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Hospital Information Systems User Needs Analysis: A Vendor Survey

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Abstract. This study was conducted to evaluate the hospital information system (HIS) software based on user requirements in Iran. Through a descriptive study 5 vendors which had the best selling software products among the university hospitals were selected. HIS softwares were evaluated based on checklist and through the observation in 8 hospitals according to defined criteria. SPSS and descriptive statistics were employed to analyze the collected data.

Maximum user's expectations were supported by Tarrahan Boali. However, Tarrahan Bali has not efficiently met user expectations in all departments; medical records (74.5%), pharmacy (58.6%), laboratory (74.5%), nursing (23.3%), radiology (51.4%) and financial (65.4%). Minimum user requirements (29%) have been met by Microafzar Qeshm.

There was no HIS software to meet the end users expectations in all departments completely. Failure to meet the user expectations among software that addresses all user expectations appropriately could be ascribed to poor user participation and revealed that HIS adoption in Iran is still in infancy. Conducting periodical evaluation; employing a comprehensive tool for HIS evaluation is crucial to ensure their effective implementation and improvement.

Keywords. Hospital Information System; Medical Records Systems, Computerized Medical Records; Medical Records Department

1. Introduction

Hospital information systems (HIS) are increasingly becoming an emerging tool in health care arena to efficient delivery of high quality health services.[1-5] Hospital Information system is one of the most common computer systems have been designed to support health care services. These systems are large computerized data bases were intended primarily for communication and store health and administrative information. HIS has a different components and includes broad scope and level of systems from departmental (a system limited a specific clinical or financial domain) to knowledge

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based systems that provide diagnostic support and intervention for patient care activities.[6-7]

It is believed that HIS implementation is an organizational process conducted toward information technology within user community.[8] User community in health care arena consists of many different user groups (physicians, nurses, administrators, managers, researchers, etc.). Neglect of any of these parties imply to missing related expertise, skills, knowledge, requirements and expectations. Expectation and requirement arise from what users see and hear about the system and interpret the ways the system will work for them.[9] Studies indicated that addressing user expectation is a distinct element to ensure the successful adoption of the HIS.[10-12] Lucas was one of the first researchers to debate the information system failure. He posed three classes of variables: user attitudes and perceptions, the use of systems and user performance to describe his model of IS failure. Gradually this theory was developed and a failure category in term of "use failure"/ interaction failure/ user failure has been emerged; use failure arise because end-users neglect as a significant stakeholder group in a HIS project.[13-16] Therefore, user need analysis and customizing HIS software with regard to user expectations provide the integral part of HIS adoption.[1,17]

Although there is a major drive to HIS in Iran, studies recognize that existing HIS fails to meet user requirements.[18-22]

Kimia far indicated that only 57.7 % of the users were satisfied with HIS. He presents user needs analysis as a valuable tool to enhance user satisfaction.[23]

A rigorous HIS software vendor survey by the aid of a multi-disciplinary team including, end users of nursing department, radiology department, laboratory department and medical records department is a critical pathway for HIS selection and evaluation. An input from user evaluation provides a feedback relating to selection, modification and promotion of HIS based on user expectations and creates an atmosphere for HIS vendors to compare their strengths and weaknesses.[24] Modification of traditional viewpoints relating to vendor as an "outsider" cause health care providers perceive vendor as a stakeholder that shares common rewards and risks with organization intent to adopt HIS.[8]

Given the importance of the role of software vendors as a service provider not only a product seller and user needs analysis as a distinct element in HIS success [8, 18,25-27] the present study was conducted to evaluate the HIS software based on the user's requirements throughout the Iran.

