Wang et al. 2003; Schmitt and Wofford 2002) and network facilities. Besides, it includes other related services such as installation (Agrawal, 2002) and training, continuing maintenance, and technical support (Shekelle et al. 2006), data entry, (Valancy, 2002), and the cost of associated devices, for instance, biometric security tools.

## 3. Discussion and Findings

This section discusses the findings demonstrated from the literature review. First of all, it was noticed that the Libyan National Health Service provides its health services free of charge for all citizens. However, the weaknesses of the Libyan health system led to patients' loss of trust their perceptions of the poor quality of Libyan hospitals, and their preference for paying out-of-pocket for private services or treatment aboard.

The main reasons for these weaknesses are the lack of sufficient financial support, the absence of management, and regular monitoring of the progress of work and human resources for health, all of which lead to neglect to follow the rules of work and Commitment to work time. For instance, doctors do not work efficiently, do not adhere to work time in the LNHS hospitals, and attempt to redirect patients to the LPHS. In addition, the frequent occurrence of medical errors may result from the service providers' inexpertness or medical personnel neglect due to the government's lack of responsibility for monitoring and controlling them. Furthermore, no standard mechanism or form in hospitals, or polyclinics for collecting health information, and each health centre has its own set of forms that are not shared with other centres and the same disease might have different descriptions. That leads to the absence of the reliability of health information needed to write reports, conduct studies in healthcare scopes, and capture the quality of healthcare services, population's health status, disease spread, etc.

What's more, a major challenge in the healthcare system in Libya is the poor health information system, despite the support of global organizations, such as WHO and UNICEF. Thus, the lack of a national health information system and difficulty accessing information leads to poor decision-making, inadequate planning, evaluation, and low quality. That also affects the assessment process, causes duplication of efforts, and wastes both time and resources

In addition, LNHS has already implemented a health information system and gained benefits by implementing a multifunctional immunization platform (Tahseen) available at https://vac.ncdc.gov.ly/. However, the implementation was limited due to the lack of knowledge about suitable information technologies and better application methods built on EHRs to enhance care and manage costs for particular health organizations.

Accordingly, all of the weaknesses and problems of the Libyan health system are likely to be solved by implementing an EHR system, which provides accurate and timely health data for effective public health. Although there are barriers to implementing the EHR system, it is a crucial tool to enhance access to patient information while simultaneously improving the quality of care in the Libyan health system. Moreover, as the EHR system is considered an essential tool for improving the quality and effectiveness of the health sector, its implementation requires considerable investments and organizational modification. Besides, if the system requirements are not clearly identified and implemented accurately, this may result in wasting resources and failure to provide the required services. In addition, obstacles such as lack of infrastructure, scarcity of resources and high-quality technology, weak expertise, and lack of capabilities and knowledge must be accommodated.

Lastly, Despite the benefit that is likely to be gained from the use of the EHR system, its implementation will be hard and resource-intensive as well as it will challenge the fragmentation and complexity of the current healthcare system. Besides, building human capabilities and shifting institutional work culture toward continuous development is also crucial. Measuring performance, acceptance, satisfaction, and addressing challenges are important to determine the extent of benefit. Therefore, institutions should develop a roadmap that defines their priorities. This involves finding the necessary methodologies, mechanisms, and procedures to monitor performance, implementing IT governance and standards, optimizing processes, and employing modern technologies.

## 4. The implementation of EHR system in the Libyan health system

Although the implementation of the ERD system requires considerable investments and organizational modification and encounters many challenges, it is considered a significant tool to improve the low quality of health services in Libya. In addition, it is important to choose the right strategy to overcome possible challenges such as lack of infrastructure, scarcity of resources and high-quality technology, weak expertise, and lack of capabilities and knowledge.

In this section, firstly, the proposed electronic health record system with its functionalities and users are defined. Then, the possible challenges of implementing the EHR system and the benefits it provides to enhance the health system quality and eliminate its mentioned weaknesses are listed. After that, the researcher's strategy of implementation is demonstrated.

