

An Assessment of Readiness for Pre-Implementation of Electronic Health Record in Iran: a Practical Approach to Implementation in general and Teaching Hospitals

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Abstract- Readiness assessment provides a proper image of the existing conditions and an explanation of facilitated operational plans and functional approaches to successful implementation of electronic health record. Readiness assessment requires indices adjusted to particular conditions in each country. Therefore, the present study attempts to provide an acceptable model in Iran and to provide an assessment of public and teaching hospitals in medical education university. After reviewing related papers and descriptive study of five selected countries, the initial model was designed in the form of a questionnaire for analysis through Delphi and distributed among 30 experts nationwide. Along identification of components in the proposed method, a 7-point Likert scale was used to determine priority of each component. Then, all general -education hospitals at Tehran University of Medical Education were examined based on this model in terms of total, relative, or no readiness. The final model was designed in five dimensions: cultural, leadership and management, technical infrastructure, governance and operational dimensions; Educational Hospitals were evaluated in this dimension. 28.6 % of general – teaching hospitals are ready for pre-implementation. It seems to establish uniform strategic and executive team in Health center is essential for the preparation them in abovementioned area in the least possible time.

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Introduction

In implementing Electronic Health Record (EHR), assessment, particularly readiness assessment, is the first and the most important step prior to implementation and helps identification of processes for ranking priorities in EHR implementation and establishment of required operational functions to support process optimization in EHR implementation (1-2). Readiness assessment must involve comprehensive measures which indicate an organization readiness for future planning which usually covers such primary areas as organizational culture,

management and leadership, operational and technical requirements (3-4). Lack of organizational readiness is a major contributor to EHR failure in the health industry (5). Readiness assessment activities virtually clarify required concepts and paths toward implementation of complex health information technologies exemplified by EHR (6). Readiness assessment is also a way to identify potential causes of failure in innovation (7). Therefore, the author decided to provide a properly localized model for Iran and also examine readiness state in public and teaching hospitals directed by Tehran University of Medical Education based on the final model.

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Materials and Methods

First, by reviewing the literature, using library resources and related databases, and examining prominent dimensions in EHR pre-implementation in five selected countries (Countries with substantial experience in the field of information technology and EHR systems, a substantial and systematic actions done in this area or because of its affinity with our country including England, Denmark, Singapore, Canada, and the United States), a descriptive-comparative approach was employed to prepare an initial pre-implementation model for EHR through Delphi. The validity of data obtained through comparative studies was confirmed based on content validity by reviewing the literature and by seeking opinions from scholars and experts. The reliability of the data was also confirmed using a value of 0.89 obtained for Cronbach alpha. Based on the main components of the proposed model (culture, management and leadership, governance, operational and technical infrastructure) a Delphi-based 7-point questionnaire (with 1 being the highest and 7 being the lowest value) was prepared and submitted to 30 experts around the country. These experts should be specialized in health information management, medical informatics, and related researcher with at least three years of experience in this area in academic institutes and Iranian Ministry of Health. Given the approval of over 90 percent of the experts, the Delphi survey was carried out in one step.

In addition, to determine the level of readiness for EHR pre-implementation in hospitals, all public teaching hospitals of Tehran University of Medical Education were examined. For this purpose, a questionnaire with a reliability of $\alpha=0.94$ was prepared based on expert opinions on required components in operational evaluation of EHR pre-implementation at hospitals. The components were assessed in three states: finished, unfinished, and in progress. In descriptive statistical analysis, a score ranging from 0 to 2 was assigned to each state. Maximum and minimum scores for each component was determined based on the respective priorities in the final model, and a three-class categorization was obtained: not ready (first 33% of maximum score or 1-2 score), relatively ready (second 33% of maximum score or 3-4 score), and ready (top 33% of maximum score or 5-6 score). This study was approved by the Ethical Committee of Tehran University of Medical Sciences. Participation in this study was voluntary, and informed consent was obtained from all of the participants. All information obtained

from the participants was kept confidential.

Results

Based on the examinations, components of the proposed model were presented in terms of readiness for pre-implementation: organizational readiness, structure readiness (8), culture readiness (9), management and leadership readiness (8-11), operational readiness (8-9,11), governance readiness (12), and technical readiness (3,8,10).

Cultural readiness

Acceptance by stakeholders (9,10,13,14); demand finding and acceptance of E-health records clinical practitioners (13-15), that is systematic acceptance of IT (15,16) by health and healthcare practitioners (8,17-20); participation of stakeholders in the implementation (6,15-17,21) including participation in decision making (22), evaluation, system selection, and implementation (21,23,24), and participation of senior managers in promoting knowledge and culture (25); raising the level of stakeholders' awareness of expectations in implementation through training (26) and promoting EHR culture through training (18); understanding new interaction (10); commitment to implementation according to a preplanned timeline (22,26); motivating healthcare practitioners (27); commitment to implementation of required process and changes in workflow parallel to implementation (6); other related issues (e.g. determining and accepting mode of interaction with patients (10), readiness to deal with challenges and obstacles (8), proper relationships between system developers and clinical staff (26), and accepting regular assessment and modification based on feedbacks (28).

Management and leadership readiness

Considerable contribution by managers and leaders in acceptance of HER (27); participation in planning (15,26) and project initiation document (PID)(7,26,29); preparing a plan to communicate the advantages of implementation (26,30-31); preparing a strategic plan (27-28,32-34); determining and defining identifiers (26); defining and designing business case (10,21,23,26,31); defining initial key dimensions (5,22,24,35) including a list of expectations (36-37), needs, users (22), potential uses (23,26) and management of stakeholders (29, 38); forming a strategic team; building up an executive team (15,29,33,39) and related workgroups for each area (22); focus on change management (changes in work

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strategies)(26,29,31); participation in information/data architecture (27,40-41); planning for Information Management readiness (14); preparing a special plan for hardware-to-software record conversion (26) (documents, support plans, data transfer and removal method, etc)(21,38); identification of human (10,21,26,38) and financial resource (10,12,14,26,29); participation in creating strong public support (through health policies and based on implementation objectives)(26); pilot implementation (21,24,26,38); focus on main components of the project management (14); focus on the provision of patient-oriented healthcare(18); balancing national and local management (23); balancing organizational roles (7); defining policies, procedure and techniques to motivate (26) movements toward goals (14); determining the needs for changes in processes (42); best practice workflows (includes: identifying the ways to success, goal-oriented implementation, integration, proper training; predicting double efforts and redundancies; building specialized groups for implementation) (22,43).

