Affecting Factors on ITIL-Based Health IT Service Management (Tehran University of Medical Sciences, Tehran, IR Iran)

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Abstract
Background:
Today, health care is supported by new technologies, namely health electronic records. Health electronic records are considered as electronic health care's streams, key element in patient care improvement and support of taken decisions. Although this is a very useful and effective development in providing services; evidences have shown that these systems are faced with problems to run.

Objectives:
The aim of this study is to identify affecting factors and risk factors on IT service management in health-oriented organization based on ITIL framework.

Methods:
This is an applied and descriptive research in terms of nature. The study sample in index determining stage included IT management academic experts fluent in ITIL and in case study include experts and elites of health care centers of Tehran University of Medical Sciences. After a review of research literatures and maturity models of health IT services and extracting dimensions and effecting factors, opinions of academic experts; finally we tested the extracted factors.

Results:
The results indicated that the components of the maturity of IT services based on ITIL framework in two dimensions of delivery and support of IT service management include financial management, configuration management, capacity management, problem management, incident management, change management, service continuity management, access management, service desk, service level management and release management. The research tool is questionnaire and SMART-PLS software was used for factor analysis.

Conclusions:
The results showed that the configuration management process and related indicators along with financial management and release in IT, both are the most influential factors on IT services management in health-based organizations. Then, in order to apply effective factors in health care centers; necessary solutions are provided.

Key-words:
Service Delivery; Service Support; Maturity Model; ITIL Framework; Health; IT Service Management

1. Background

Modern technologies are an integral part of human daily life and affect all aspects of life. They are considered as a complement for organizations in the form of "competitive advantage" to increase their ability to overcome their rival organizations. Organizations invest in IT systems services because they consider it as a tool to reach the organization's objectives. It is more than a decade that hospitals and health systems are trying to understand IT to provide safer and better care services. Health electronic records that are a mix of health care systems and information and communication technologies for empowering health care services are considered as a very useful solution for these cases (1).

Despite the growing emergence of health electronic records and users' willingness to implement it in most developed countries, its adoption has been slower than expected. This is true for developing countries, too. Some of the important factors limiting the implementation of the above systems include cost, IT infrastructure, planning and preparation of appropriate personnel. These factors should be considered to implement health electronic records (1). Some of systematic activities and projects for the implementation of health electronic records at a global level include working to add value through e-information (WAVE) (Kia hopu tengaru) in New Zealand, a long-term agreement program named electronic records development & implementation program (ERDIP) in England (2). They are considered as a management strategy for changing

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paper health records to implementation of health electronic records.

Although this development is very useful in health services; the evidences have shown that these systems are faced with specific problems and some of the services are provided by delay and even in some cases they are ended with failure. Computer science experts and health professionals believe that lack of suitable standards and IT services frameworks, lack of systems integration and finally the evaluation of these services are the most problematic factors. It is necessary to pay more attention to these cases.

Now, the question is: "What are the factors affecting IT service management in the health system?" In this study, we tried to recognize affecting factors on IT services in health-based organizations by utilizing IT services standard frameworks. Then, we provided suggestions for improvement of delivery and support of services in health-based organizations and to resolve possible weaknesses.

For this reason, information technology infrastructure library (ITIL) is a common language for organizations with the duty of providing services; especially when they want to provide better and faster services in the field of IT services. It seems that the aim of this framework is mechanizing the behavior of a system (3).

2. Objectives

The aim of this study is finding the link of health sector and ITIL to merge these two. On the other hand, we tried to identify the main elements and factors that are very important in evaluating the relationship between the health sector and ITIL processes.

3. Methods

3.1. A Review of the Literature

In this study; we reviewed 26 maturity models of IT services in details to identify affecting factors in IT services. Some models are related to the public criteria and the others were specifically related to health criteria. In this study, levels and applications of models were compared. The models are reviewed based on their dimension, affecting factors, advantages and disadvantages. Table 1 represents the most important patterns in health information technology services. Their dimensions and affecting factors are mentioned explicitly or implicitly.

