Iran's National Health Information Network: Developing an Architectural Model

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Abstract

Aim: This study was conducted to develop a model for the architecture of Iran's National Health Information Network (NHIN).

Method: In this study, based on the literature review, the necessary information was obtained about the concept of the architecture of the NHIN; then, documents related to NHIN architecture in the United States and the United Kingdom were collected. In the second stage, according to the information obtained in the previous stage and considering the structure of Iran's health system, an architectural model for the NHIN of Iran was presented. Then, the Delphi technique was used to validate the proposed architecture.

Results: The proposed architecture of the NHIN of Iran includes three dimensions of nodes or network members, member's interfaces, and finally, communication with the environment (confidentiality and security). 90% of the experts evaluated each dimension of the proposed architecture on an acceptable scale. In general, the proposed architecture was evaluated by 90% of experts on an acceptable scale.

Conclusion: In proposing the architecture of Iran's NHIN, attention was paid to the experiences of the two leading countries, approaches to NHIN design, and the structure of Iran's health system. However, the proposed architecture is critical and can be used for the countries whose health system structure is almost similar to Iran.

Keywords: National health information network, Health information systems, Architecture, Model

The National Health Information Network (NHIN) is a network that connects all health service providers, health plans and initiatives, health information providers, government agencies, and other related health organizations to exchange health information. (1-3). By creating an electronic health record (4) and improving the flow of information, this network will be an essential factor in improving health care quality, access to health services, and the cost-effectiveness of health care (5). The NHIN is expected to collect health data from a variety of systems and then share it among a variety of stakeholders. Using this information sharing, different audiences in the field of health, especially the Ministry of Health, can accurately monitor health issues and problems across the country (6-8).

A review of scientific literature shows that developed countries have realized the status and importance of the NHIN for many years.

The United States and the United Kingdom are among the countries that have been working since the early 2000s with projects called the NHIN (Nation-wide Health Information Network) and NPfIT (National Program for Information Technology) in the National Health Service to build a national health information network (9-11). However, the study of national health information systems in developing countries shows that the lack of comprehensive policies and plans on health information at the national level is an important shortcoming in these countries (12-13).

In Iran, reviewing the documentation of health information systems projects in the Ministry of Health, including SEPAS (Electronic Health Record System) and SHAMS (National Health Network) projects (14-18) and evaluating them according to the definitions of NHIN in the authoritative texts (2) indicates that the mentioned projects are not in full compliance with the concept of NHIN (2). Some studies have also pointed to some problems related to the country's health information system, such as lack of standards, legal problems, and inadequate infrastructure (19).

In general, it can be said that insufficient attention to the design and development of an NHIN in Iran is an important shortcoming in information and health services (14-18). On the other hand, it is clear that to achieve the goals and benefits of launching NHIN, its design and creation must be based on appropriate architecture (20-21). The National Center for Coordination of Health Information Technology in the United States (ONC) has also referred to this network's architecture in NHIN documents. It considers architecture one of the most critical points in designing and developing a national health information network (22-21).

From the International Organization Standardization (ISO) perspective, architecture is the science of examining and identifying the components of a phenomenon, the relationships between them, and the relationship between the set of components and the environment (23). In network architecture, the components are subsystems. NHIN subsystems are, in fact, the information systems of stakeholder organizations. These systems are different in terms of technology, and the types of data collected and are at different stages of the life cycle at any point in time; therefore, in creating and operating NHIN, by focusing on relationships, it was tried to create interaction and communication between these different and separate systems and create a network of networks (5). In the present study, regarding NHIN architecture documents in the United States (21-22) and related articles (20), NHIN architecture includes three components of network members or organizations, interfaces, and network communication with the environment. However, since the health system structure varies from country to country and it is not possible to provide a single architecture for NHIN in each country, the present study was conducted to provide a model for the architecture of Iran's national health information network.

Method

In the first phase of the study, based on the literature review, the concept of NHIN architecture was explained in three dimensions, including network members or organizations, interfaces, and network relationships with the environment.

Then, by reviewing the website of the Ministry of Health of the United States and the United Kingdom, as well as scientific databases, the documents related to the architecture of the NHIN of these countries were obtained. These documents were then analyzed according to the dimensions of NHIN architecture.

In the second phase, using information related to the architecture of the NHIN of the studied countries, valid scientific texts, and

considering the structure of Iran's health system, a model for the architecture of Iran's information network was proposed.

In the third phase, to validate the proposed architecture, the Delphi technique (24) was implemented. Ten experts in health informatics and health information management were surveyed about the three dimensions of the model using a semi-structured questionnaire (with 11 closed questions).

The questionnaire's validity was measured by determining the validity of the content and reliability by Cronbach's alpha ($\alpha = 0.88$). For each closed question, three options, including "acceptable," "relatively acceptable," and "unacceptable," with numerical values of 3, 2, and 1 (respectively) were considered. Thus, according to the number of experts participating in the Delphi technique, each question's maximum and minimum possible points could be 30 and 10, respectively. If the score of each item was more than 25, it would be accepted. Questionnaires were distributed and collected both in person and by e-mail, and finally, the data were analyzed using SPSS-23.