Governance readiness

Strong (public) support for implementation (26); EHR implementation strategies (12) and implementation based on the existing laws and regulations (44-45); coordination between governance and EHR implementation strategy (12,15); having IT-related strategies (15) (security, information/data quality (46)); having clear policies for EHR implementation (36); making clear decisions in connection to IT (12) and responsibilities; clear definition of roles (22); having national rules for data sharing (47); accessibility of foreign financial support (15); access to internal assets and facilities with reusability at organizational level for interoperability (48); governance capacity of human resources at organizations for large-scale projects similar to EHR implementation (15).

Technical infrastructure readiness

Having a network equipped with physical security system and proper bandwidth (49) (network configuration, components, equipment, technology, and protocols); design and implementation of networks at province level (50); communication infrastructure (29,50) (for hospitals and healthcare centers and other centers at national and provincial levels); determining general software at national level (21,38) (programming language, operating system (49) (e.g. Unix), application program e.g. VB, SQL) (26,49), defining databases (49); having required hardware (21,38) including

input/output, processing, storage, memory, backup, facilities like computers, terminals, and workstations; peripheral facilities (49) such as printers; security considerations (38); solution architecture (e.g. interfaces for different users, data repository, data warehouse messaging services, data interaction exchange) (40); scalability considerations¹(49).

Operational readiness

Reinforcing legal frameworks for EHR implementation including confidentiality policies (18,26), data protection security policies (security infrastructure and clinical security) (26), Existence of privacy policy and access to clinical information (26) based on the defined roles, policies, protocols, and particular methods based needs (51); training (26,52) including defining training content and its modules (38), evaluation of staff to identify the level of their skills (21,29), training strategies (29), training programs (21,53), training methods and techniques (53); process review and modification process (18,40), controlling workflows (9,43), reviewing the existing processes (30,54), defining required processes, redesigning workflow and identifying gaps in the existing and ideal conditions (15,38,55); managing relationships with vendors and selecting systems (11,26,43); care management (9); developing a program for user registration (21,29,38,56).

Results from Delphi indicate that none of the components in the culture readiness were rejected. Average score for the main components ranged from 1.6 to 2.07 indicating that experts totally agreed or agreed with the components. With regard to management readiness, the highest level of disagreement was observed at 6.7% with an average score ranging from 1.24 to 1.97 in the agreement area, indicating total agreement for a major part. The highest priority was given patient-oriented services and then strategic plan. For governance readiness, the experts agreed with most components at 96.6% with an average score ranging from 1.47 to 2.38. With respect to technical readiness, disagreement was at 7.1%, in agreement area highest priority was given to security consideration in infrastructures with 100% agreement in the first quartile, and the lowest priority was given to scalability considerations with an average score of 1.82. For operational readiness, the data indicated an agreement

¹In electronics (including hardware, communication and software), scalability is the ability of a system, network, or process, to handle a growing amount of work in a capable manner or its ability to be enlarged to accommodate that growth

with most components at a percentage greater than or equal to 93.1% with the highest score being assigned to the legal framework and the lowest priority given to healthcare management with an average score of 2.1 (Figure 1).

In addition, readiness assessment at general-teaching hospitals (Table 1) shows that components of the culture

readiness, except for proper relationships between system developers and clinical staff that have been carried out in 42.9% of hospitals, other component have been taken into account at 28.6% of hospitals. Rows 1, 8, 9, and 11 in Table 1 have not been implemented in any hospital.

