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An Integrated Framework for Delivering Healthcare Services through Information Technology

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Abstract— Egyptian integrated healthcare services delivery is undergoing a transformative shift driven by the rapid advancements in information technology . This paper presents an integrated framework designed to leverage IT solutions for the efficient delivery of healthcare services for patients. The proposed framework encompasses various components, including electronic health records , telemedicine, and interoperability standards.The integration of electronic health records serves as the foundation for seamless information exchange among healthcare providers, ensuring a comprehensive and up-to-date view of patient health. Telemedicine, a key aspect of the framework, facilitates remote consultations, enabling healthcare professionals to extend their reach and provide timely interventions. Additionally, the framework incorporates advanced data analytics techniques to derive meaningful insights from the vast amount of healthcare data generated.

Keywords- Healthcare Services, Business Intelligence, integrated healthcare service, Information Technology, EHR

I. INTRODUCTION

Today, Health care is an essential service that is a vital necessity for all individuals. High-quality health care is often characterized by safety, patient concentration, cost-effectiveness, equity, and accessibility, with ongoing endeavors aimed at promoting these aspects [1]. Healthcare infrastructure is often constrained, even in urban regions of developing nations [2]. In developing nations, individuals residing in rural regions face diminished access to adequate healthcare services, a problem that persists even under typical conditions. [2] Therefore, it is imperative to develop a technological solution that effectively and efficiently addresses the healthcare concerns, while also offering accessible, affordable, and individualized healthcare services to both rural and urban populations. [3] Telehealth is an essential component in enhancing healthcare services by using technological advancements. Telehealth refers to a comprehensive range of strategies and techniques that aim to improve the provision of healthcare, delivery of health education, and provision of support through the utilization of telecommunication technologies [3]. Moreover, it has been shown that there is a decrease in expenses for both the patients and the healthcare system, specifically for individuals residing in rural regions [4]. The patients can be diagnosed remotely and their data is shared with clinical experts either via store and-forward technology or in the online session [5]. In addition to facilitating patient diagnosis, telehealth also offers streamlined methods for the procurement of medications and medical equipment by pharmacies and patients. However, it is essential to prioritize the preservation of sensitivity, security, and privacy of data in an online environment [5]. The seamless and protected transmission of data between healthcare organizations and researchers encounters challenges related to interoperability, which must be addressed in order to fully benefit on its advantages. The main objective of this paper is providing an integrated framework for health-care services that will lead to better decisions in health-care organizations, improve the quality and efficiency of patient care, and provide integrated health information across all medical providers which can improve efficiency in patient care.

The remainder of the paper is structured as follows: Section 2 discusses background on healthcare services and gives insight into the related work, Section 3 describes the proposed framework, Section 4 demonstrates various services on the proposed framework, and Section 5 concludes the future considerations for the future.

II. BACKGROUND

Healthcare is an indispensable service that every individual must have. Quality healthcare is regarded as being safe, patient-centered, cost-effective, equitable, and accessible, with ongoing efforts to enhance [6]. Telehealth is an important tool for improving healthcare services through the use of technology. Telehealth is a group of tools or approaches for improving healthcare, health education delivery, and support via the use of telecommunication technologies [7]. The healthcare system is made up of various aspects (government structure, local government, medical resources, patients, etc.) and its major goal is to safeguard public health [8]. Healthcare is recognized for the many different ways, places, and times that services can be given to a patient. This leads to the categorization of