2. Methods

Through a descriptive study in 2009 vendors best selling software products in university hospitals (Rahavard Rayaneh, Tarrahane Boali, Microafzar Qeshm, Rayavaran and Peyvand Dadeha) were selected. Sample HIS software was chosen in selected health care settings according to following characteristics:

1. The software has been implemented for at least three years
2. Fully implemented throughout the hospital departments (medical record, pharmacy, laboratory, radiology, financial, nursing)
3. Hospital agreement on HIS evaluation

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4. Availability and accessibility to target software

The health care facilities that have executed given hospital information system software including: Masih Daneshvari and Shaheed Rajee in Teharn (Rayavaran); Khoram Abad's city, Shaheed madani hospital and Amiral moamenin hospital in Semnan (Peyvand Dadeha); Emam khomeini hospital in Tehran and Qom's valeeasr hospital (Tarrahane Boali), Sahamiye kodakan hospital in Qom (Microafzar) and Feiz Hospital in Esfahan (Rahavard Rayaneh) were chosen based on above mentioned features in different cities (Tehran, Qom, Semnan, and Esfahan).

Data were gathered based on checklist and through the direct observation of trained questioners, interview with end users and hospital IT administrators.

After taking hospital agreement, HIS software functionality and capability were collected through a self-administered checklist: The evaluation was made for medical record (inpatient, outpatient and emergency admissions, medical coding, statistical reporting, etc), Laboratory (defining specific tests, reporting, providing alarm and reminders, etc), pharmacy (drug administration, drug packaging, defining corporation name, defining goods, etc), Radiology (scheduling, registration, defining the type of services, image communication, incorporation to Picture archiving and communication systems (PACS) ,etc), financial (Accounting, account payable, account receivable, compensation, inventory, etc) and nursing department (tracking test results, operating room scheduling, patient monitoring, etc).

Tentative checklist developed based on review of literature [28-32], and HIS vendors' catalogues/ brochures. In the following steps, initial tool were modified according to the end user viewpoints of selected departments and experts panel (hospital information technology administrators, computer consultants and faculty members). Finally, revised checklist containing 467 questions related to the following six fields were developed: medical records (251 questions), pharmacy (70 questions), laboratory (55 questions), radiology (35 questions), nursing (30 questions) and financial (26 questions).

To support validity and reliability of checklist a pilot study was conducted to evaluate HIS software in given hospitals. SPSS and descriptive statistics employed to analyze the collected data.

3. Results

The study findings indicate that maximum user's expectations were supported by Tarrahan Boali Co. However, Tarahan boali has not efficiently met its user expectations in all departments such as: medical records (74.5%), pharmacy (58.6%), laboratory (74.5%), nursing (23.3%), financial (65.4%) and radiology (51.4%).

As Table -1 reveals minimum user requirements (29%) in medical record department has been met by Microafazar Qeshm Co. Although the highest user's expectations in clinical and ancillary departments including pharmacy (58.6%), laboratory (69%), and nursing departments (60%) were considered by Microafzar Co. More than 40 % of user needs at laboratory and pharmacy departments were supported by all HIS softwares, Except Microafzar Co. More than 48% of medical record department expectations have been addressed by all HIS software vendors.

Table-2 indicates that all HIS software meet user requirement relating to entering patient and insurance data. Although all of the HIS softwares fail to meet user needs relating to send message for patient and dynamic medical order management.

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Table -3 shows that all the HIS softwares do not support drug- drug interactions and alerting and verifying prescription rules. HIS functionality most support basic features like defining drug usage and defining type of patient admission in pharmacy department. Microafzar Qeshm is the weakest HIS vendor to meet user needs in laboratory department. All of the HIS softwares fail to meet quality assurance function in laboratory department (Table 4).

Access to clinical guideline is not considered by noun of HIS softwares. Microafzar Qeshm is the only vendor that meets user need for scheduling patient's sonography, MRI, and other diagnostics procedures (Table 5).

4. Discussion

Weakness of HIS software vendors to address user expectations (maximum 66.6%), emphasize on an existing huge gap between the user needs and HIS capability; Iranian HIS vendors have neglect the crucial role of their user needs analysis as an important factor in HIS success.[33-36] Non- considerable efforts to address the user need leads to the poor user acceptance and finally HIS failure. 70% of information systems were failed or cannot provide their end user satisfaction. [37-39]

In health care organizations many different user groups (physicians, nurses, administrators, managers, radiologists, pharmacists, etc) with variety of backgrounds and conflicting interest exit. To underestimate user acceptance and expectations leads to boycott 40% of newly installed systems.[40] According to Leclercq implementation of a hospital information system could not happen without an analysis of the feelings and perceptions of individuals who make use of it.[41]

Therefore, user- centered design that focuses on user tasks and requirements, account for critical responsibility of health care organizations and software vendors.[42]

Results of present study indicate that user requirements in medical records and ancillary departments were higher than the nursing department. Failure to meet the user's expectations in nursing departments stated that, HIS functionality and usability has been restricted to financial and administrative tasks rather than to support more clinically -oriented functions.