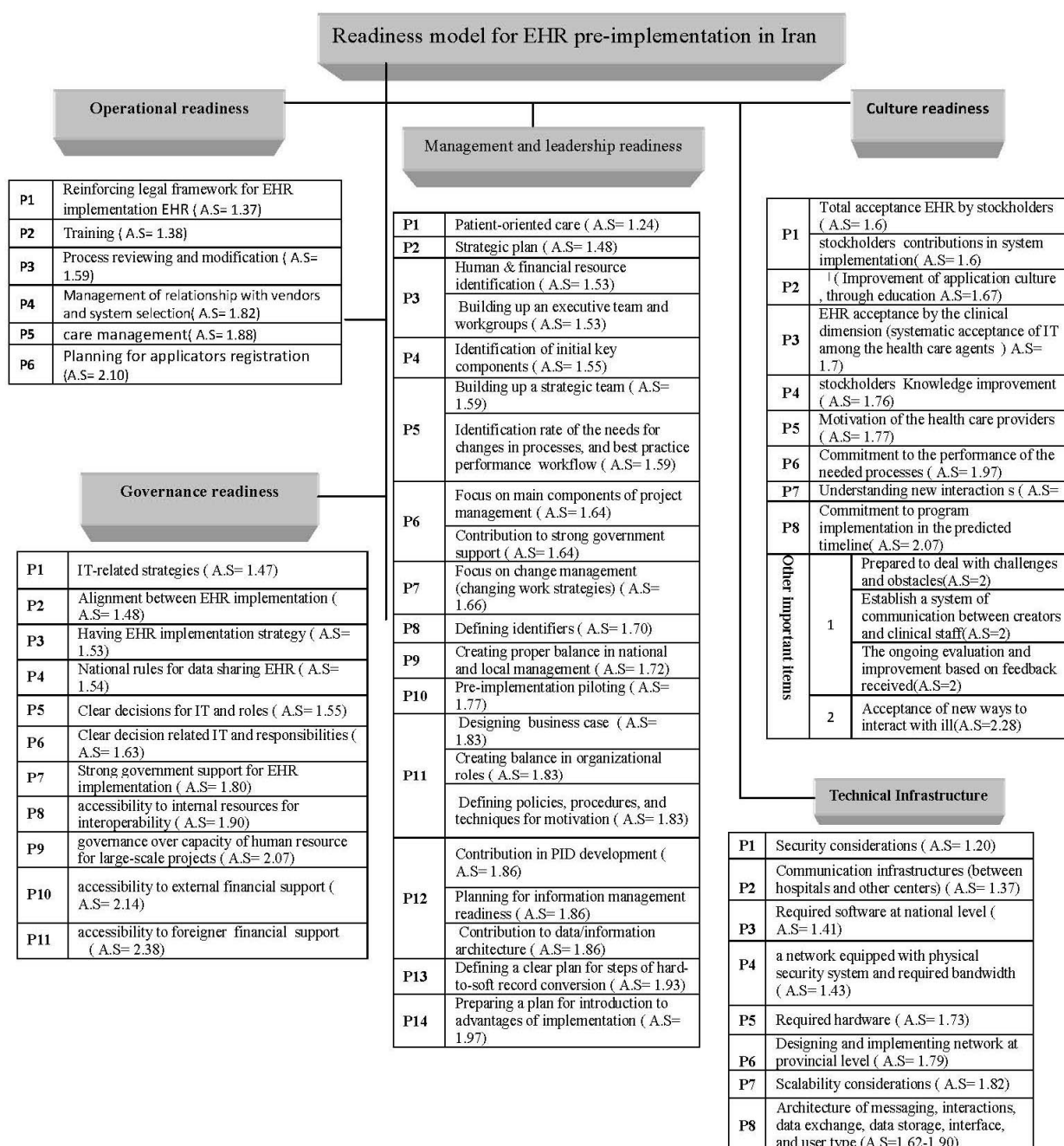


Figure 1. Iran EHR pre-implementation Model (p= priority and A.S= Average Score)

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With respect to management readiness, 87.7% of components are in progress or unfinished at 71.4%. Except for 100% participation of management in this area, the largest finished portion was observed for system uses and users (57.1%) and the finished portion for the rest of components was smaller than or equal to

42.8%. For governance readiness, all components except for clear IT decisions in hospitals and defining the related responsibilities for it (28.6%) were finished at 14.2% in the hospitals studied here.

Table 1. Frequency distribution for dimensions of readiness assessment in EHR pre Leadership & Management area

Component	Finished		Unfinished		In progress	
	NO	%	NO	%	NO	%
Preparing and confirming operational strategic plan (for hospital) for EHR implementation	2	28.6	2	28.6	3	42.8
Identification of key dimensions in EHR	2	28.6	3	42.8	2	28.6
Identification of uses and users	4	57.1	3	42.9	-	-
Planning for promoting advantages of implementation for stakeholders	3	42.8	3	42.8	1	14.4
Planning for information management readiness	-	-	2	28.6	5	71.4
Planning for hard-to-soft record conversion	1	14.3	1	14.3	5	71.4
Significant participation of managers and leaders in planning	7	100	-	-	-	-
Plan setting, regular planning, documentation, and defining roles and responsibilities	-	-	4	57.1	3	42.9
Creating proper link and balance between hospital management in project implementation and national-local management	3	42.9	4	57.1	-	-
Implementation of initial (main) dimensions of project management	3	42.9	4	57.1	-	-
Planning for changes in workflow toward best practice	2	28.6	-	-	5	71.4
Participation in creating strong government support through policies that match implementation goals	2	28.6	5	71.4	-	-
Announcing organizational policies and methods for motivation	1	14.3	4	57.1	2	28.6
Supplying financial-managerial resources	1	14.3	6	85.7	-	-
Supplying human resources in hospital	2	28.6	5	71.4	-	-
Strategic & executive team						
Forming a strategic team in hospital for EHR implementation	2	28.5	3	42.9	2	28.6
Forming special workgroups	1	14.2	3	42.9	3	42.9
Forming a project executive team	1	14.3	5	71.4	1	14.3
Cultural area						
Overall acceptance for EHR and IT system(systematize acceptance them by practitioners)	-	-	5	71.4	2	28.6
Stakeholders' team participation in planning, decision making, assessment, and selection	2	28.6	3	42.8	2	28.6
Stakeholders' team participation in system implementation	2	28.6	3	42.8	2	28.6
Increasing stakeholders' awareness of EHR implementation expectations through training	1	14.2	3	42.9	3	42.9
Promoting EHR application culture through training	1	14.2	3	42.9	3	42.9
Stakeholders' Acceptance and Understanding of new forms of communication	1	14.2	3	42.9	3	42.9
Accepting proper communication between system developers and clinical staff	3	42.9	3	42.9	1	14.2
Hospital and participants' commitment to program implementation based on the predefined timeline	-	-	5	71.4	2	28.6
Managerial, clinical, administrative, and financial personnel's commitment to implementation of processes and changes in workflow	-	-	4	57.1	3	42.9
Creating required conditions for readiness of staff to face challenges and obstacles	1	14.3	4	57.1	2	28.6
Creating acceptable conditions for regular assessment and modification based on feedbacks	-	-	5	71.4	2	28.6
Governance area						
Existence of a strong leverage (public) for supporting the implementation process of E-health records in hospitals	1	14.2	3	42.9	3	42.9
Synergism of the implementation strategy of E-health records with governance in hospital	1	14.2	3	42.9	3	42.9
Clear decision making related to IT in hospitals and defining the related responsibilities for it	2	28.6	2	28.6	3	42.8
Clear definition of roles (having execution guarantee for roles and responsibilities ,formalization of roles)	1	14.2	3	42.9	3	42.9
Defining the rules adopted to national rules for data sharing	-	-	5	71.4	2	28.6
Accessibility to assets and internal facilities with repeated usage (at organizational level)	1	14.3	5	71.4	1	14.3
Access to foreign financial supports	1	14.3	5	71.4	1	14.3
Defining the human resource provision for implementing the E-health record	1	14.3	4	57.1	2	28.6
Operational area						
Evaluation and revision of the legal framework for the implementation of E-health record based on the hospital needs and situation	1	14.2	3	42.9	3	42.9
necessary Prediction for education regarding to implementation	1	14.3	5	71.4	1	14.3
Investigating and reforming the processes and related clinical and non clinical workflow	3	42.8	2	28.6	2	28.6
Definition of the management procedures for the system change*	1	14.3	4	57.1	2	28.6
Designing the registration program in different levels of hospitals for users	1	14.3	4	57.1	2	28.6
Suitable management for relationship with vendors and selection of suitable system	-	-	6	85.7	1	14.3

* Providing the care management strategy , defining health care components and related issues (designing the quality indices for improving the quality care and defining the effective roles in patients results through health care management

Table 1 shows that in operational readiness, process reviewing and modification and clinical/nonclinical workflows were finished in 42.8% of hospitals.