Results

There are different perspectives on the term architecture (23, 25-26). In this study, NHIN architecture includes three dimensions: 1- network members, 2- interfaces (interactions between members), and 3- communication with the environment (security and confidentiality) (23, 21). Given these dimensions, a review of the NHIN architecture in the studied countries showed that both countries had acted almost identically on how to establish interfaces and how to regulate the issue of security and confidentiality in the NHIN. This means that a gateway has been defined to connect the network members (21, 29-27) and the environment in the case of network interfaces. These relationships are based on autonomy and local responsibility, technical solutions, and

legal agreement regulation on the exchange and use of health data (21, 33-30).

Regarding the members of the network, it can be said that the NHIN in the United States is connected by entities such as health information exchange centers, regional health information organizations(RHIO), integrated care delivery networks, state health information exchange programs, federal agencies (33 national agencies and organizations), state and local governments, hospitals, clinics, pharmacies, laboratories, imaging centers, insurance and payment systems, local health centers and other health organizations (21- 22).

In the UK, members of the N3 network include the following: Community of Interest Networks (CoINs), gateways to other networks including Internet gateway, telephone and mobile network, pharmaceutical network, university network Gateways to national medicine in Wales and Northern Ireland, gateways to the government network (including government departments, local authorities) and direct members (including acute trusts, ambulances, caregivers, dentists, basic trusts, family physicians, providers of health systems and software, terminally ill care centers, independent health care departments, local authorities, mental health trusts, national blood system, health and social care center (HSCIC) systems, insurance systems and payers, primary care trusts, health authorities and special authorities (29, 32).

The comparison of NHIN architectural dimensions in the studied countries and the proposal for the NHIN of Iran are shown in Table 1. The proposed NHIN architecture in Iran is shown in Figure 1.

According to Figure 1, the main foundations of the proposed architecture of the NHIN of Iran are the provincial health information networks. Interfaces also include gateways created by the private and public sectors based on the standards and technical requirements of the

network, based on the type and needs of member organizations.

The network's relationship with the environment will also be regulated by technical requirements, a multilateral legal agreement on the exchange, sharing, use of health data and information, and local responsibility (local components and networks). Table 2 shows the frequency distribution of expert opinions and the score of the studied items in each of the proposed architectural dimensions.

Table 1: The comparison of NHIN architectural dimensions in the studied countries and proposed model

Architecture Dimensions	United States	United Kingdom	Iran
Network Members	- Federal agencies (the latest list including 33 ministries, agencies, and national organizations with their sub-centers) - Health Information Exchange Centers (HIEs) - Regional Health Information Centers (RHIOs) - Integrated Care Delivery Networks (IDN) - Personal Health Record (PHR) - Registration systems and data warehouses - Hospitals - Clinics -drug stores - Labs - Imaging centers - Insurance system and payers - Local health centers - State and local governments - State health information exchange programs	- Community of Interest Networks (CoINs) - Direct members of the network - Acute trusts - Ambulance trusts - Care trusts - Dentists - Basic trusts - Family doctors - Providers of health systems and software - Inpatient care centers - Independent health care department - Local officials and authorities - Mental health trusts - National blood system - HSCIC center systems - Insurance systems and repayers - Primary care trusts - Special health officials and authorities - Gateway to other networks - Internet gateway - Telephone and mobile network - Pharmacy (pharmaceutical network) - University Network Gateway (JANET) Gateways to National Medicine in Wales and Northern Ireland - Gateway to the government network, including government departments, authorities, and local offices	- Ministries and national organizations under the President - Organizations and centers under the supervision of the legislature and the judiciary - Organizations and centers under the supervision of the leadership - Provincial networks of health information - National commercial companies in the field of health - NGOs in the field of health - Patients (to receive a personal health record)
Interfaces	- Gateways	- Aggregators - Gateways	- Gateways with the participation of stakeholders
Communication with the environment (security and privacy)	- Autonomy and local responsibility - Technical solutions - DURSA Agreement	- Security protocols - Declaration of Conformity and Governance of Information (IGSoC) - Local responsibility	- Autonomy and local responsibility - Technical solutions - Legal agreement for the exchange of health data and information

Table 2: Frequency distribution of expert opinions on the architecture of the NHIN for Iran