Table 1: A number of Maturity Models Studied in This Study

	Pattern	Scope	Source	Number of Levels	Dimensions/Factors	Reference
	Model V	General	Traditional Software Models	4	Project management, requirements, architecture and design , configuration management , software quality assurance	Munassar and Govardhan (4)
	Healthcare analytics adoption model (HAAM)	Data Warehouse & Analysis	EMRAM	9	New data sources; complexity; data literacy; data timeliness	Sanders et al. (5)
	IDC healthcare IT (HIT) maturity model	General	N/A	5	Program implementation & management/project management, including project scheduling and tracking/customizable project implementation processes/business analysis & management/risk identification & management/quality control management/ contract administration/budget & schedule development/systems maintenance management	Holland et al. (6).
	Electronic health records maturity model (EHR)	EHealth	CMM	7	Quality ,costs, time, software quality and usability deficiencies, unintended consequences, privacy and confidentiality,	Sanders (7)

	NEHTA interoperability maturity model (NIMM)	Interoperability	IMM / CMMI	5	Organization, information; technical/financial management/stakeholder management /supplier management /SLA Management /availability management/change management */configuration management /release management */problem management /incident management */service desk /capacity management /IT service continuity management/service monitoring *	NEHTA (8)
	NHS infrastructure maturity model (NIMM)	Infrastructure IT	CMM	5	Process; people & organization; technology; security & information governance; strategy alignment & business value	NHS (9)

The focus of different models in health IT management is on important components but in this study, we tried to provide a model based on scientific resources in researches that are useful for health-oriented organizations. For this reason, this model should be based on all aspects that are mentioned in the reviewed models and also by considering health-oriented organization's need. For example, establishing and running HER systems is significantly associated with users' roles and due to this fact that IT systems experts are gaining HER systems management positions gradually in information technologies sectors; it is very important for this model to be able to increase the knowledge and expertise of the users in terms of description, record and management of data or analyzing them; and more importantly in terms of health information strategies. But telemedicine maturity model (TMSMM) is used for measure management and optimizing all the components of a telemedicine system. This means to emphasize on each component and affective factors in telemedicine with a comprehensive view.

HER model focuses on recording all information about patient's health condition. Comprehensive point of view in this model for health care of patients is clinical in terms of gathering and completing electronic health records. And also health care system model (NIMM) tries to provide a coherent framework for health care organizations. This model is capable of measuring active abilities of IT infrastructure in certain areas. The focus of this model is to identify and prioritize the processes that increase the technologies' capabilities.

Informatics capability maturity model (ICMM) aims to encourage leaders towards the developments and changes for empowering informatics in organizations that considers informatics as a strategic resource. The model is formed based on optimizing commercial values related to the department of health management and informatics.

But IT Maturity Model MITA as a process maturity model based on a basic model of CMMI and is based on a services-based architecture. In this model, common commercial services and technical services are described and these services can be also adjusted relatively to be compatible for changing needs. This model relies heavily on health information standards and data exchange. In this model user tasks are designed as end-to-end processes. In this design, it is possible to perform essential services in several separate systems for the user.

3.2. ITIL Framework

There are several frameworks to implement IT governance in an organization; but ITIL framework is the best and most accepted. And efficiency of the model is at a high level so that ISO 20000 Standard is designed based on this framework (ISO, 2011). Library ITIL is one of the widest collections of best experiences and best practices in the field of information technology. Now, it is known as a framework of guidance for IT administrators to optimize IT infrastructures in management organization and in line with the objectives and requirements of the favorable business use (10). ITIL provides best practices for IT service management planning and IT management plans implementation for improving the quality and reducing costs and risks (11).

In a research, Zhang et al. (12) studied the level of acceptance for COBIT5, ITIL in IT governance in small and medium size companies in China. The results showed that due to ease of use and superior experiences; ITIL is used more in small and medium Chinese companies compared with COBIT (12).

Fasihi (13) has studied the operational processes. Then, he analyzed the gap between the two levels for designated criteria by collecting information related to the current and desired levels.

Due to this fact that the approach in this study is based on ITIL framework; we divided selected management processes of studied models in to criteria of delivery of services and support systems in to 11 management processes with extracted indicators.

3.3. Research Model

The increasing value of information and new technologies introduced them as one of the key sources of value creation and key resources for the organizations. Due to the fact that all proposed models in studies literatures have some strengths and weaknesses in determining the constituent elements of IT management and each of them emphasize on one element and its implementation because of their nature and practical reasons; it was quite necessary for us to suggest a model to answer the provided hypothesis in this study. As a result, using combined indicators that are compatible with health sector seemed necessary.

As mentioned above, IT maturity model MITA as a process maturity model is based on a service-oriented architecture in which services can be also adjusted relative to changing needs.