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healthcare into basic and specialized care, open and closed outpatient care, emergency care, and short-term and long-term treatment [7]. Efforts to improve the performance of healthcare are based on making the best use of healthcare databases, existing material, financial, and human resources (medical staff and their skills), and time dedicated to their work [9] [10]. Health services are mostly given by Independent Public Healthcare Units, Private Healthcare Units, individual medical practices, dental care, and medical buildings. Some of the health care units are full-service health care centers that offer some services for free, but most of their services are paid for by contracts [11]. The healthcare worker wants to help the patient get better quickly and effectively, so they don't think about how much it will cost [12]. Today, healthcare is a crucial component of our society, thus it is essential that those who supply it carry out their duties effectively and efficiently. The computerization of the healthcare industry is a crucial component of its development. Large volumes of data processing are a challenge for healthcare organizations [13]. The amount of clinical, financial, and operational information that must be managed and integrated by the company's workers grows with performance. Data were previously organized and kept in a traditional manner (both paper-based and digital), which took time and made it challenging to achieve the appropriate degree of efficiency [14] [15]. Healthcare information technology (HIT), which includes resources for telemedicine, health information interchange, and personal health records, is one answer to this issue. These systems incorporate all clinical, financial, and administrative applications. HIS offers numerous apps that cater to the demands of various departments and users within a healthcare organization. They manage clinic data Physician Information Systems, Electronic Medical Records, EMR, Electronic Health Records (EHR), finance, laboratory, nursing, pharmacy, and radiology [16]. A properly-developed and implemented HIS provides various benefits to a healthcare company, including improved patient treatment and care as well as better financial management [17]. It is also important to emphasize that HIS should be patient-centric, medical-staff-centric, economical, and scalable. A good HIS system must be available on the web in addition to having user-friendly features [17]. Because the information is available on the web, authorized personnel can access it whenever and whenever they wish. Although there are distinctions between the three, the phrases EHR (Electronic Health Record), EPR (Electronic Patient Record), and EMR (Electronic Medical Records) are frequently used interchangeably [18]. However, there are certain similarities between the three. One possible definition of an electronic medical record, or EMR, is a computerized version of a patient's medical history that is maintained by a facility (such a hospital or an ambulatory care center) that provides medical care and acts as a data source for an electronic health record, or EHR [19]. Electronic medical records are typically a component of a health information system that provides the capability to store, retrieve, and make changes to medical records [12]. Electronic health

records (EHRs) may include a wide variety of data, such as demographic information, medical history, drugs and allergies, immunization status, laboratory results, radiology images, and personal information such as age and weight. A standard definition of an electronic health record (EHR) that is controlled by the individual patient will be referred to as a Personal Health Record (PHR) [20]. However, the information system's collection, processing, and sharing of data are severely lacking at the present time. Clinical data in healthcare continue to be stored in proprietary or incompatible formats in silos of information systems [9]. It's possible that some of these data could be put to use to make the process of treating patients and taking care of them even more efficient. However, there are many situations in which it is extremely difficult to locate these data in a timely manner and gain access to them without engaging in an intermediate step that requires a lot of effort [10]. It is essential to provide cross-sectional analyses and reports if one wants for their work to be efficient and to permit reasonable decision-making. Business Intelligence (BI) systems are what people generally refer to these days when they talk about an effective solution to this problem [9]. Business Intelligence (BI) has been extensively examined and debated in scholarly literature [9]. The subject has witnessed a notable surge in interest following the emergence of reviews that assert the indispensability of Business Intelligence (BI) systems in contemporary corporate information infrastructure [9]. These systems are believed to play a crucial role in enhancing the success and competitiveness of companies. Business intelligence (BI) systems encompass more than just data analysis, as they also encompass the collection and presentation of information [21]. Moreover, it is noteworthy that their focus extends beyond technology and applications, encompassing aspects such as the business context and decision-making [21]. It is noteworthy to mention that business intelligence is widely acknowledged by numerous businesses as a valuable instrument for achieving strategic objectives, enhancing profitability, enhancing customer satisfaction, and ensuring compliance with regulatory requirements [22].In order to comprehensively examine the different facets of its evolution, it is imperative that the Business Intelligence (BI) system is not confined to a limited understanding [21].

III. Literature Review

A literature review on healthcare services is a comprehensive examination of existing research, theories, and findings related to the delivery, quality, accessibility, and effectiveness of healthcare services. This type of review helps to identify gaps in the literature, trends, and areas where further research is needed. Here, I will provide an overview of key themes and findings from the literature on healthcare services.

Several studies have highlighted disparities in access to healthcare services, with factors such as socioeconomic status, geographic location, and insurance coverage playing crucial roles [27].

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The previous research Quality of care is a critical aspect of healthcare services, with numerous studies examining patient safety, effectiveness, patient-centeredness, timeliness, and efficiency emphasizes involving patients in their care decisions, addressing their preferences and needs, and enhancing communication between healthcare providers and patients [26] [27].

The previous research Telemedicine has gained prominence, especially during the COVID-19 pandemic, allowing remote consultations and monitoring. Emerging technologies such as electronic health records (EHRs), health information exchanges (HIEs), and wearable devices are transforming healthcare service delivery [28] [25] [3].

