IT Infrastructure of e-Health of the Republic of Kazakhstan

M. Kalimoldayev[1], S. Belginova[2(✉)], I. Uvaliyeva[2], and A. Ismukhamedova[2]

[1] Institute of Information and Computational Technologies, Almaty, Kazakhstan
[2] D. Serikbayev East Kazakhstan State Technical University, Ust-Kamenogorsk, Kazakhstan
saule.belginova@mail.ru

Abstract. The article describes the IT infrastructure for implementing e-health based on the development of standards that determine the feasibility of realization a service-oriented architecture. This IT infrastructure provides full interoperability between information systems involved in supporting healthcare processes. Particular attention was paid to the introduction, use and features of a unified health information system. Also features of architectural models and management characteristic for e-health of Kazakhstan are described. The functional and architecture of e-health information systems are considered; the proposed conceptual functional architecture for health care; architecture of software and hardware for e-health.

Keywords: E-healthcare · Medical information system · Information system architecture · Infrastructure · Electronic health passport

1 Introduction

In the modern world, one of the main factors determining the dynamics of social and economic development of any state, including health care, is the informatization of society and the active introduction of information and communication technologies in all sectors of human life.

The main goal of informatization of healthcare in general can be formulated as follows: the creation of new information technologies at all levels of health management and the introduction of new medical computer technologies that improve the quality of medical and preventive care and contribute to the realization of the basic function of protecting public health - to increase the duration of active life [1].

In order for health services to promote the integration of medicine and public health, they must have three main characteristics: a population-based and geographical focus in the context of a decentralized health system; an attempt to

Y. Shokin and Z. Shaimardanov (Eds.): CITech 2018, CCIS 998, pp. 54–63, 2019.
https://doi.org/10.1007/978-3-030-12203-4_6

develop organizational models to support coordination and integration processes; and the proper use of the health information system.

As we know, the medical industry produces and accumulates a very large volume of medical and statistical data. All these data are to some extent used by doctors, medical workers, and also by the governing bodies in order to properly organize and improve the quality of medical care and raise the overall standard of living of the population.

To be relevant, a health information system must fit into the organization of the health system for which it generates information. Based on clearly defined management functions, it is relatively easy to identify the information needed to make appropriate decisions at each level of management.

The next question is how to obtain this information in the most efficient and effective way. To answer this question, it is important to understand the structure of the health information system.

Health information system, like any system, has an organized set of interrelated components that can be grouped into two objects: information process and management structure. Through the information process, raw data (input data) are converted into information in a "convenient" form for management decision-making (output data). The information process can be broken down into the following components: (I) data collection, (2) data transmission, (3) data processing, (4) data analysis and (5) reporting for use in patient and health care solutions for service management.

Not only health of the population depends on the qualitative use of medical information, but also the level of development of the country as a whole. Thus, the use of constantly growing large volumes of medical data in solving diagnostic, therapeutic, statistical and management tasks for the development of e-health in Kazakhstan is topical.

The prerequisites for the development of e-health in the Republic of Kazakhstan are:

(1) The State Program of Health Care Reform and Development for 2005–2010.
(2) The Code of the Republic of Kazakhstan "On the health of the people and the health care system".
(3) The State Program for the Development of Health Care of the Republic of Kazakhstan "Salamatty Kazakhstan" for 2011–2015, approved in November 2010.
(4) Message from the President of the Republic of Kazakhstan N. Nazarbayev. to the people of Kazakhstan on December 14 2012 "Strategy" Kazakhstan-2050 ": a new political course of the held state".
(5) The state program "Information Kazakhstan 2020", approved in January 2013.
(6) The concept of e-health development in the Republic of Kazakhstan for 2013–2020, approved by order in September 2013 and road map.
(7) The State Health Development Program of the Republic of Kazakhstan "Densauly" for 2016–2019, approved in January 2016.

(8) Law of the Republic of Kazakhstan of November 24, 2015 No. 418-V "On Informatization".
(9) Project of the World Bank and the Government of the Republic of Kazakhstan "Transfer of technologies and institutional reform in the health sector of the Republic of Kazakhstan.

List of officially approved regulatory and legal acts that regulate the development of e-health in the Republic of Kazakhstan; a number of important medical automated systems integrated into a single health information system was studied in [2]. A detailed review of the current automated information systems in medical organizations of the country was conducted, using methods of system and structural-logical analysis, SWOT analysis was carried out.