## 4.1. The proposed EHR system

Overall, the system should focus on improving patient's experiences with diagnosis and medical errors, especially with the spread of pandemics and chronic diseases. More specifically, the primary aim of this system is simply to register all citizens in one database with their health information, providing the ability to view and edit this information. In addition, the system allows medical personnel and other authorized users, such as technical support teams, documentation and health centres, and system administrators to access these records, and each user will have limited access according to their function in the system.

Moreover, the system will consist of two parts: the user interface, which allows users to interact with the system and is built by a suitable programming language; and the database, which will store health records of citizens' data and related health information and be connected with the user interface.
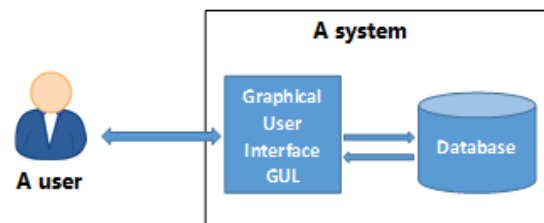
**Figure 3** A system consists of GUI and Database.

### 4.1.1. The objectives of the system

The objectives of the system are:
- To provide computerized records of citizens' health information that include their medical history.
- To enable doctors to retrieve the medical history of a patient according to their health records.
- To allow doctors to add diagnoses, order laboratory tests and radiology, write prescriptions, and add, edit, or delete prescribing medicine.
- Providing security for patient data by implementing identity verification tools so only authorized users such as doctors, technical support teams, and admins of the system can access them. The authentication of users can be implemented through user passwords, identity verification cards, or biometric identification methods such as fingerprints.
- To provide tools for cross-sectoral collaboration and sharing patient data for health-related purposes such as generating statistics about specific disease spread rates.
- To generate reminders of required immunisations, check-ups, etc.
- To issue death certificates.

### 4.1.2 Functional Requirements Specification

This is an important stage of the system development process. Besides, the requirements of implementing a successful EHIS rely on the current health system's functionalities so it is necessary to analyse the existing healthcare system in Libya. In addition, if the system requirements are not clearly identified and implemented accurately, this may result in wasting resources and failure to provide the required services. In this section, the functions of the proposed system, which are divided into primary and secondary requirements, were specified. Besides, the main users of this system were illustrated.

The primary system requirements are:
1. To login into the system.
2. To register patients' details and their related health information.
3. To search for a patient's record.
4. To retrieve patient information.
5. To modify patient information.
6. To add diagnosis, prescription, and medical test results.
7. To manage immunisations.
8. To issue death certificates.

The secondary system requirements are:
1- To arrange patients' appointments.
2- To exchange information.
3- To prescribe medication.
4- To manage patient referrals (i.e. referrals recording, and viewing).
5- To automatically send reminders of appointments and check-ups.
6- To manage information.

7- To manage invoices.

8- To generate reports and statistics.

9- To alert when prescribed medications conflict with current medications or have an allergic reaction.

### 4.1.3. System users

The main users of the EHR system are:

- Patient.
- Doctors.
- Technical support team.
- System administrators.

Further users, who can use the system, are:

- Nurse, who will check out the immunization, injections, or other treatments given to a patient.
- Lab technician, who will input the result of a patient's laboratory test into the system.
- Pharmacist, who will prescribe the medicine given to a patient.

Organisations that can use information in EHRs are:

- National Centre for Disease Control (NCDC) to manage citizens' immunization and obtain information about diseases.
- Healthcare information centres, which manage patient information to create, for example, reports or statistical studies.
- Insurance companies to access bills.

### 4.2. Advantages of implementing the EHR system in the Libyan health system

This part provides a comprehensive set of advantages the EHR system employment would bring to the Libyan healthcare system.

✓ This system will be useful for clinicians and patients with a disease history as it provides the following:

- A good way to document diagnosis, medications, and immunization practice.
- Managing medications and ensuring their compatibility.
- Increasing adherence of physicians to standardized treatment plans.
- Eliminate the loss of reports and reduce the need to repeat tests.

✓ The system will increase the patient satisfaction experience by:

- Reducing the rate of medical negligence and errors occurring in medication and vaccination.
- Improving safety
- Managing appointments, thus reducing the waiting time for an appointment, bed, or operation and eliminating the problem of favouritism mentioned previously.