There were several studies have used machine learning and other techniques to solve the problems of patent's data entry and changing service in healthcare stored in the EHR system. Although, they have been used for analyzing and processing to improve health care services [26] [27].

There were several studies have used neural networks techniques to improve integration of processes in care delivery for patient-centered chronic disease management Services [27] [28].

Some of the previous studies have Applied deep learning to clinical tasks based on EHR data, where we find a variety of deep learning techniques and frameworks being applied to several types of clinical applications including information extraction, representation learning, outcome prediction, improving performance in many

analytical tasks. It is noteworthy that deep learning models are ideal tools for recognizing diseases or predicting clinical events or outcomes treatment response. [28][29].

IV. THE PROPOSED FRAMEWORK FOR INTEGRATED HEALTHCARE SERVICES

The main objective of this research is to propose a framework for integrated healthcare services delivery, that be able to help in making the right decision in a timely manner and helping to achieve our goals that were briefly shaped: improving health care services delivery. The proposed framework includes three different stages: **data acquisition, data management**, and **presentation as shown in figure 1.** The framework will be described in the following sections.
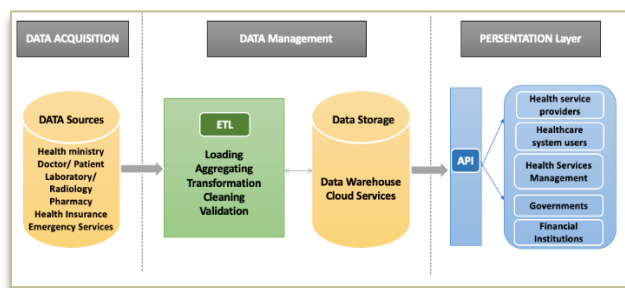

Figure 1. Integra3ted Healthcare Services Delivery Network Framework

A. stage1: Data Acquisition

The data is obtained from different resources such as areas, health ministry, doctors, the size of governorates, clinical distribution, and health care services within each governorate stores data about the patient's, laboratory, radiology, radiation and insurance. These resources are collected from different institutions as well as entered into different forms of files (csv, pdf, jpg, txt and xlsx).

This decentralized application is to cater to the needs of the central health regulatory authority by establishing a robust and reliable telehealth infrastructure. Moreover, it is incumbent upon the organization to ensure the authentication of all users by their respective regulatory authorities and their registration [29].

The Doctor's Application is designed to ensure the inclusion of only verified doctors in the proposed framework. This is achieved by requiring each doctor to undergo verification by the relevant authorities. The patients will assess the doctors and their professional information will be documented.

The Patient's Application aims to provide patients with the ability to access and manage their data at any location and time, thereby eliminating the existence of information silos that may be created by hospitals and laboratories. Patients could evaluate the performance of doctors, laboratories, radiology and pharmacies, as well as report instances of Adverse Drug Reactions resulting from medication consumption directly to pharmacists. By doing so, patients can receive recommendations aimed at mitigating the associated side effects.

Patients have the option to contact accredited laboratories and Radiology departments in order to undergo diagnostic tests that have been prescribed by their physicians.

The laboratories and Radiology departments will be responsible for updating the patient's record on their respective profiles. The patient in question will assume ownership of their medical record and will have the ability to share it with any healthcare professional.

This Application enables pharmacists to register them and accepts digital prescriptions from patients. The identity of the registered doctor who wrote the prescription for the drugs will be extracted from the tokenized digital prescriptions before they are processed further via smart contracts and approved.

This decentralized application facilitates the creation and validation of financial structures in accordance with the terms outlined in the insurance agreement. Legitimate insurance companies possess the capability to monitor and authenticate insurance plans, thereby mitigating the occurrence of fraudulent claims. Furthermore, the consolidation of data onto a unified platform facilitates the expeditious processing of insurance claims [29].

This decentralized application aims to provide a trusted environment for emergency service authorities, including ambulance personnel and first aid providers, by enabling them to undergo verification and deliver their services. Patients can submit requests for emergency services via the established framework, thereby enabling them to promptly receive responses from emergency service providers who are currently available [29].

B. stage2:Data Management

The development of a clinical data warehouse poses a challenge due to the presence of diverse care practices, different data types and definitions, and the perceived inadequacy of clinical information systems [23]. The data management phase consists of two main processes which are Extract, Transform, and Load (ETL) and data storage.