These differences could be attributed to historical background of the use of computers to support the functions of medical record departments. However, studies also revealed that those early HIS in term of departmental systems have not completely managed to meet user's expectations. [18-22]

According to such studies, these shortcomings and weaknesses to meet the user requirements imply that installed HIS neglect a major aspects of HIS adoption: The User!.[13-16,40-41,43]

Regardless of the historical background to neglect the critical role and capability of legacy systems is another reason to cause newly invested information system failed to meet user expectations. Current HIS does not benefit from the potential capability of legacy systems, such as ADS-9 and Hospim softwares, previously used in medical records departments and suffers from the same shortcomings.

Furthermore, ancillary department mainly focuses on specimen tracking, financial and billing functions, rather than those have a great impact on the quality of care [44-46]; Information system in ancillary departments, do not support clinical alerts for abnormal test results, quality assurance, quality control, clinical guidelines, incorporation to Picture Archiving and Communication Systems (PACS), etc.

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These findings, as well as the previous studies do emphasize the limitation of HIS functionality in financial systems, such as patient accounting and payroll.

Ahmadi (2010) revealed that the major purposes of HIS were to capture charges and supporting financial work flow rather than to assist with clinical care .[47] Hadianfard (2002) indicated that existing HIS core functions share common features with the first generation of HIS.[48] They focused on patient scheduling and admission discharge and transfer (ADT), business and financial system and reporting results from ancillary departments.[6-7,49]

Therefore, HIS software should enter in second wave; next generations of HIS must be catered on users' expectation, quality of care and patient safety. In this context, using management technique like change management, team building, effective communications, Business process improvement (BPI) and continuous process improvement (CPI) initiative which facilitate user involvement and participation pave the way to develop HIS based on user requirements.[50-54]

5. Conclusion

None of the hospital information system software has met the end user expectations: Most efficient software in medical records departments were Tararhan Boli and Peyvand Dadeha ; in laboratory department Tararhan Boali and Rayavarn addressed most of the user needs; in nursing department Microafzar had the best functionality; in radiology department Peyvand Dadeha met most of their user needs, in financial department Tararhan Boli and Rayavarn had the most capability. In pharmacy Tararhan Boli and Microafzar had the most usability.

Failure to design holistic hospital information software that addresses all users' expectations appropriately could be ascribed to poor user participation. These findings indicate that there is huge gap between HIS development and user needs. This gap arises as a result of distance between world of technical designers "hard" and "soft users" (manager and users).

The solution to this gap is the employment of project manager to foster team work and create "hybrids", those who understand both business workflow and role of information technology.[55]

User needs failures in this study also revealed that HIS adoption in Iran is still in infancy. Conducting periodical evaluation; employing a comprehensive tool for HIS evaluation is crucial to ensure their effective implementation and improvement.

Evaluation of HIS must be conducted with regard to some multidimensional aspects: including user requirements, cost containment, goal achievement, etc. There is no single best way to evaluation, conducting one dimensional study relating meeting user requirements does not provide a distinct tool for selecting best HIS software. However, user- centered design account for crucial role in HIS success and its underestimation makes HIS failure inevitable.

Since, a portfolio of evolution approaches to address all aspects of hospital information system is advisable.

A single approach to study the HIS vendors in present research could be ascribed to the absence of a comprehensive and well- organized data base to compile HIS software features (usability, functionality, pricing, etc) and of course immature prevailing IT in health care arena in our country. Existing scant literature relating to

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HIS and its components (laboratory, radiology, pharmacy) in Iran and other countries (current literatures focus on EHR) was debated another problem in this study.