✓ The system will increase the efficiency and quality of the health system by:

- Improving the accessibility, availability, and portability of patient information.
- Providing better data capture at the time of delivering care.
- Incorporating data from other internal and external sources such as laboratories and medical imaging facilities.
- Facilitating the cross-sectoral collaboration of delivering the healthcare and instant exchange of information.
- Monitoring of required immunizations.
- Simultaneous access to EHRs simplifies doctors' workflow.

✓ For management, control, and improvement purposes the system will assist by::

- Supplying accurate data that is essential for future development plans
- Supporting better decision-making for better healthcare
- Supporting disease monitoring, prevention strategies, and tracking health facility performance.
- Control over human resources for health to eliminate negligent duties.
- Facilitate the management of medical information and generate reports.

### 4.3. Challenges of implementing the EHR system in the Libyan health system

This section of the study outlines the potential challenges that are likely to be encountered in the process of implementing an EHR system in Libya. The need for strong technical and managerial skills, supervision, policies, rules controlling the digital transformation, and ICT infrastructure.

➢ Large-scale investments in ICT infrastructure, staff training

➢ Unknown cost and revenue of the investment.

➢ The lack of technical infrastructure and resources.

- ➢ The need for strong technical and managerial skills.
- ➢ The need of IT staff.
- ➢ The integration of healthcare services, public and private into the system.
- ➢ Cybersecurity consideration.
- ➢ Challenges after implementation, including:
  - The possibility of system damage and updating requirements.
  - The unavailability of enough qualified staff to use the system.
  - The resistance to change and the refusal to use the new system.
  - The lack of trust.

## 4.4. Recommended strategy to overcome possible challenges

Transforming a business digitally can take a lot of time and effort; in addition, it requires a thoughtful strategy to ensure the desired results with the possibility of continuous development (Appleby et al. 2021). Furthermore, a well-defined strategy toward digital transformation is the core of implementing this system and overcoming challenges that could be faced in this complex transformation. Additionally, it is important to choose the right strategy.

The recommended strategy for applying the EHR system is to manage the implementation in two stages. The first stage is to create a primary system with basic functionalities, on which sophisticated functionalities can be gradually built over time. In the second stage, which would come after the success of the first stage, additional functionalities would be added. In addition, in each stage, basic requirements must be identified alongside understanding the implementation condition to evaluate the readiness for transformation and recognize possible issues, vulnerabilities, and related issues, which can be measured using one of the risk management tools. Furthermore, to implement both primary and advanced systems, each one must go through the phases of The System Development Life Cycle SDLC, which is a project management model that outlines the necessary steps for designing, developing, testing, and deploying an information system or software product. Besides, SDLC is essential for taking a project from the idea or concept stage all the way to deployment and maintenance. Additionally, throughout each phase, the outlined plan should be persistently validated and long-term sustainable development should be a consideration.
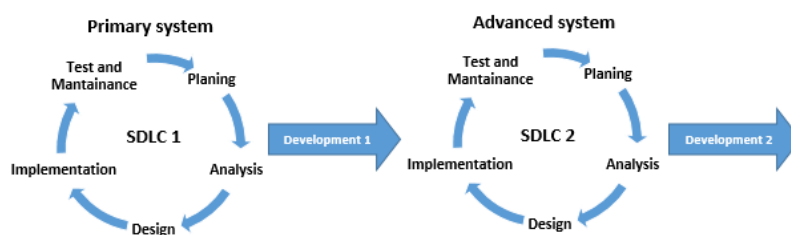