- *EXTRACT TRANSFORM AND LOAD (ETL)*

Extract, Transform, and Load (ETL) modules are integrated components of every Business Intelligence (BI) solution. The process of extracting data from a single source and subsequently loading it into a data warehouse is referred to as data extraction [25]. Data is extracted from several data sources ETL tools are tasked with facilitating the transfer of data from operational or transactional systems to data warehouses. Extract is the process of retrieving or accessing data from a data source or database is commonly referred to as extraction. Transform is the process of transformation involves converting data that has been extracted from its original format into a format that is suitable for storage in a data warehouse or another database. In order to obtain the necessary data for integration into the final destination, the transformation stage employs a series of rules or functions to manipulate the extracted data from the data source. Load is the process of transferring data into a designated database or data warehouse is commonly referred to as the loading process [25]. Healthcare data sources exhibit a multitude of complexities in their structure. The process of extracting data from several database platforms necessitates the integration of the data into a unified format, followed by the capture of the resultant data. The integration of data is necessary in order to consolidate it into a unified form, and afterwards, the resultant data should be captured [25].

- *DATA STORAGE*

The data storage phase consists of two primary components, the first is a data warehouse (DW) utilized as a storage repository. The defining attributes of a data warehouse include subject orientation, integration, time variance, and non-volatility [24]. Subject-oriented refers to a focus on concepts that are specific to the enterprise, such as customers, products, sales, and orders. An integrated dataset refers to the process by which a data warehouse combines diverse sources of data into a unified schema. The term "time-variant" refers to the characteristic of data stored in a data warehouse (DW) that

includes a time dimension. This time dimension allows for the tracking of changes or trends in the data over time. The term "non-volatile" refers to the characteristic of data stored in a data warehouse where it is strictly read-only [25]. Users are explicitly prohibited from making any modifications or deletions to the data that is stored. Additionally, a Data Mart can be defined as a condensed or consolidated version of the data that is stored in a primary data warehouse. The aforementioned comprises a collection of pertinent information components pertaining to a particular domain of commerce, organizational division, or cohort of individuals [25]. Within the proposed framework, there exist three distinct categories of data mart. An operational data mart is a component of the data warehouse that encompasses information pertaining to the day-to-day operations within healthcare organizations. Its primary function is to facilitate analytical endeavors. The medical claims data mart is a repository that houses claim data, which comprises the billing codes submitted by various healthcare providers such as physicians, pharmacies, hospitals, and other entities responsible for payment. The financial data mart encompasses a comprehensive collection of information pertaining to various financial aspects, including expenses, medication costs, insurance providers, and miscellaneous payment transactions [25]. A data warehouse is a specialized database designed for the purpose of reporting, querying, and conducting data analysis. It serves as a repository for storing data. A data repository is established through the integration of data from one or multiple sources. The tools used for analyzing, reporting, and presenting data include OLAP, which enables users to access, analyze, and model business problems by sharing information stored in data warehouses. Data mining tools are employed to identify patterns, generalizations, regularities, and rules within data resources. Reporting and ad hoc inquiry tools are utilized to generate various synthetic reports, including drill-down reports [24].

C. stage3: PERSENTATION

The presentation phase includes customized graphical and multimedia interfaces or dashboards, which serve the purpose of delivering information to users in a comfortable and accessible form. This level includes information display tools in various formats for different users. Web browsers, web apps, mobile apps, dashboards [26]. Managers and executives that require a thorough perspective of their business performance might be supplied with data visualization tools such as dashboards [26]. Users can also access more specific data on important performance indicators across their organizations. [26] Managers can more effectively monitor their business performance and progress toward specified targets by doing so. Web browsers are a software that help you navigate the Internet. Using the suggested BI architecture, they can also access information provided by web servers in private networks or files in healthcare organization-related file systems [26]. Mobile

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phone apps are exploding. He has produced a list of the greatest representative health applications.

Business Intelligence (BI) systems are specifically engineered to receive data from various sources, both internal and external to the organization, and subsequently convert this data into information that can be effectively utilized for decision-making purposes [7].