One of the major weaknesses of these models is the absence of a unique framework or structure that can be used to measure the overall dimensions of health information technology. For identifying the dimensions of IT technology maturity model that is compatible with this structure from a special point view (e.g. ITIL); we used appropriate indicators based on the structures of health-oriented organizations. The proposed classification in this model based on ITIL is generally consists of two groups: providing IT services and supporting IT services. The main task in providing IT services is to detect the business customers' expectations of service providers to provide adequate supports for the customers. However, supporting IT services ensures the users that they will receive appropriate support for their services. Planning and management of jobs in professional levels, infrastructures and implementations are considered as the most important factors for providing IT services and for supporting IT services, the intermediate level of the organization that are involved in it are more important. Service management has described 5 main processes that are related to providing services in the organization. The collection of these processes is in tactical layer: financial management, capacity management, service continuity management, access management and service level management. Service support management has described 6 main processes to support services for users. The collection of these processes in operational layer includes release management, service desk, configuration management, change management, incident management and problem management.

In this study and to use these models as a base for determining influencing factors; it is necessary to classify models based on IRIL and based on the functions and applications in health care services and also it is necessary to have some changes in extracting indicators. In order to determine the indicators and calculate the values of the factors in the organization; we used a questionnaire.

3.4. Research Methodology

According to the main goal of the research, in terms of utilizing the results in health care centers in our country, this is an applied research. The research methodology is descriptive. Thematic territory of this research is IT service management and ITIL framework. Time domain is cross-sectional and location domain is some of the health care centers related to the department of health of Tehran University of Medical Sciences. Research tool was a questionnaire. Two main hypotheses and 11 sub-hypotheses were described for testing IT services management components.

The main hypothesis 1: There is a relationship between providing IT services and the level of IT services

The main hypothesis 2: There is a relationship between IT services support and the level of IT services

Sub-hypotheses are defined based on processes in each dimension. This study includes a combination of quantitative and qualitative methods (hybrid). It means that at first domestic and foreign literatures and 26 models of IT maturity were studied to extract important indicators. Then, variables were identified by using case study strategy. And also relationships between the variables determined and initial conceptual model was designed. Then, collected data by the questionnaire was analyzed by using descriptive and inferential statistics. The most effective components of IT maturity in health criteria were identified and finalized by statistical methods. To be sure about the accuracy and correct relationships between the defined indicators and also for confirming or rejecting the hypotheses extracted from research literature; we used confirmatory factor analysis and also we used PLS and SPSS software for facilitating the statistical processing.

The population included ITIL experts and IT elites fluent in ITIL and in the implementation phase (qualitative phase); it included experts and elites who have been working in health care centers and had the necessary expertise in this area.

Sample size in qualitative phase included 15 elites and in quantitative phase included 100 experts working in health care centers.

In this study, data collection was conducted in two ways: library and field research. To test the validity of questionnaire's content; we used Delphi technique (opinions of a group of academic experts and IT CIOs). For this reason a questionnaire including 69 indices

(items) in 5 Likert scale to determine the effective indices on the maturity of IT services was designed. For determining the influences of these factors and indices; 58 indices were considered as valid indicators. Indicators were developed in the form of a questionnaire, and finally, it was distributed between the respondents (Table 2).