Only 14.3% of hospitals finished other components. Therefore, majority of hospitals (over 85.7%) have not finished these components or have them in progress, with the largest portion of unfinished components.

Table 2 shows that components of technical infrastructure readiness, except scalability that have been carried out in any hospitals and relational infrastructure for hospital and other center maximum

in%14.3 in hospitals, other component have been taken maximum in %57.1 hospitals. Finding in network section shows %71.6 of component were finished or in progress in over %71.6 hospitals. Except providing protocol item that was not finished in hospitals, in section of Defining and selecting the supporting software for EHR adopted to define cases at national level in hospitals, %62.5 of component were finished in %57.1 of hospitals .In other section in this area maximum, finished component were %28.4.

Table 2. Frequency distribution for dimensions of readiness technical infrastructure procedures in EHR pre-implementation in general-teaching hospitals of Tehran university of Medical Education

General (Basic) component	Finished		Unfinished		In progress	
	NO	%	NO	%	NO	%
Defining the architectural model of the system (without contribution in ranking)	4	57.1	1	14.3	2	28.6
Defining and providing the suitable relationship infrastructure between providers and service recipients	4	57.1	1	14.3	2	28.6
providing the suitable relationship infrastructure for hospitals and other local ,regional and national centers	1	14.3	4	57.1	2	28.6
Providing the needed hardware	4	57.1	2	28.6	1	14.3
Attention to scalability design and implementation of the system (scales for defining the product ability and providing indexes)	-	-	7	100	-	-
Security considerations	3	42.9	4	57.1	-	-
Network						
Performing the needed actions for designing and establishment of network	4	57.1	2	28.6	1	14.3
Providing the suitable configuration for network and EHR architecture	5	71.4	2	28.6		
Design of the suitable topology for the network	4	57.1	1	14.3	2	28.6
Definition of the network components	4	57.1	1	14.3	2	28.6
Defining the network equipment (Hob, Bridge, router, for the connection of different networks , switch, multiplexer , modem)	5	71.4	2	28.6	-	-
Defining the network protocol(data send –receive rules)	-	-	7	100	-	-
Unlimited access to internet (<i>without involving in ranking</i>)	3	42.9	4	57.1	-	-
Defining and selecting the supporting software for EHR based on defined cases at national level: in hospitals						
Programming language	2	28.6	2	28.6	3	42/9
Application system (windows , Unix based systems such as Linux)	4	57.1	2	28.6	1	14.3
Defining the database	4	57.1	2	28.6	1	14.3
Application software in database management system	4	57.1	2	28.6	1	14.3
Interface/ integration application programs (word , Excel, Access , PowerPoint , Outlook)	4	57.1	2	28.6	1	14.3
Application program needed for clinical , para clinical and management dimensions	2	28.6	5	71.4	-	-
uses of organizational components and services (electronic) in hospitals in clinical dimension	4	57.1	1	14.3	2	28.6
uses of organizational components and services (electronic) in hospitals in management dimension	3	42.9	1	14.3	3	42.9
Consideration of the architecture of special solutions						
Interface architecture for different users			7	100	-	-
Architecture of database , data repository and data warehouse	2	28.6	5	71.4	-	-
Architecture of messaging , data interaction and exchange	1	14.3	6	85.7	-	-
Other						
Suitable actions for design and providing database and data storage	-	-	6	85.7	1	14.3
Design and usage of search engine	-	-	7	100	-	-
Design and usage of rules engine	-	-	7	100	-	-
Design and usage of middleware	-	-	7	100	-	-
Attention to the implementation of interactive/ exchange standards and homogenization	-	-	7	100	-	-

Discussion

For the culture readiness for EHR pre-implementation, the final model was developed with ten components and eight priorities based on the mean scores and priorities (Figure 1). In culture readiness model in Iran, since participation of stakeholder has

been given the highest priority, the components may be ordered based on expert opinions as follows: stakeholders' participation in the implementation; decision making, system selection and evaluation; senior managers' participation in promoting knowledge, skills, understanding of security, enhancing automation, participation by all relevant organizations such as

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pharmacies, social security, and insurance companies in national implementation of the system. Based on the expert views, presence of IT and HIT personnel – especially senior managers and project leaders – doctors, and service providers – boards and academic colleges – were identified as priorities 1 to 4 in this area. In the subcomponent decision making and system selection and evaluation, the highest priorities are given to the presence of members and representatives of relevant committees, researchers, and patients after four abovementioned priorities and in implementation subcomponent the lowest priority was given to participation by patients and citizens. In his star model, Golden states that there is no accessible leverage for healthcare leaders and policymakers that do not directly affect values and culture; rather, culture and values are indirectly changeable. This is not in line with the findings of the present study. However, he emphasizes the use of motivating methods as suggested by the present study (57). In Ash model about successful factors for CPOE, he integrated environmental factors including motivation, cooperation and trust, and determining values for users (58). In people-process-technology model, Curtis emphasizes the significant role of participation by individuals in changing systems and implementing new systems which require the improved level of awareness, knowledge, skill, and motivation

(59). Kotter *et al.*, focuses on the formation of group with sufficient power to direct changes, promote activities, provide trainings for new behaviors, improve culture and awareness, and create proper links based on perspectives and strategies. Such proposition is consistent with the findings of the present (60). In studies conducted on designing EHR implementation readiness assessment tools in California, the highest priorities were given to the proper understanding of EHR, readiness for achieving higher-quality care, involvement by doctors, personnel, and patients, their mode of involvement in clinical and managerial decisions, and establishing communication processes to balance patient-provider relation which are in line with Priority 1 (two components) and Priorities 3 and 7 in culture readiness assessment in the present study (10). Ahlstrom *et al.* emphasized readiness for change in the organization, employee participation, cross- and intra-department connections, and involvement by leaders, senior managers, and researchers in solving problems and dealing with challenges (8). In cultural area, readiness of hospital studied here (Table 3) ranged from 3 to 4 indicating a relative readiness: 14.3% of hospitals scored 5-6 (complete readiness), 28.6% showed relative readiness and the rest fell in the range 1-2 showing no readiness.