To ensure the successful implementation of business intelligence (BI) systems in the healthcare sector, it is crucial to thoroughly identify the requirements of organizations and their users. includes assessing the capabilities of care providers, examining their track record, evaluating costs and availability, analyzing encounter results, assessing effectiveness, considering cost and time lines, and reviewing conditions and treatment plans for patients. Additionally, it is important to define appropriate metrics and prepare a suitable data access and presentation layer [21]. The highest point of the healthcare organization [24]. Business intelligence (BI) systems are utilized to effectively accomplish broader strategic objectives, including enhancing operating margin, maximizing return on investment for strategic investments, and improving care quality indices [26]. Business intelligence (BI) solutions have the capability to offer access to information across an entire organization, utilizing tools that are well-known and adaptable to cater to various needs and users. These tools have the potential to mitigate expenses associated with implementing novel solutions and expedite the overall execution process. Various stakeholders, including management, managers, medical professionals, and administrative staff, possess the capability to generate reports and conduct analyses with the aim of enhancing their individual work performance as well as the overall functioning of the organization [27]. Business intelligence (BI) systems play a crucial role in enhancing teamwork among employees within healthcare organizations, thereby facilitating the achievement of departmental objectives [28].

V. INTEGRATED HEALTHCARE SERVICES

This section delineates the execution of the Framework for Integrated HealthCare Services Delivery across six significant usage scenarios of telehealth services. Prior to participation, all entities involved must undergo registration and verification. Consequently, this process is presented as a distinct use case. The use cases demonstrated encompass online consultations between patients and doctors, access to healthcare and laboratory facilities, prevention of drug counterfeiting, and provision of emergency services. The subsequent sections provide a comprehensive overview of the individual use cases for validating an Integrated HealthCare Services Delivery. The Integrated HealthCare Services Delivery provides a secure platform that caters to all stakeholders within the healthcare industry. Nevertheless, its design is intended to operate within a centralized governing body. Healthcare professionals, including

doctors, pharmacies, drug suppliers, laboratories, and other practitioners, are obligated to undergo a registration process in order to offer their services, as illustrated in Figure 2. The entities first submit a registration request to the relevant regulatory authority for verification using their respective decentralized applications through the smart contract. After the verification process, the entities' profiles and associated information are stored in a decentralized storage system as an authenticated element of the Integrated HealthCare Services Delivery Network.
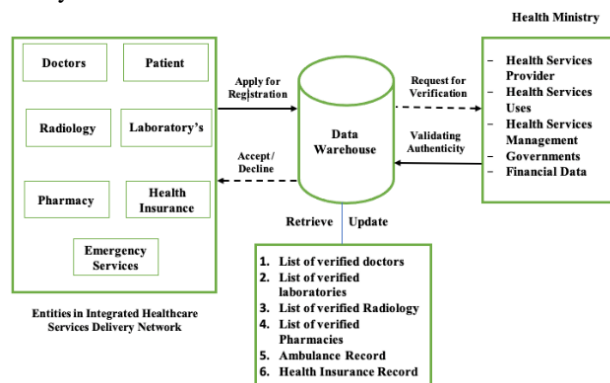

Figure 2: Users registration and verification

A. Online Consultation Sessions between Patients and Doctors

The patient utilizes the decentralized patient application, and the doctor employs the corresponding decentralized application to send a formal request to the verified medical practitioner. Upon receiving a request from a patient, a doctor has the option to schedule a consultation or decline the request. In addition, the physician has the ability to suggest the involvement of other specialized medical practitioners, if deemed appropriate. In the context of seeking consultation, when a physician desires to review a patient's prior medical history, a formal request will be forwarded to the patient. In the event that the patient provides consent, the physician will have the capability to retrieve the data. In the interim, the patient possesses the prerogative to terminate the granted access. The scenario is depicted in Figure 3. The physician issues medications by creating a digital prescription using a tokenization process. This involves the doctor providing authentication information to ensure effective control over drug manipulation.
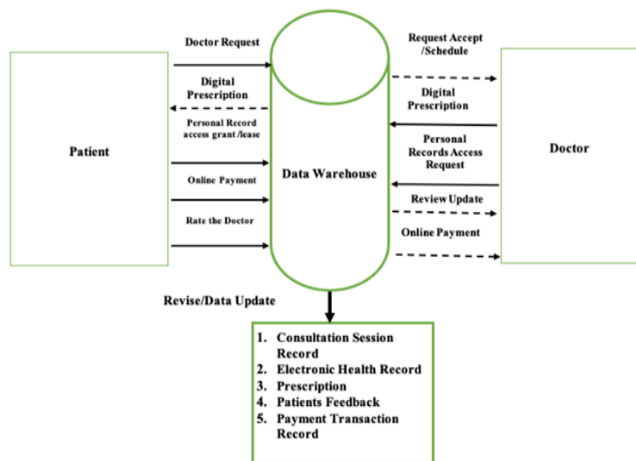
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Figure 3: Online consultation service between patient and doctor