Table 2: Extracted Indicators of Research Model

No.	Index	Load Factor	Average
Availability Management Process			
1	% of critical business processes not covered by a defined service availability plan	0.29*	3.66
2	Critical-time failures	0.83	3.63
3	Number of business disruptions caused by problems	0.86	3.59
4	% of outage due to changes (planned unavailability)	0.82	3.49
5	% of outage due to incidents (unplanned unavailability)	0.87	3.31
6	% of unplanned outage/unavailability due to changes	0.85	3.15
Capacity Management Process			
7	% of CIs with under-capacity	0.82	3.42
8	% of service requests due to poor performance	0.9	3.51
9	% of unplanned purchases due to poor performance	0.84	3.57
10	Average time between updates of capacity plan	0.81	2.93
11	Cost of producing capacity plans	0.89	3.27
IT Continuity Management Process			
12	% of changes that cause incidents	0.83	3.63
13	% of unauthorized implemented changes	0.86	3.59
14	% of urgent changes	0.82	3.49
15	Average costs of change implementation	0.87	3.31
16	% of services not covered in continuity plan	0.86	3.15
17	Average time between updates of continuity plan	0.84	3.34
Financial Management Process			
18	Average time spent on continuity plans	0.76	3.63
19	Cost of producing continuity plans	0.84	3.72
20	IT service continuity plan testing failures	0.77	3.71
21	% of business processes with continuity agreements	0.75	3.78
Service Level Management Process			
22	% of delivered services not in the service catalogue	0.84	3.49
23	% of SLA reviews conducted on-time	0.87	3.56
24	% of SLAs under review	0.83	3.49
25	% of SLAs without service level breaches	0.73	3.32
26	Average delay in SLAs review	0.85	3.97
27	Average penalty costs per SLA	0.83	3.79
Configuration Management Process			
28	% of CIs under maintenance contract	0.81	3.95
29	% of incidents not solved in-time due to inaccurate configuration data	0.92	4.05
30	% of licenses purchased and not accounted for in configuration repository	0.89	4.28
31	Average number of versions of software	0.71	4.01
32	Average time period between identifying and rectifying a discrepancy	0.89	3.92
Change Management Process			
33	% of changes that cause incidents	0.91	3.62
34	% of unauthorized implemented changes	0.87	3.71
35	% of urgent changes	0.81	3.12
36	Average costs of change implementation	0.4*[1]	2.45
Incident Management Process			
37	% of overdue incidents	0.87	3.62
38	% of reopened incidents	0.83	3.71
39	% of repeat incidents	0.82	3.12
40	% of unmodified/neglected incidents	0.76	3.14
41	Average incident response time	0.11*	3.49
42	Mean time to repair (MTTR)	0.84	3.38
Problem Management Process			
43	% of overdue problems	0.89	3.95
44	% of unmodified/neglected problems	0.82	3.82
45	Average cost to solve a problem	0.76	3.35
46	Average problem closure duration	0.83	3.62
47	% of problems with available workaround	0.72	3.71
Release Management Process			
48	Average costs of a release	0.73	3.63
49	Percentage of successful releases	0.83	3.72
50	Average cycle time between	0.76	3.71

[1] * meaning is number <0.5

	urgent releases		
51	Average costs of release	0.73	3.78
52	% of successful software installations	0.81	3.66
Service Desk Process			
53	% of incorrectly assigned service requests	0.89	3.95
54	% of resolved calls that have not been closed	0.82	3.82
55	Average speed to answer phone call	0.74	3.35
56	Rate of incoming phone calls	0.82	3.62
57	Average number of calls/service request	0.72	3.71
58	Costs of operating call center/service desk	0.35*	3.77

Structure validity and questionnaire's reliability was gain at the value of 0.9 by using Cronbach's alpha test. Cronbach's alpha coefficient was calculated separately for testing the internal consistency of variables in suggested model in each set of selected criteria. The results are shown in Table 3 which shows a high validity of the questionnaire.

Before performing factor analysis; it is necessary to determine the statistics that are able to identify and explain the suitability of data for performing factor analysis test. The results of sample size adequacy (KMO) test and Bartlett's sample sphericity significance test by SPSS were 0.717 and 0.000, respectively.

4. Results

Due to the fact that there are many variables in this study and providing micro-data for each of the individual variable is outside the scope of this article, so, we just mention to the results at the hypotheses level. The average experts responses, redundancy, number of questions, approval or rejection of each of the processes for management processes in this research for a health care center and also the results of a single-sample t test is mentioned in the following Table.

Table 3: Information Derived From Factor Analysis Test

Dimension	Management Process	Importance	Hypothesis	Cronbach's Alpha	Redundancy	Number of Questions	t	df
Service Delivery	Availability management	3.47	OK	0.855	0.501	6	7.821	99
	Capacity management	3.34	OK	0.90	0.402	5	-.347	99
	Financial management	3.71	OK	0.794	0.119	4	.274	99
	Service level management	3.6	OK	0.910	0.354	6	-6.50	99
	ITIL Continuity management	3.42	OK	0.924	0.555	6	7.391	99
Support System	Configuration management	4.4	OK	0.904	0.205	5	-.122	99
	Incident management	3.41	OK	0.820	0.438	6	10.54	99
	Problem management	3.69	OK	0.867	0.452	5	2.772	99
	Release management	3.72	OK	0.833	0.248	5	-.050	99
	Service desk	3.7	OK	0.826	0.396	6	-9.04	99
	Change management	3.23	OK	0.759	0.451	4	4.282	99

Research hypotheses studied management processes and their relation with IT service maturity in two dimensions of providing IT services and supporting IT services. All the hypotheses have been confirmed in this study.

For rating influencing factors in this research; ANOVA test was used. The results showed that there is a significant difference between influencing factors' rate at the confidence level of 95% and the variables had no equal rates and the most important factor to determine the

relationship between the two areas of health and ITIL in this study was configuration management. The two others of financial management and release management were determined respectively with higher influences compared with the other factors.