As part of the development of e-health in accordance with the approved Concept of e-Health Development of the Republic of Kazakhstan information and communication technologies will be introduced into the medical sphere everywhere. The focus of e-health will be the formation of a single health information space in which all interested parties, including the patient, have access to the necessary information, regardless of the type of information systems used.

2 Development of e-Health in Kazakhstan

One of the most important strategic directions for the development of the healthcare system is the organization of a single information space and its technological infrastructure.

By today, Kazakhstan's healthcare sector is transitioning to automation of medical information processing and document management. This implies an increase in processing speed, thereby improving the quality of patient care, facilitating the work of medical and medical personnel.

In order to implement e-health in Kazakhstan, it is planned to develop and implement standards that enable the realization of a service-oriented architecture. In turn, it will ensure full interoperability between information systems involved in supporting health processes. That is, this architecture allows the system to interact and function with other products or systems without any restrictions on access and implementation.

Today, the information and technology platform, the so-called Unified Health Information System (UHIMS), is actively implemented in the country, the main purpose of which is to create an information healthcare structure of the Republic of Kazakhstan that corresponds to the level of economic, social, technical and technological development of society and ensures the rational use of health resources in more quality provision of medical services to the population [3].

The creation of UHIMS involves the fulfillment of a number of tasks based on the development and implementation of uniform standards for the exchange of medical data, the use of a unified system for identifying objects of account and subjects of information interaction in health care. It is planned to implement centralized management and open access to a database of common classifiers,

directories and standards, including a database of standards of medical care, patient records, state registries of medicines and medical products [4].

Within the framework of the State Health Development Program of the Republic of Kazakhstan "Densaulyk" for 2016–2020, the development of a unified national health information system (hereinafter - UHMIS) will continue to develop common standards, technological specifications and characteristics of various information systems for the required functionality.

It is clear that the task of forming the UHMIS can be solved only at the state level and only for many years. At the same time, the technological prerequisites for its solution already exist. Two private information technologies (in addition to many other components), which have received significant development in recent years, are the basic ones for solving this problem: telemedicine and medical information systems [5].

By the end of 2018, it is planned to create the necessary software and hardware for the implementation of the Electronic Health Passport (hereinafter - EHP), a single repository of analytical health data, an integration bus, tools for maintaining single classifiers, directories and registers.

EHP will become the central link ensuring the interaction of medical information systems and providers of medical services through the implementation of a standardized model of medical information. At the same time, information security mechanisms and protection of personal and confidential data will be provided.

Most medical institutions are currently developing an environment using medical information technology, through the introduction of integrated access to clinical information. Here information technologies and their tools help with administrative and financial issues, in scientific research, in office automation, and also helps patients. At the heart of these evolving integrated environments is an accessible, confidential, secure and integrated electronic medical record [6–9].

3 Health Information Systems: Architectural Models and Management

From a functional point of view, e-health in Kazakhstan supports three main levels of the health system:

Centralized management at the national and regional levels: this includes central planning, resource management, the rules and procedures to be followed, overall financial control, quality and safety control.

Primary health care: this level includes all systems that support services provided to citizens throughout the national or regional territory. It includes all service providers, such as general practitioners, local customs, etc.

Secondary health care: this level refers primarily to systems that support health processes among health care providers.

These three levels are usually interrelated only with respect to administrative and accounting flows, but the potential exchange of data between different layers makes ICTs important for both exchange and processing of large sets of clinical

data. These data provide a great potential for the future development of health care. In fact, ICT solutions that are now present in the healthcare industry have the opportunity not only to simplify the relationship between patients and physicians that improve the overall effectiveness of health services - but also to better control the entire health care system.

Functionality and architecture of e-health information systems, as well as the need for standardization is determined by the information model EMR (Electronic Medical Record)/EHP (Electronic Health Passport) (Fig. 1).