B. Laboratory Services:

Figure 4. illustrates the steps through which patients may obtain access to registered healthcare and laboratory data, as well as submit requests for medical diagnostic tests as prescribed by their physician, utilizing a patient application. The patient's request for a medical diagnostic test is transmitted to the appropriate healthcare facility, which has the option to dispatch laboratory personnel to the patient's residence. The digital report will be uploaded to the corresponding patient's profile, and the patient will receive a notification via the healthcare application. Once the record has been established, it becomes immutable and can only be accessed for viewing purposes by the patient, doctor, or any other authorized user through the corresponding centralized application.
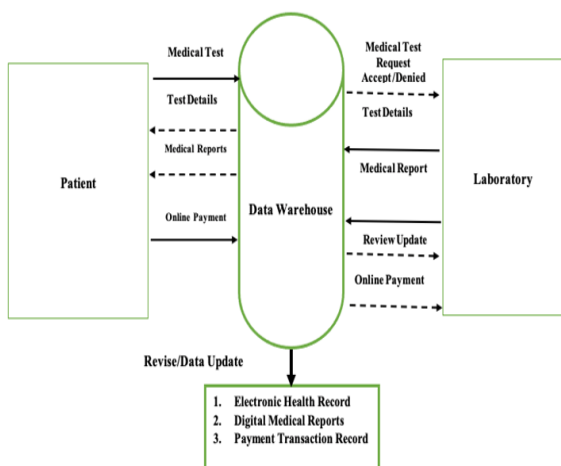

Figure 4: Online Laboratory Service between Patient and Laboratory

C. Radiology Services:

Figure 5. illustrates the steps through which patients may obtain access to registered healthcare and Radiology data, as well as submit requests for medical diagnostic tests as prescribed by their physician, utilizing a patient application. The patient's request for a medical diagnostic test is transmitted to the appropriate healthcare facility, which has the option to dispatch Radiology personnel to the patient's residence. The digital report

will be uploaded to the corresponding patient's profile, and the patient will receive a notification via the healthcare application. Once the record has been established, it becomes immutable and can only be accessed for viewing purposes by the patient, doctor, or any other authorized user through the corresponding centralized application
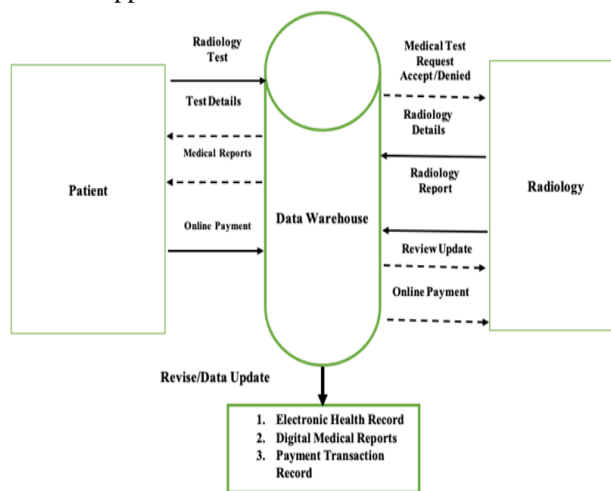