It is recommended that future studies concentrate on the evaluation HIS in terms of benefit realization, cost benefit analysis, usability, functionality and economical outcomes of system implementation to ensure the HIS improvement.

At the bottom line, since planning for system evaluation should be started parallel with the system design effort, following steps is recommended to ensure HIS success in health care organizations:

- Formulating a structured approach for health information selection through:

    1. Developing HIS selection multidisciplinary team
    2. Identifying critical goals
    3. Assessing user needs, identifying key workflows and improving processes via process improvement mechanisms
    4. Creating and submitting request for proposal (RFP) based on user's requirements, organization's goals and workflows
    5. Providing on-site demonstration
    6. Ranking the vendors and make informed decision based on organization's critical goals, user needs and identifying key workflows

- Incorporating HIS failures as an organization learning
- Develop a databases to collect factors affecting the HIS failures; evaluating HIS and present organizations with best practices
- Appeal to knowledge management tools including community of practice (COP), sharing alliance and working with experts and coaches to ensure HIS success.

References

[1] Abdelhak M, Grostick S, Hanken M, et al. *Health information: management of a strategic resources*. Philadelphia: W.B. Saunders Company; 2001:654–659.

[2] Adler, K.G. (2005 Feb) "How to Select an Electronic Health Record System", *Fam Pract Manag.* **12**(2), 55–62.

[3] Ahmadi M, Barabadi M, Kamkar M. (1389) Evaluation of Hospital Information Systems in the Medical Records, *Health Information Management Journal* **l7**(1), 16–23.

[4] Aiatolahi, H. *Study of users' viewpoint about ADS-9 software in The Teaching hospitals of the Iran Medical Sciences University [Thesis in Persian]*. Tehran: School of Medical Information Management, Iran university of Medical Sciences; 2002.

[5] Al-Mashari, M., and Zairi, M. (1999) BPR implementation process: An analysis of key success and failure factors. *Bus. Process Manag. J.* **5**(1), 87–112.

[6] Al-Nashmi, Maha Eissa. *The role of vendors in health information systems implementation: Assessing the perception of healthcare executives and vendors University of Pittsburgh*; 2003. Available at: http://proquest.umi.com.

[7] American Academy of Family Physicians (AAFP). Available at: http://www.aafp.org/online/etc/medialib/aafp_org/documents/news_pubs/fpm/pcmhtools/ehrvendorrating. Par.0001.File.tmp/ehrvendorrating.pdf.

[8] Barabadi, M. *Study of rate of hospital information system correspondence with Medical Records user needs [thesis in Persian]*. Tehran: School of Medical Information Management, Iran university of Medical Sciences; 2008.

Submitted: January 22, 2010 *Accepted: March 16, 2011*

[9] Beynon-Davies, P., *Information systems failure and risk assessment: The case of the London Ambulance Service Computer Aided Despatch System*. In Proceedings of the European Conference on Information Systems. Proceedings of the 3rd EuropeanConference on Information Systems. Athens: Greece; 1995.

[10] Beynon-Davies, P., and Lloyd-Williams,M. (1999) When health informationsystems fail. *Top. Health Inf. Manage* **20**(1), 66–79.

[11] Bruce I, Reiner M, Knight N, Eliot L, Siegel B. (2007 May) Radiology Reporting, past, present and future: The Radiologists perspective. *J Am Coll Radiol.* **4**(5), 313-9.

[12] Carter J. *Electronic Health Records: a guide for clinicians and administrator*. Second edition. US, American College of Physicians; 2008.

[13] Carter J.H. *Electronic Medical Records: A Guide for Clinicians and Administrators*. New York: American College of Physicians; 2001:5-7.

[14] Chang, R., *Process Reengineering in Action: A Practical Guide to Achieving Breakthrough Results*. Jossey-Bass Pfeiffer, San Francisco, 1999.

[15] Electronic health record workgroup. *Electronic health records vendor report USA: American Academy of Neurology*; 2008, June 30: 879-1960. Available at; http: //www.aan.com/go/practice/electronic.