5. Discussion

Based on the results; it seems that IT services management in our research population needs infrastructure empowerment and improvement because of facing problems and challenges. It needs higher abilities of IT in health care centers by considering the processes of providing IT services and supporting IT services to improve processes quality and empowering services based on new technologies. In this case, in addition to providing excellent health services; health IT services will be improved and the organization can enjoy an evidenced upgrade and empowerment.

The results of this study indicated privileges and priority of extracted indicators. Key variables of access management, capacity management, financial management, IT service continuity, service level management, change management, configuration management, incident management, service desk, configuration management and distributed versions management can influence greatly on IT services management in health care services (in Table 2, the priority of indicators is shown by the factor loadings).

According to the research population strategies; it is necessary to pay attention to the role of change management and capacity management in health care centers while formulating related policies. Infrastructures related to continuity and incident managements can be improved by paying attention to reported warnings by systems and/or software defects and trying to solve these problems; and paying attention to costs and duration of providing services or providing very successful software. Based on service level management process indicators; documentation of agreements and also identifying the needs of customers and providing continuous improvement programs is necessary.

Based on the verified indicators in reliability management process; for creating a reliable level of providing IT services with a reasonable method in terms of costs; it can be used as a guarantee of IT infrastructures in health-oriented organizations.

Based on the results of this research; it is suggested to use continuous service process in health-oriented organizations to restore essential services after emergencies to normal and operational conditions and supporting organizational continuous business. And also it is suggested to use capacity management in health-oriented organizations for all the times with suitable and reasonable methods in terms of costs with a reasonable capacity of IT in organization for gaining goals and current or future needs of organization's business. It is suggested that for facilitating activities of the organization and restoring them to the normal and operational condition with minimum negative effects on organization's business; the requests of each customer should be received just by service desk. It is also recommended to use incident and problem process indicators for immediate restoring of stopped operations of a service and preventing reoccurring incidents and/or identifying the root of problems and reducing the adverse effects of incidents on organization's business.

For improving the reliability of health care centers; the results of the research model showed that using systematic and periodic evaluations for improving IT parts configuration process has greater influence.

References

[1] Lorenzi NM, Kouroubali A, Detmer DE, Bloomrosen M. How to successfully select and implement electronic health records (EHR) in small ambulatory practice settings. BMC medical informatics and decision making. 2009;9:15.

[2] Campion-Awwad O, Hayton A, Smith L, Vuaran M. The National Programme for IT in the NHS A Case History. Cambridge, UK: University of Cambridge, 2014.

[3] Napolian K. Information Technology Infrastructure Library (ITIL) [in Persian]. 1 ed. Tehran, Iran: Jaam-e-jam Publications; 2014.

[4] Munassar NMA, Govardhan A. A Comparison Between Five Models of Software Engineering. IJCSI Int J Comput Sci 2010;7(5).

[5] Sanders D, Burton DA, Protti D. The Healthcare Analytics Adoption Model: A Framework and Roadmap (White Paper) 2013 [Oct 2015]. Available from: https://www.healthcatalyst.com/whitepaper/healthcare-analytics-adoption-model.

[6] Holland M, Dunbrack L, Piai S. Healthcare IT Maturity Model: Western European Hospitals -The Leading Countries. European IT Opportunity: Healthcare Healthcare Provider IT Strategies Health Industry Insights, an IDC Company; 2008.

[7] Sanders D. A Model for Measuring Industry-Wide Adoption and Capability of Healthcare Analytics and Data Warehousing in the USA. Electronic Healthcare. 2012;3:9-11.

[8] NEHTA. Interoperability Maturity Model: Version 2.0. Sydney, Australia: National E-Health Transition Authority Ltd.; 2007.

[9] Tahmassebpour M. Performance Evaluation and Scalability of IP-based and Heuristic-based Job Scheduling Algorithm Backup Systems. Indian Journal Of Science And Technology. 2016; 9(26).

[10] Atafar, A., Shahrabi, M., Esfahani, MJ. Evaluation of university performance using BSC and ANP. Decision Science Letters. 2013; 2(4): 305-311.
[11] Mehravani S. A model for accepting IT infrastructure reference in Iranian selected companies [Dissertation in Persian]. Tehran, Iran: Al-Zahra University; 2012.
[12] Zhang J, Walji MF. TURF: toward a unified framework of EHR usability. Journal of biomedical informatics.44(6):1056-67.
[13] Fasihi F. Assessment of IT Service Management based on ITIL framework in Bank of Industry and Mine [Dissertation in Persian]. Iran: Allameh Tabataba'i University; 2006.