Figure 5: Online Radiology Service between Patient and Radiology

D. Pharmacy Services:

Figure 6. Pharmacy services encompass a wide range of healthcare-related functions that revolve around the safe and effective management of medications and patient care. These services play a crucial role in the healthcare system by ensuring that patients receive the right medications, at the right doses, and with the necessary guidance and support. Here are some key aspects of pharmacy services: Medication Dispensing: Pharmacists and pharmacy technicians are responsible for accurately dispensing prescription medications to patients. They ensure that the prescribed medications are available, properly labeled, and provided in the correct form (tablets, capsules, liquid, injections). Medication Counseling: Pharmacists offer counseling and education to patients on how to take their medications correctly.
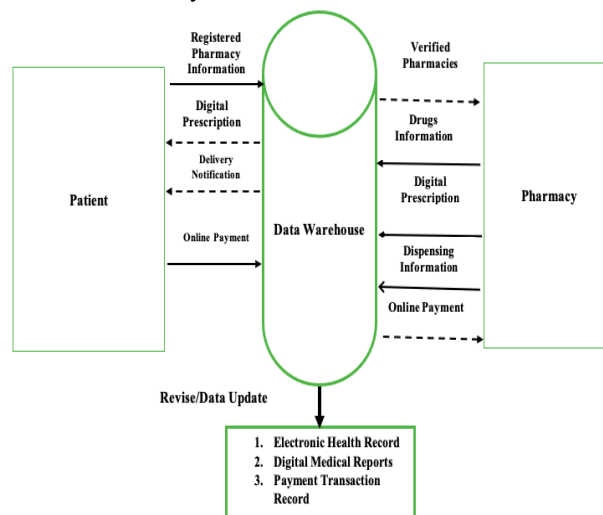

Figure 6: Online Pharmacy Service between Patient and Pharmacy

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E. Emergency Facility Services

Emergency facility services typically refer to the range of services provided in response to urgent situations that occur within various types of facilities, such as buildings, campuses, or institutions. These services are designed to address immediate needs, ensuring the safety, well-being, and proper functioning of the facility during critical situations. Medical Services: Facilities may have medical personnel on standby to provide immediate medical attention in case of accidents, injuries, or medical emergencies. This could range from basic first aid to more advanced medical care.
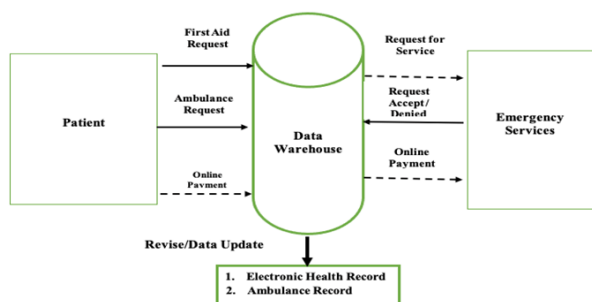

Figure 7: Online Emergency Service between Patient and Emergency

VI. CONCLUSION

The integrated framework presented in this paper offers a holistic approach to harness the power of information technology in healthcare delivery. By seamlessly connecting various components, healthcare providers can offer more personalized, efficient, and accessible services, ultimately contributing to the overall improvement of healthcare outcomes. As the healthcare landscape continues to evolve, the integration of information technology is crucial for building a sustainable and patient-centric healthcare ecosystem. a conceptual framework for the establishment of an integrated healthcare services delivery network in Egypt, aiming to overcome the deficiencies observed in current approaches. The primary objective of the integrated healthcare services delivery network structure is to offer a comprehensive solution that encompasses all necessary health-centric services. The integrated healthcare services delivery network framework encompasses all participants within the healthcare system and facilitates a comprehensive decentralized structure that holds the capacity to revolutionize conventional centralized industries into a reliable and secure system. Hence, the integration of technology within the framework of a healthcare services delivery network ensures the provision of genuine, secure, and punctual healthcare facilities. The architecture comprises of three distinct stages: data collecting, data administration, and presentation of the decentralized applications layer. This layer is overseen by the central health regulatory body to guarantee the inclusion of verified and trustworthy parties within this ecosystem. The framework for integrated healthcare services delivery network was applied in five healthcare scenarios, and the importance of patient integration was emphasized. It is posited that the suggested framework effectively addresses the disparity in access to high-quality healthcare services for individuals residing in various regions of the nation. The suggested framework presents a novel approach to reimagining the virtual in-person care model, with the potential for widespread implementation and adoption. This has the potential to enhance healthcare accessibility and cost. In pursuit of this objective, the present study introduces a comprehensive framework that offers integrated services to healthcare professionals as well as other relevant stakeholders. Currently, we have formulated multiple use cases to substantiate the validity of our work. Nevertheless, the subsequent phase of this research necessitates a comprehensive investigation encompassing healthcare experts and other relevant stakeholders. Our intention is to expand upon this framework and implement a pilot project in order to showcase the full potential of the framework for an integrated healthcare services delivery network.

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