Table 3. Assessment of the practical preparation in EHR pre implementation based on the proposed model for Iran in general-teaching hospital of Tehran university medical science, Iran

Hospitals	Hospit al1	Hospit al2	Hospit al3	Hospit al4	Hospit al5	Hospit al6	Hospit al7	Readine ss level
	rational readiness	No readiness	rational readiness	No readiness	rational readiness	No readiness	rational readiness	No readiness
Situation	rational readiness	No readiness	rational readiness	No readiness	rational readiness	No readiness	rational readiness	No readiness
Indices	5-6	3-4	1-2	5-6	3-4	1-2	5-6	3-4
Management and leadership readiness	-	✓	✓	✓	✓	✓	✓	✓
Cultural readiness	-	✓	✓	✓	✓	✓	✓	✓
Governance readiness	-	✓	✓	✓	✓	✓	✓	✓
Operational Readiness	-	✓	✓	✓	✓	✓	✓	✓
Technical infrastructure readiness	General dimensions	-	✓	✓	✓	✓	✓	✓
	Network	-	✓	✓	✓	✓	✓	✓
	Software selection	-	✓	✓	✓	✓	✓	✓
	Special solutions architecture	-	✓	✓	✓	✓	✓	✓
	others	-	✓	✓	✓	✓	✓	✓
Total(based table2)	-	✓	✓	✓	✓	✓	✓	✓
Total sum	-	✓	✓	✓	✓	✓	✓	✓

In addition to internal components incorporated in the model and the questionnaire, stakeholder participation in planning, decision making, assessment, selection and implementation were among high-priority components in the model. However, assessment of hospitals shows that managers, particularly senior managers and leaders, participated in planning and decision making only in 57.1% of hospitals, in assessment and selection only in 57.1% of hospitals, and in the implementation only in 71.4% of hospitals. Personnel, physicians, and service providers, as major contributors to the implementation, participated in planning, decision making, assessment, and selection only in 28.6% of hospitals while the rate of participation in implementation was 42.9%. Only in 42.9% of hospitals IT personnel participated in planning and only in 57.1% of hospital the personnel participated in the system selected and assessment, decision making, and implementation. Three abovementioned persons were assigned the first priorities in decision making, assessment, selecting and implementation but the hospitals often ignored this important aspect. In final model implementation, the next priorities were given to special dimension Board and association and academic colleges, patients, and citizens with participation rates of 57.1%, 14.3%, and 0%, respectively. In decision making, assessment and selection, the first three priorities (leaders, senior management; HIT or IT personnel and providers) are followed by the presence of representatives from relevant committees, special boards and academic colleges, and other stakeholders including researchers with actual participation in at most 42.9% of hospitals. This probably has contributed to advancements in the implementation process. This component, though crucially important in proper and correct EHR implementation, is far from the final model approved by experts. Therefore, it is necessary to take into account cultural dimensions in order to avoid failure.

For management readiness in Iran (Figure 1) the related items were classified into twenty five components with fourteen priorities. Based on expert views, it seems that, according to countries studied and the literature reviewed here, a proper executive team must be in place to get completely involved in all stages of implementation by providing specialized multifaceted opinions, innovation, time, and commitment. The presence of strong managers and leaders, senior clinical managers, and clinical and para clinical personnel is also important. Other priorities include presence of

implementation workgroups for IT services and networks, specialized and technical workgroups, system supplier and integrator. In ITPOSMO model, Heeks emphasizes the role of management and structure in implementation of new systems (61) and according to Berg, different leadership styles in various organizations with different conditions (62) are particularly important as confirmed by the present study. In people-technology process model, Curtis emphasizes the role of human resources in implementing systems and preparing sections for the process. Most organizations admit that continuous organizational improvement requires important changes in management styles and employment of good human resources for development and for maintaining software and information systems (59) as confirmed by the present study. In system based-readiness, Overhage *et al.*, considered a separate component for commitment and leadership (63) while Li incorporated management into commitment (17); the former view is to some extent consistent with the findings of the present study while the latter is not in line with this study. Li also emphasized the importance of change management, IT infrastructure, and communication (17) as taken into account in the present study.

Readiness assessment in terms of management and leadership in public hospitals studied here indicated readiness scores ranging from 5 to 6. Three hospitals (Hospitals 2, 4, and 6) were ready, three (Hospitals 1, 5, and 7) were relatively ready, and one hospital with a score ranging from 1 to 2 was not ready. In addition to main components in management readiness, two subcomponents (hardware-to-software record conversion and formation of workgroups, and executive team) were also examined due to their increasing importance in information management and executive management. In terms of hard-to-soft record conversion, only 42.8% of hospitals considered conversion documentation, support plans, data/information removal, data transmission, information/data quality, proper documentation, and access to data/information, while only 28.6% considered determination of data/information links between administrative staff and clinical staff, integration of clinical IT into management and technical areas, optimization of information management system, and supporting modules.

The findings on workgroups and executive teams indicated that having a proper composition and condition in executive teams has not been observed by over 71.4% of hospitals and over half of the hospitals

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(57.1%) did not form workgroups based on the final model. In less than 28.6% of hospitals, members of project executive teams (provided that such team) has been matched with the final model. In governance readiness has been achieved a mean score of 1.47 to 2.38 in surveys for the main component with the highest priorities given to IT-related strategies based on the final model. According to Gupta, government must adopt regulations that not only facilitate the exchange of healthcare records among stakeholders, but also protect privacy and rights of patients (64). This is in line with the component national laws for data sharing.