[16] Electronic Health Records Work Group. *Electronic Health Records Vendor Report. The American Academy of Neurology*; 2006. Available at: www.aan.com/globals/axon/assets/2290.pdf

[17] Elkhuizen, S., Limburg, M., Bakker, P., and Klazinga, N.S. (2006) Evidencebased re-engineering: Re-engineering the evidence: A systematic review of the literature on business process redesign (BPR) in hospitalcare. *Int. J. Health Care Qual. Assur.* **19**(6), 477–499.

[18] EMR questionnaire.
Available at: www.ncmedsoc.org/non_members/project.../EMR_Questionnaire.pdf.

[19] Farshid, P. *Study of rate of Medical Records graduates participation in development of hospital information system from Managers and Medical Records professors' viewpoint [Thesis in Persian]*. Tehran: School of Medical information Management, Iran university of Medical Sciences; 2002.

[20] Freed, D. H. (2006) Certain death: Ten predictors of hospital information system failure. *Health Care Manag. (Frederick)* **25**(1), 26–33.

[21] Goldfinch, S. (2007) Pessimism, computer failure, and information systems development in the public sector. *Public Adm. Rev.* **67**(5), 917–929.

[22] Hadianfard A .*The survey of hospital information system structure in Shiraz hospitals. [Thesis]*. Tehran: Shahid Beheshti University of Medical Sciences; 2002. [In Persian].

[23] Hamborg K, Vehse B, Bludau H. *Questionnaire based usability evaluation of hospital information systems*. Available at: citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.67.

[24] Heek R. *Failure, Success and Improvisation of Information Systems Projects in developing countries*. 2002. Available from: unpan1.un.org/intradoc/groups/public/documents/.../unpan015601.pdf. accessed 2011.

[25] Heeks R. (2006) Health information systems: failure, success and improvisation. *Int J Med Inform.* Feb; **75**(2), 125-37.

[26] Hoseini, M. *Comparison of Medical Coding Software package in the Medical Sciences universities and presentation a model [Thesis in Persian]*. Tehran: School of Medical Information Management, Iran university of Medical sciences; 2007.

[27] Kaelber D, Greco P, Cebul RD. *Evaluation of a commercial Electronic Medical Record (EMR) by primary care physicians 5 years after implementation*. AMIA AnnuSymp Proc. 2005:1002.

[28] Kimiafar, K. *Study of user's viewpoint about hospital information system quality in the Teaching hospitals of Mashhad medical sciences university [thesis in Persian]*. Tehran: School of Medical information Management, Iran University of Medical sciences; 2006.

[29] Langarizadeh, M. *Computerize Medical Records systems in the Teaching hospitals of The Iran, Tehran and Shahid beheshti universities of Medical Sciences [Thesis in Persian]*. Tehran; School of Medical Information Management, Iran University of Medical sciences; 2003.

[30] Leclerp A. (2007) The perceptual evaluation of information systems using the construct of user satisfaction: case study of a large French group. *AGM pres New York* **38**(2), 27-60.

[31] Lindgaard G. & etal. (2006) User Needs Analysis and requirements engineering: Theory and practice. *Interacting with Computers* **18**(1), 47-70.

[32] Lium JT, Tjora A, Faxvaag A. (2008 Jan 10) No paper, but the same routines: a qualitative exploration of experiences in two Norwegian hospitals deprived of the paper based medical record. *BMC Med Inform Decis Mak.* **8,** 2.

[33] Mantas J.*Textbook in health Informatics*. Amesterdam: IOS press; 2002: 256.

[34] McCarthy,M., and Eastman, D., *Change Management Strategies for an Effective EMR Implementation*. Ohio: HIMSS; 2010. Available from: www.himss.org/content/files/Change Management.pdf. Accessed 2010.