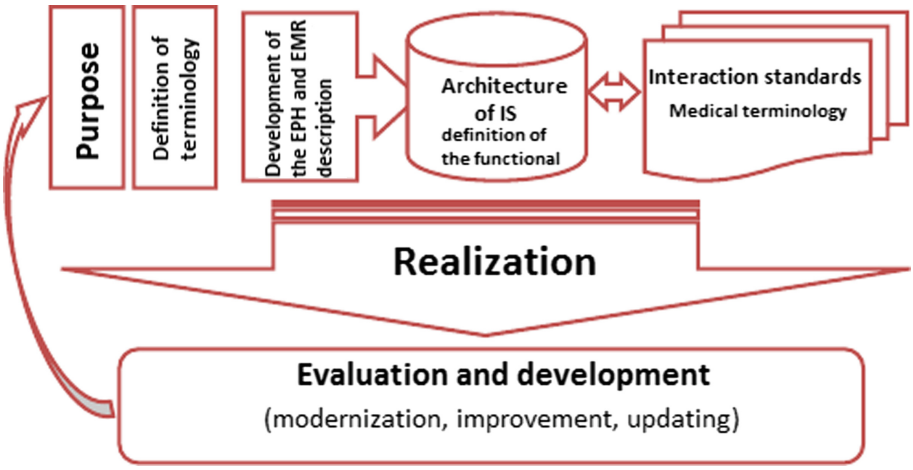

Fig. 1. General scheme for the implementation and development of e-health.

The creation of e-health is based on the following fundamental directions:

- digitization of information flows at the national and regional levels;
- development of a national, as well as a regional social insurance card;
- the presence of an integration bus and a single repository that provides centralized storage of medical and non-medical health data, including electronic health passports of each citizen of the Republic of Kazakhstan (Fig. 2);
- development of regional infrastructure supporting online services for citizens;
- development of a strong set of interrelations between providers of medical services (secondary care) and general practitioners (primary health care);
- establishment of a regional electronic health record, which will subsequently be integrated at the national level;
- digitization of the processes of providing services with secondary care.

Among other priority areas of e-health, the State Program "Information Kazakhstan 2020" noted the following:

- creation of a unified database of medicines;

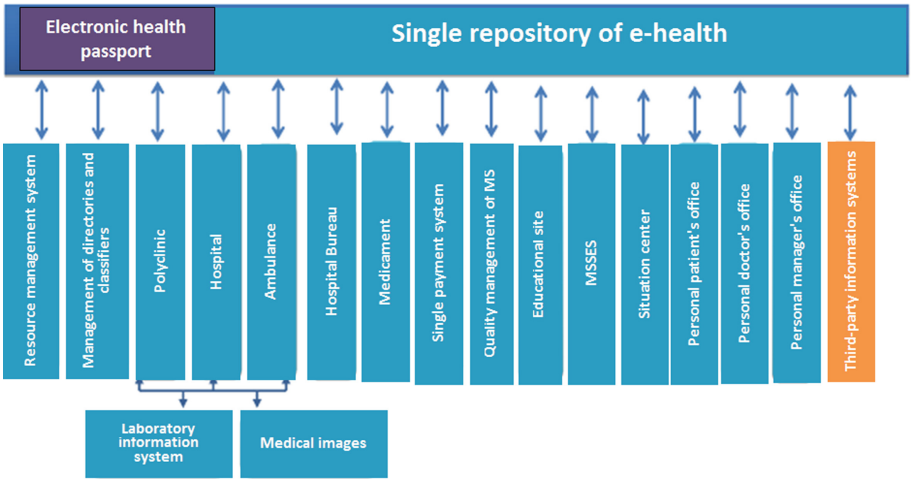

Fig. 2. The proposed conceptual functional architecture of e-health.

- creation of electronic system of medical prescriptions and prescriptions;
- introduction of a system of telemedicine bracelets for monitoring the state of health;
- automation of ambulance services;
- creation of a database of scientific and medical information [3].

Technical architecture is the architecture of the hardware and software infrastructure that ensures the operation of application systems and the execution of operational (non-functional) requirements for the architecture of application systems and information.

Currently, the e-health architecture contains two types of information systems and applications. The first part is developed on the principle of client-server desktop applications. When using these systems, it is assumed that all MOs have servers within the enterprise itself, and all users work with systems on the local network from their workstations. During the night, all the data that was updated during the day is sent from the local server to the top (to the level of the area to ensure data backup), where the data is synchronized, and downward possible changes in directories, data structures and software codes are transmitted. Exchange of operational information necessary for the process of medical care between centralized systems and nodes of UHMIS systems is carried out by accessing services through messaging through the transport environment. The second part of the applications is developed on the web technologies, in which users via web browsers access directly to the central data center of the Ministry of Health of the Republic of Kazakhstan, where web servers, applications and databases are located.

In the future, the transition to cloud technologies is expected. The availability of a backup center for processing medical data (MDC) and a communication

channel is considered. In this architecture, there are two categories of medical organizations: (1) working in the cloud, and (2) working with the local server, at the beginning most organizations will be from the second category (Fig. 3).