Hendriks argues that the most important elements of governance strategies in the implementation are making clear decisions, accountability and sufficient involvement by stakeholders (12). In revising the concepts of security and privacy in Canada in connection to EHR, CHI incorporated interoperability and emphasized the role of controllers and managers as well as the architecture used for data exchange (47). Furthermore, Esterle and Kouroubali admitted the need for strong government support and clear definition of roles (22), as confirmed by the present study. Readiness assessment in terms of governance based on the final model resulted in a score ranging from 3 to 4 for hospitals, indicating a relative readiness in this area; 71.4% of hospitals are relatively ready (3,4) and the rest are not ready (1-2)(Table 3).

Figure 1 and also show the model used to assess operational readiness based on expert views. Results indicate that with respect to training, the highest priorities should be given to training content and its modules, evaluation of personnel training to identify the level of skills, creating training strategy, offering training programs, and determining training methods and techniques. With regard to the legal framework, the experts gave the highest priorities to data security policies (security structure, and clinical security), confidentiality policies, privacy policies, policies on access to clinical information based on the defined roles, special methods and policies customized to need of each region, protocols and with regard correction process, priorities have determined by experts include process modification according to results, reviewing and defining the existing processes, defining required processes, redesigning workflows, process classification, identification of gaps in the existing and ideal conditions, directing the workflows.

The fourth, fifth and sixth priorities were assigned for the management of vendors and system selection, care management and user registration programs.

Wickramasinghe *et al.*, proposed the components policies, protocols and methods, government laws, rules, user access, and accessibility of policies which are affected by culture, economics, education, and mortality; the first and the third components are in line with the present study while the rest are not considered here and, therefore, not consistent with the present study (65). Among their implementation components, Esterle and Kouroubali (2010) considered two separate components: training for managing relationship with vendors and focus on legal framework for EHR implementation consisting of implementation rules, operational procedures and related laws, and privacy policies (22). Although the present study did consider these separate components, however, the classification proposed by Esterle and Kouroubali differs from the one in the present study. In operational readiness assessment in hospitals based on the final model, it followed that in general- teaching hospitals were relatively ready in the operational area; 57.1% of hospitals were not ready, and the rest were relatively ready. Given the descriptions below, the remarkable difference from complete readiness based on expert views becomes evident. Priorities of the model with respect to legal framework revision ranged from 14.3% to 57.1 of hospitals. While the training components were considered in 28.6% of hospitals and the components related to process revision and redesign were dispersedly considered in 14.3 to 42.9% of hospitals.

Figure 1 also indicates priorities in terms of technical infrastructures in the final model. In this area average score for subcomponent is 1.20-1.82 that highest priority was security consideration. In identifying the components of electronic health readiness assessment, Li considered technical readiness as an important component (17). According to Ahlstrom and EHR implementation assessment by California Health Care Foundation, the components should include technical capacity assessment, integration of the available technology, evaluation of applications of the existing systems, integration of systems into future processes, infrastructure analysis, hardware requirement analysis and operation, and determining security infrastructures (8, 10) which are in line with the present study in terms of hardware considerations. Jennet believes that technical readiness stems from embodiment of advantages, risk assessment, awareness of providers, and intra and intergroup dynamicity (66) which differs from the classification used in the present study. Hospital assessment for the items presented in Table3 indicates a relative readiness(score 3-4) in terms of general

components including defining the system architectural model (without ranking) providing and definition of a suitable relationship infrastructure between service providers and service recipients , providing a suitable relationship infrastructure for hospitals and other centers in local , regional , and national level , defining and providing the needed hardware , attention to designing and implementing (for defining the product ability and application indexes) security considerations, complete readiness in terms of network requirements (score 5-6), readiness in terms of selecting EHR implementation software according to national assessment rules (score 5-6), and not ready in terms of special approaches such as interface, database, data storage messaging architecture, and data exchange service (according to priorities defined in the model)(score 1-2). However, in terms of general technical readiness, except for one non-ready hospital and two relatively ready hospitals, the rest of the hospitals were evaluated as being completely ready in this area according to the priorities defined by the final mode.

As seen in Table 3, in technical readiness Hospitals 2, 3, 4,5 are ready (57.1%), Hospitals 1 and 6 are relatively ready (29.6%), and Hospital 7 are not ready (14.3%).

The main model presented here incorporates indicators identified by Iranian experts as critical indices in five dimensions include culture, leadership and management, technical infrastructure, governance, and operational area. Given that the country is still in the beginning of its way to EHR implementation, taking these components into account prior to implementation will be helpful in minimizing failures. Since hospitals are among the most important information sources in countries like Iran and play a significant role in EHR implementation, a sample of the largest hospitals of the country was examined in this study. Readiness of studied hospital indicated that, in cultural area, 14.3% of hospitals, in management area 42.9%, in the governance area and operational area 0% and intertechnical infrastructure 57.1% hospitals were assigned in readiness condition. In total 29.6% hospital were in readiness area for implementation. It follows that achieving technical readiness is not enough for securing success in EHR implementation; other dimensions like culture readiness, management and leadership, governance support, and operational readiness must also be taken into account. Therefore, it is necessary to facilitate and improve commitment to EHR implementation by promoting the culture in different groups of stakeholders, enhancing conditions for

cooperation in implementation, creating a proper managerial process, and providing required infrastructures along with proper methods of training tailored to meet the needs of different groups of users.