Options and frequency percentage Architecture dimensions	Acceptable		Relatively Acceptable		Unacceptable		Score each item (Maximum 30)
	no	%	no	%	no	%	
Members of the National Health Information Network (Ministries, Organizations, and Institutions Related to Health)	9	90	1	10	0	0	29
Create different interfaces based on the type and needs of member organizations	9	90	1	10	0	0	29
Setting the network connection with the environment based on local responsibility, technical requirements, legal agreement of exchange, sharing and use of health data	9	90	1	10	0	0	29
Total/mean	27	90	3	10	0	0	87
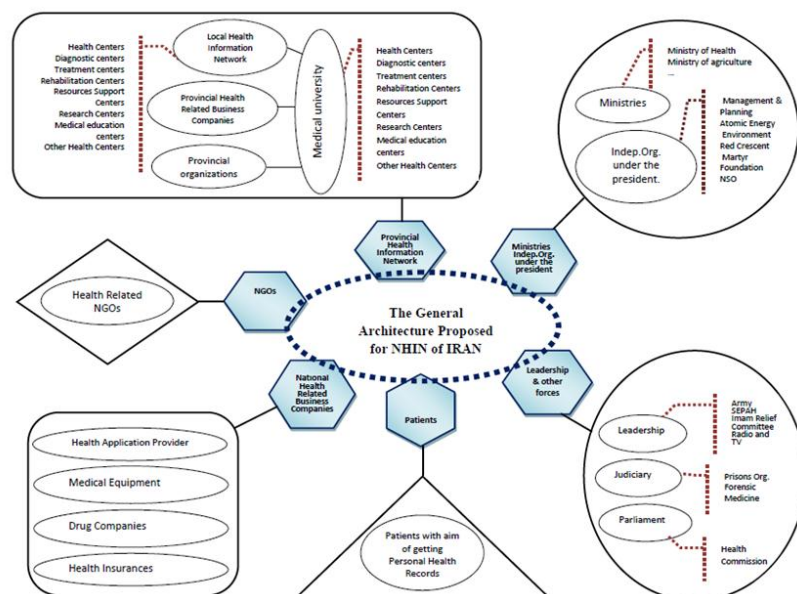
Figure 1: The proposed architecture for the National Health Information Network of Iran

Discussion

This study aimed to investigate the architecture of the NHIN in the United States and the United Kingdom and provide a model for the architecture of the NHIN in Iran. Based on the findings of the present study, the NHIN architecture consisted of three main components: network members, member interfaces, and environmental relations (security and confidentiality).

The United States and the United Kingdom acted almost identically on building interfaces and regulating security and confidentiality in the NHIN. However, in the area of security and confidentiality, the United States has also enacted federal and state laws, which may be due to the sensitivity of the issue of security and confidentiality in that country.

Another important difference observed in the two countries' NHIN architecture was how the network members were arranged to form NHIN. In other words, the NHIN architecture in the United States was formed from the connection of local networks called health information

exchange centers, regional health information organizations, integrated care delivery networks, state health information exchange programs, federal agencies, and other health organizations, including insurance. Among them were state health information exchange programs from 2010 onwards, which had been the mainstay of the RHIO network (21).

This type of architecture is called the bottom-up approach (35-34). In the UK, the N3 network architecture was central; this means that governance, system creation, and network members are defined in a completely centralized manner (29), also known as the top-down approach (34-35).

According to the findings of the study by Coiera (2009), due to the large scale of the NPfIT project, the top-down approach of the NHS cannot adapt quickly to the challenges and changes related to health care delivery. In contrast, a bottom-up approach is resistant to drastic changes such as new technologies or system redesigns. On the other hand, according to the NHIN architecture in the United States, in the end, a single electronic health record is not created, but views of the electronic health record are taken from each of the local networks; but in the approach used in NPfIT program, a single electronic health record is created for each person. In this case, Coiera (2009) states that the creation of a single, national electronic health record, given the scale of the NPfIT project, increases the risk of this project (34).

The studies on the design and architecture of NHIN, in addition to the above approaches, have also referred to a third approach called "middle-out" (Middle -out) (35-34). This approach considers the needs of health care providers, the IT industry, and the government, then defines common goals for NHIN technical and non-technical issues. The government leads the network and plays the role of facilitator, and then, by defining interoperability standards,

a national health information network is formed by connecting provincial (state) health information networks and other stakeholders (34-35).

However, each of the approaches in the NHIN architecture of the countries under study has advantages and disadvantages, but the important point is that these approaches generally depend on the structure and nature of a country's health system. The health system is quite centralized in some countries and completely decentralized in others, which will be somewhat different in the type of NHIN architecture in these systems (35).

Considering the points mentioned above, and the main structural blocks of Iran's health system include medical universities of each province, and this structure is more compatible with the middle-out approach, so this approach was used in the NHIN architecture of Iran. This architecture's main basis is the provincial health information networks led by the University of Medical Sciences of each province. In the suggestion of other NHIN members of Iran, the two countries' architectural similarities were used.

Moreover, in determining the interfaces and communication with the environment, since these two components are almost similar in the two countries studied, it is also proposed for Iran. The findings of Table 2 also confirm that the proposed architecture has been considered so that a total of 90% of the experts have evaluated it on an acceptable scale. The findings of Targovsky's study (2011) are also consistent with the findings of this study. He has presented the architecture of the NHIN in the United States at four levels, including local, regional, national, and international (36).

In general, the proposed architecture is expected to create more coordination between the stakeholders of information and health

services in the country and act as the basis of all Ministry of Health projects to manage health information in the country.

Conclusion

In proposing the Iranian NHIN architectural model, attention has been paid to the experiences of the two leading countries in the creation of NHIN, the approaches proposed in the design of NHIN, as well as the structure of the health system of Iran. However, the proposed architecture is critical and can be used in countries whose health system structure is almost similar to Iran.

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