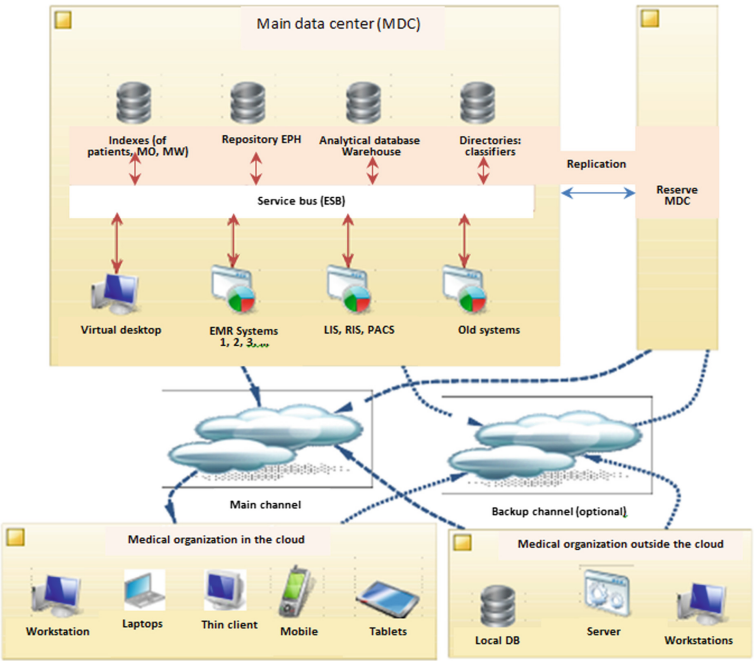

Fig. 3. The architecture of software and hardware in e-health.

Inside the MDC, all databases will be stored, among which the following are highlighted:

- patients Index (PI), which contains the basic identification data for each patient (the personal data are stored in encrypted form in a database), demography and other basic data;
- Electronic health passport, which stores the basic medical data of each patient;
- Specialized databases of individual EMR and web applications, as well as centralized information systems operating in the cloud;
- Data warehouse for statistical calculations.

Data center servers will be treated as existing systems (centralized database from local systems and web applications), and software for virtual desktops and new systems (EHP, IP Polyclinic, IS Hospital, IS Ambulance), etc.

Now the service "Software as a Service" (SaaS) is becoming more widespread. Consequently, cloud computing services are becoming more popular. Often they

even completely displace local systems and data stores. It is assumed that such systems can rely solely on SaaS services and provide all the necessary functions through thin clients, which are a combination of inexpensive hardware, an operating system and a web browser.

The health benefits of the SaaS model are undeniable. These advantages are expressed in the following points:

(1) Availability of a single information space. The ability to quickly access computing and information resources when needed is largely the ideal solution for many hospitals, medical clinics and doctor's offices. This should provide them with an opportunity to improve services for their patients.
(2) All system data is stored in a single storage and processed on the system servers. The problem, at least for now, is maintaining patient privacy. The risks of providing sensitive patient data, especially in public cloud infrastructures, continue to constrain the pace of cloud adoption.
(3) Updates and backups are done automatically. The distribution of electronic medical records, implemented on the basis of cloud technologies, allows you to automate not only the registration of the patient, but also to conduct centralized monitoring of the process of providing medical services at a higher level. It also facilitates the transfer of statistical, administrative, financial data in electronic format, which greatly simplifies their processing and optimizes business processes.
(4) System requirements to jobs user is minimal, no need to install and configure, thereby saving time and money.
(5) Possible access from any node of the system. The cloud brings powerful it resources to healthcare professionals, healthcare organizations that are available anywhere in the world. World-class applications and computing infrastructure are available to all without significant upfront investment.

Areas of application of the SaaS model in health care:

– ERP (Enterprise Resource Planning) system that allows you to store and process most of the critical data: workflow, financial report, personnel records, procurement and inventory management;
– System of medical reference information;
– CRM (Customer Relationship Management) - software for organization and automation of work with customers. In health care, these include: management of the patient base, management of the current activities of the health facility);
– Portal solution. In order to raise public awareness, an information portal is being created within the framework of the unified health system. It aims to increase public awareness, transparency and accountability and effectiveness in the health system. Through this, citizens should have access to reliable and complete information about: public health programs, medical services, service providers, medical equipment, medical personnel and their workplace. The portal should allow the citizen to check his/her insurance status and find out what services are available to him/her within the framework of health care programs.