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References

1. Ammenwerth E, Brender J, Nykanen P, et al. Visions and strategies to improve evaluation of health information systems: Reflections and lessons based on the HIS-EVAL workshop in Innsbruck. *Int J Med Inform* 2004;73(6):479-91.
2. Committee MDoHatMe-HIA, editor. A Prescription for Meeting Minnesota's 2015 Interoperable Electronic Health Record Mandate A Statewide Implementation Plan. 1st ed. Minnesota: Minnesota Department of Health and the Minnesota e-Health Initiative Advisory Committee; 2008: p. 103.
3. Community Clinic EHR Readiness Assrsment Introduction & Instruction. AHRQ. (Accessed in Mar 2014, 10, at <http://www.norc.org/6275/Module2/Community%20Clinic%20EHR%20Readiness%20Assessment%20Tool.pdf>).
4. Ajami S, Ketabi S, Isfahani SS, et al. Readiness Assessment of Electronic Health Records Implementation. *Acta Inform Med* 2011;19(4):224-7.
5. Ventures IH, editor. Medical Center Electronic Health Record Readiness Assessment. InTech Health Ventures; 2008.
6. Health Care Leader Action Guide on Implementation of Electronic Health Records. LabInter Operability Collaborative. (Accessed in Mar 2014, 10, at <http://labinteroperabilitycollaborative.org/pdfs/implementation-ehr.pdf>).
7. WHO, editor. Electronic Health Records Manual for Developing Countries. 1st ed. Geneva: world health organization; 2006: p. 17-24.
8. Ahlstrom J. Electronic Health Records (EHR) - Assessing Organizational Readiness. (Accessed in Mar 2014, 10, at <http://www.wipfli.com/resources/images/11935.pdf>).
9. Assessing Your Practice for Electronic Health Record

Readiness for pre-implementation of EHR

- Adoption. (Accessed in May 2014, 14, at <https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCg...>).
10. California Community Clinics EHR Assessment and Readiness. National Association of Community Health Centers. (Accessed in Mar 2014, 10, at http://www.nachc.com/client/EHR_Starter_Assessment_final.pdf).
 11. Morton ME. Use and Acceptance of an Electronic Health Record: Factors Affecting Physician Attitudes [Dissertation]. Drexel Univ., 2008.
 12. Hendriks J, editor. Realizing the Goal of Electronic Health Records in the United States- Lessons Learned from Canada Sierra Systems; 2009.
 13. Davies NE. Making IT Happen: Strategies for Implementing the EMR-EHR. (Accessed in Mar 2014, 10, at http://apps.himss.org/davies/docs/Davies_WP_Implementation.pdf).
 14. Khoja S, Scott RE, Casebeer AL, et al. E-health readiness assessment tools for healthcare institutions in developing countries. *Telemed J E Health* 2007;13(4):425-31.
 15. Canada Health Infoway. EHRS Blueprint/an Interoperable for Sharing EHR. (Accessed in Mar 2014, 10, at https://www.infoway-inforoute.ca/index.php/resources/technical-documents/architecture/doc_download/284-ehrs-blueprint-v2-full).
 16. National Board Health. National IT Strategy for the Danish Health Service 2003–2007. *Sundhedsstyrelsen*; 2003.
 17. Li J, Pek Wee Land L, Ray P, et al. E-Health readiness framework from Electronic Health Records perspective. *Int J Internet Enterp Manag* 2010;6(4):326-48.
 18. Working draft on Integration of healthcare services-role of primary care by the. Ministry of Health; 2010.
 19. Health Do, editor. EMR Champion Guide. Saskatchewan: Saskatchewan Ministry of Health; 2010: p. 18.
 20. Muttitt S. Is Sustainability of Healthcare Possible without eHealth? (Accessed in Mar 2014, 10, at <http://www.worldofhealthit.org/sessionhandouts/document/s/PS6-1-Muttitt.pdf>).
 21. NHSCfH. The National Programme for IT Implementation Guide/Guidance to support trusts that form Local Health Communities in implementing National Programme products and services. Leeds: NHSCfH; 2007: p. 83.
 22. Esterle L, Kouroubali A. Political and organisational factors influencing large scale implementation of electronic health records. CNRS. (Accessed in Mar 2014, 14, at http://www.cermes3.fr/IMG/pdf/EHR-I_Recommendations.pdf).
 23. Edwards J. Case Study: Denmark's Achievements with Healthcare Information Exchange. Gartner. (Accessed in May 2014, 14, at https://www-304.ibm.com/industries/ca/en/healthcare/files/gartner-case_study-denmarks_achievementswHIE.pdf).
 24. Kaye R, Kokia E, Shalev V, et al. Barriers and success factors in health information technology: A practitioner's perspective. *J Manag Marketing Healthc* 2010;3(2):163-75.
 25. Jones V, Jollie C. eHealth strategy and implementation activities in England: Report in the framework of the eHealth. (Accessed in May 2014, 14, at http://www.ehealth-era.org/database/documents/ERA_Reports/England_eHealth_ERA_Country_Report_final_07-06-2007.pdf).
 26. Deutsch E, Duftschmid G, Dorda W. Critical areas of national electronic health record programs--Is our focus correct? *Int J Med Inform* 2010;79(3):211-22.
 27. Clinics EHR Readiness Starter Assessment. Professional Systems. (Accessed in May 2014, 14, at http://www.profsystems.com/psi_ehr_readiness_assessment_starter.pdf).
 28. Doolan DF, Bates DW, James BC. The use of computers for clinical care: a case series of advanced U.S. sites. *J Am Med Inform Assoc* 2003;10(1):94-107.
 29. NHSCfH, editor. The National Programme for IT Implementation Guide/Guidance to support trusts that form Local Health Communities in implementing National Programme products and services. Leeds: National Health Services; 2005: p. 72.
 30. Are you EMR ready? Physician office electronic medical record system pre-implementation guide Canada Health Infoway. (Accessed in May 2014, 12, at <https://www.infoway-inforoute.ca/lang>).
 31. Muttitt S. Enter Once, Use Many Times Unleashing the Value of Reusable Clinical Data. Ltd MP; 2010.
 32. Lorenzi NM, Riley RT, Blyth AJC, et al. Antecedents of the people and organizational aspects of medical informatics. *J Am Med Inform Assoc* 1997;4(2):79-93.
 33. WP5 - National reports of EHR implementation Denmark, in EHR Implement. (Accessed in May 2014, 12, at <http://www.ehrimplement.eu/index.cfm?objectid=5BF4F332-1143-DEB7-7424B463EB2D48EE>).
 34. Synergy across borders [monograph on the internet]. Danish Centre for Health Telematics. Medcom. (Accessed in May 2014, 14, at <http://www.medcom.dk/wm1>).
 35. Canada PHCTFH, editor. The EMR Toolkit. Ottawa, Canada: Ontario The authority of the Minister of Health /Health Canada; 2006.
 36. Ltd MP, editor. Muttitt C, Sarah Singapore's National Electronic Health Record, The Roadmap to 2010. MOH Holdings Pte Ltd; 2009.
 37. Health Do, editor. Informatics Planning 2009/2010 For the