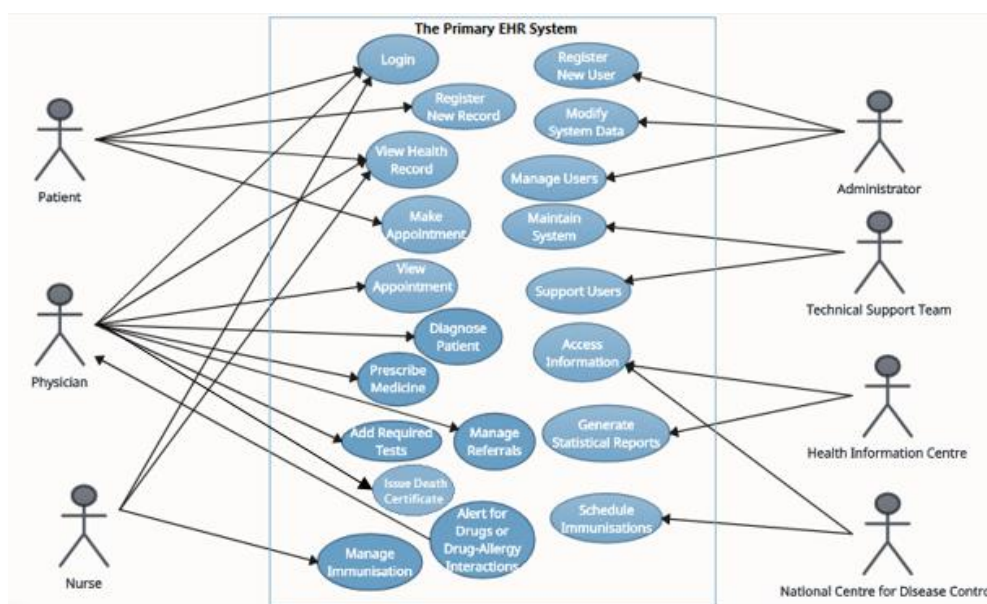**Figure 4** The system development life cycle of the primary and advanced systems.



**Figure 5** Use case diagram of the system.

Furthermore, to ensure the sustainability of system development, it is important to choose the right development software. This requires a robust and reliable programming language that is platform-independent. This will enable the system to run on various devices and provide flexibility in the development process without damaging data in the database, and it is necessary to build an easy-to-use graphical user interface. In addition, to prevent citizens from being registered more than once or refusing to register in the medical records system, it is necessary to link the EHR system with the National ID system.

Eventually, the strategy of implementing the EHR system with only essential features is advisable to reduce the overall cost, effort, and time required for the implementation. Advanced functionalities consume more time, effort, and resources, and demand extensive training. Therefore, it is recommended to avoid them in the primary stage to minimize financial, resource, and time losses if the implementation fails to achieve its goal. Implementing the primary functionalities will help achieve the digital transformation goal of replacing paper-based services with electronic services. Besides, this outcome will serve as the foundation for the next development stages and prepare users and institutions for complete digital transformation.

To sum up, the implementation of a health information system in Libya remains challenging, but it is essential to strengthen the health sector. An appropriate implementation strategy will enable the creation of proper infrastructure and outline a plan for future requirements.

## 5. Conclusion

Digital transformation is crucial for improving healthcare systems, and the implementation of an Electronic Health Record (EHR) system can facilitate many processes for doctors and healthcare centers. It allows for easier access to patients' medical histories, which improves the quality and effectiveness of diagnosis, treatment, human resources management for health and medical facilities, and health-related reports. This will help advance the health sector in Libya and solve problems such as patients' diagnosis errors.

Without an EHR system, it is impossible to assess and improve the quality of healthcare services, and good Healthcare System Governance cannot be applied. Therefore, the EHR system should be a vital part of the Libyan healthcare system. It deals with the issue of health information collection and documentation methods. However, implementing an EHR system requires an accurate description of the infrastructure and economic situation of the country where it will be implemented. This means that implementing the EHR system in Libya would be challenging and perhaps costly. Despite the challenges, it is important to understand the relative costs and benefits of implementing an EHR system. It can deliver timely, safe, efficient, patient-centered, and rightful healthcare services. It is unclear how long digital transformation will take in the health sector and how much it will cost, but it is an investment that is worth the time and effort.

## 6. Recommendations

The study concludes with a set of recommendations mentioned below that could be followed to support implementing an effective EHR system in Libya.

➢ Libyan Ministry of Health must make efforts and invest for digital transformation adoption.
➢ EHR system must be implemented in the Libyan health system to improve the quality of health care services and eliminate weaknesses of the current system for better health care.
➢ The implementation of the EHR system should begin with primary functionalities to minimize the risk of failure. Once successful, more advanced functionalities that consume significant time, effort, costs, and training can be added
➢ Conduct field studies to gather more details about the barriers to EHR implementation.
➢ Flexibility and scalability of implementation are needed to achieve an ever-evolving system.
➢ Cybersecurity should be considered and integrated at every phase of the system implementation.

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