Thus, the introduction of cloud technologies in the medical industry can solve a number of problems associated with the inefficiency of medical services.

Large volumes of various medical data, which are mainly stored in paper form, are difficult to process and analyze. Also this medical data are prevent rapid clinical decision-making.

Although this approach may be rational in some cases, it can not be universal, because it is thus impossible to provide usability, full integration with productive desktop systems, and the ability to work offline (without an Internet connection). Therefore, it is considered expedient to apply the advanced approach "software products and Internet services" (S + S) [10].

4 Conclusion

This article presents the urgency of the process of development of administrative and clinical information systems in the medical sphere of the Republic of Kazakhstan. Particular attention was paid to the introduction, use and features of a unified health information system. Also features of architectural models and management characteristic for e-health of Kazakhstan are described. The functional and architecture of e-health information systems are considered; the proposed conceptual functional architecture of e-health; architecture of software and hardware in e-health.

The introduction of medical information systems, even if well-organized and technologically sound, has its own difficulties. The main problem is that information systems are managed and used by people who have certain beliefs, attitudes and practices, and it will take time to change them.

Most health care providers feel threatened by a system that leads to objective decisions and are suspicious of automation; health consumers believe that more accessible information systems pose a threat to privacy; and there is no close relationship between consumers.

Another important issue of resource management concerns the appropriateness of computerization and at what level. Although the majority of medical institutions in big cities, now have access to the computer equipment, in many rural areas of the country, the computers may still not be available and the computer literacy of the population is not at the proper level.

However, rapidly evolving computer technologies will make health information systems an increasingly effective and powerful management tool for health services. Computer equipment is becoming increasingly available. Software applications for database management and geographic information systems can improve the use of information for decision-making on the health of individuals and society as a whole.

However, the introduction of computer technology is not necessarily the decisive factor that creates efficiency and effectiveness in the health sector. On the other side, the lack of properly trained staff, as well as problems with hardware and software, sometimes lead to the decline and obsolescence of expensive computer equipment without any benefit in decision-making. Therefore, in this

area it is also important to train medical staff in the use of information and communication technologies for their professional needs.

In the future, due to the development of e-health, it will be possible to provide medical care to citizens through various telecommunication services, for example, services that provide remote interaction between doctors or doctors and patients, remote monitoring of the patient's health status, maintaining medical records of the patient in electronic form, creating a personal account of the patient.

The development of e-health is considered as a complex project in terms of integration of computing, information and telecommunication infrastructure with the health care system. This will bring the quality of medical care to a new level. E-health technologies will make it possible to monitor the population at a distance, better disseminate information among patients, and improve access to health care.

References

1. Nazarenko, G.I.: Medical information systems: theory and practice. Moscow (2005)
2. Shopabaeva, A.R., Blatov, R.M., Sydykov, S.B., Zhakipbekov, K.S., Elshibekova, K.M.: Information and communication technologies in the healthcare system of the Republic of Kazakhstan: problems and development prospects. Bull. Kazakh Natl Med. Univ. (1), 769–775 (2016)
3. The concept of e-health development of the Republic of Kazakhstan for 2013–2020
4. Kuznetsov, P.P., Stolbtsov, A.P.: Modern information technologies and healthcare development. Med. Almanac (3), 8–12 (2008)
5. Shifrin, M.A.: Creation of a unified health information environment - the mission of medical informatics. Doct. Inf. Technol. (1), 18–21 (2004)
6. Uvalieva, I.M., Belginova, S.A.: Development of the conceptual model of the diagnostic object in the medical diagnosis system. Bull. KazNITI (5), 69–74 (2017)
7. Uvalieva, I.M., Belginova, S.A.: The concept of e-health of the Republic of Kazakhstan. In: EUROPEAN RESEARCH: A Collection of Articles of the XI International Scientific and Practical Conference. Penza, MCSN "Science and Education", pp. 65–69 (2017)
8. Uvalieva, I.M., Belginova, S.A., Ismukhamedova, A.M.: Analysis of decision support systems in medicine. In: ADVANCED SCIENCE: A Collection of Articles of the International Scientific and Practical Conference. At 3 o'clock Part 1. Penza, MCSN "Science and Education", pp. 99–101 (2017)
9. Belginova, S.A., Uvalieva, I.M., Ismukhamedova, A.M.: Use of decision support methods for medical diagnosis. Bull. Shakarim (2)
10. The methodology of building integrated medical information systems, 2nd edn. Microsoft Corporation (2009)