- NHS in England. NHSCfH; 2008.
38. deployment guide for clinicians involved in deploying IT system/a one Stop Guide to Clinicians Involved in Deploying IT Systems. (Accessed in May 2014, 14, at <http://www.connectingforhealth.nhs.uk/engagement/clinical/publications/guide.pdf>).
 39. Synergy across borden odense. Danish center for health telematics. (Accessed in May 2014, 14, at <http://www.medcom.dk/dwn>).
 40. McKinnon S. National Electronic Health Record Procurement. MOH Holding Pte Ltd; 2009.
 41. Moghaddasi H, Sheikhtaheri A. CEO is a Vision of the Future Role and Position of CIO in Healthcare Organizations. *J Med Syst* 2010;34(6):1121-8.
 42. Successful Preparation and Implementation of an Electronic Health Records System, Best Practices. California Medical Sciences. (Accessed in May 2014, 14, at <http://www.cmanet.org/files/pdf/ehr/best-practices-7.pdf>).
 43. Medical Center Electronic Health Record Readiness Assessment. Arizona: Medical Center 2008.
 44. National policies for EHR implementation in the European area. *EuroRec*. (Accessed in May 2014, 14, at http://www.eurorec.org/RD/ehr_implementation.cfm).
 45. Tan JKH, editor. *Medical informatics: Concepts, methodologies, tools, and applications*. 2nd ed. Medical Information Science Reference; 2009: p. 28-30.
 46. Asadi Z. Health system in United Kingdom. (Accessed in May 2014, May 14, at <http://if3m.blog.com/2011/08/19/%D9%86%D8%B8%D8%A7%D9%85-...>).
 47. An overview of the Electronic Health Record Privacy and Security Conceptual Architecture. Canada Health Infoway. (Accessed in May 2014, 14, at https://www.infoway-inforoute.ca/index.php/component/docman/doc_download/286-ehr-privacy-and-security-architecture-summary).
 48. *Electronic Health Records: A Global Perspective*. MISS. (Accessed in May 2014, 14, at http://www.himss.org/files/HIMSSorg/content/files/Global_pt2-edited%20final.pdf).
 49. California Behavioral Health Electronic Health Record (CA BH-EHR) Request for Information. Information Technology Division. (Accessed in May 2014, 14, at http://s3.amazonaws.com/zanran_storage/www.dmh.ca.gov/ContentPages/610596817.pdf).
 50. The National Programme for IT in the NHS: an update on the delivery of detailed care records systems. National Audit Office. (Accessed in May 2014, 14, at http://www.nao.org.uk/wp-content/uploads/2011/05/1012_888.pdf).
 51. Doctor's office quality –information technology (DOQ-IT). EHR Assessment and Readiness Starter Assessment. (Accessed Jul 2014, 8, at <http://www.himss.org/files/HIMSSorg/content/files/Code%2049%20Masspro%20Practice%20Starter%20Assessment.pdf>).
 52. Petersen D. Development and implementation of electronic health records in Denmark. NVMA conference of national EHR/ International session 4; 2008 12 june; Amsterdam. (Accessed Jul 2014, 8, at <http://www.ifhima.org/docs/AmsterdamabstractEHRDarleyP.doc>).
 53. Carter JH. Electronic Health Record Implementation. In: Nolan CK, eds. *Electronic health records: A guide for clinicians and administrators*. 2th ed. Philadelphia: ACP Press, 2008: 473-81.
 54. Boonstra A, Broekhuis M. Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions. *BMC Health Serv Res* 2010;10(1):231.
 55. EMR Success Factors. Canada Health Infoway. (Accessed in May 2014, 14, at <https://www.infoway-inforoute.ca/working-with-ehr/health-care-providers/emrs/success-factors#collaborative>).
 56. Registration Authorities and Smartcards 2012. NHS. (Accessed in Mar 2014, 14, at <http://www.connectingforhealth.nhs.uk/systemsandservices/rasmartcards>).
 57. Golden BR, Martin RL. Aligning the Stars: Using Systems Thinking to (re)Design Canadian Healthcare. *Healthc Q* 2004;7(4):34-42.
 58. Ash JS, Fournier L, Stavri PZ, et al. Principles for a successful computerized physician order entry implementation. *AMA Annu Symp Proc* 2003;2003(1):36-40.
 59. Curtis B, Hefley EW, Miller SA. Overview of the People Capability Maturity Model. (Accessed in Mar 2014, 10, at <http://www.sei.cmu.edu/reports/09tr003.pdf>).
 60. Kotter JP, Gestion Ccd. Leading change: Why transformation efforts fail. *Harv Bus Rev* 1995;73(1):59-67.
 61. Heeks R. ICT4D 2.0: the next phase of applying ICT for International Development. *Computer* 2008;41(6):26-33.
 62. Berg M. Implementing information systems in health care organizations: myths and challenges. *Int J Med Inform* 2001;64(2-3):143-56.
 63. Overhage JM, Evans L, Marchibroda J. Communities' readiness for health information exchange: the national landscape in 2004. *J Am Med Inform Assoc* 2005;12(2):107-12.
 64. Gupta U. Global networks: Promises and challenges. *Inf Syst Manag* 1992;9(4):28-32.

Readiness for pre-implementation of EHR

65. Wickramasinghe NS, Fadlalla AM, Geisler E, et al. A framework for assessing e-health preparedness. *Int J Electron Healthc* 2005;1(3):316-34.
66. Jennett P, Yeo M, Pauls M, et al. Organizational readiness for telemedicine: implications for success and failure. *J Telemed Telecare* 2003;9(Suppl 2):S27-30.