Submitted: January 22, 2010 *Accepted: March 16, 2011*

[35] Metfessel, B.A**.** *Financial and Clinical Features of Hospital Information Systems*. Available at:healthcarefinancials.com/.../Hospital%20Information%20Systems.pdf
[36] Moradi Gh. *New dimensions of health information management. First Edition*. Tehran: word processor; 2003: 179.
[37] Murff H,J,Gandhi T.K, Karson A.K, Mort E.A, Poon E.G, Wang S.J. (2003) Primary Care Physician attitudes concerning follow- up of abnormal test results and ambulatory decision support system. *International Journal of Medial Informatics* **71**, 137-149. Available at: http://www.elsevier.com
[38] Mutschler, E, Cnaan R. (1985 February) Success and Failure of Computerized Information Systems: Two Case Studies in Human Service Agencie. *Administration in Social Work* **9**(1), 67 – 79.
[39] National Institutes of Health. *National Center for Research Resources. Electronic Health Records Overview*. 2006, April. Available at: www.ncrr.nih.gov/publications/informatics/EHR.pdf.
[40] Nauman, A., Aziz, R., Ishaq, M. *Information Systems Development Failure: A Case Study to Highlight the IS Development Complexities in Simple, Low Risk Projects in Developing Countries*. The Second International Conference on Innovations in Information Technology. Dubai: UAE University; 2005. Available from: www.it-innovations. ae/iit005/proceedings /.../I_5_IIT05_ Nauman.pdf . Accessed 2007.
[41] Ndira SP, Rosenberger KD, Wetter T. (2008) Assessment of data quality of and Staff Satisfaction with an electronic health record system in a developing country (Uganda): a qualitative and quantitative comparative study. *NCBI* **28,** 6–8.
[42] Nitrosi A, Borasi G, Nicoli F, Modigliani G, Bott A. (2007 Jun) A film less radiology department in a full digital hospital: quantitative evaluation of the increase quality and efficiency. *J Digit Imaging* **20**(2), 140-8.
[43] Palm J.M, Colombet I,sicotte C, Degoulet P. *Determinants of user satisfaction with a clinical information system.* 2006, 614–618.
[44] Peterson D, Kim C, Kim J.H., Tamura T. (2002 Dec) The perceptions of information systems designers from the United States, Japan, and Korea on success and failure factors. *International Journal of Information Management* **22**(6), 421–439.
[45] Povey, B., (1998) The development of a best practice business process improvement methodology. *Benchmark. Int. J.* **5**(1), 27–44.
[46] Rahimi B, Vimarlund V, Timpka T. (2009 Oct) Hospital information system implementation: a qualitative meta-analysis. *J Med Syst.* **33**(5), 359-68.
[47] Rehm S, Kraft S. (2001) *Electronic Medical Records: The FPM Vendor Survey Fam Pract Manag.* **8**(1), 45-54. Available at: http://www.aafp.org/fpm/2001/0100/p45.html
[48] Rezaei A, Asadi A, Rezvanfar, A, Hassanshahi H. (2009 Sep) The impact of organizational factors on management information system success: An investigation in the Iran's agricultural extension providers. *The International Information & Library Review* **41**(3), 163-172.
[49] Scott JT, Rundall TG, Vogt TM, Hsu J. (2005 Dec 3) Kaiser Permanente's experience of implementing an electronic medical record: a qualitative study. *BMJ.* **331**(7528), 1313-6.
[50] Staggers N, Thompson CB, Snyder-Halpern R. (2001) History and trends in clinical Information systems in the United States. *J Nurs Scholarsh*. **33**(1), 75-81.
[51] Tait p, Vessey I. *The effect of user involvement on system success: A Contingency approach*. Management information system research center, university of Minnesota 1998.
[52] Thompson DI, Osheroff J, Classen D, Sittig DF. (2007 Winter) A review of methods to estimate the benefits of electronic medical records in hospitals and the need for a national benefits database. *J Healthc Inf Manag.* **21**(1), 62-8.
[53] Wager K & etal. *Managing Health Care Information Systems: A Practical Approach for Health Care Management*. Jossey-Bass; 2005:
[54] Wetter T. (2007 Jun) To decay is system: the challenges of keeping a hospital information system alive. *Int J Med Inform*. **76** Suppl 1, 252-60.
[55] Winston T.L, Benjamin SH. (2000) The relationship between user participation and system success: study of tree contingency factors on government – owned companies. *Journal of information and management* **37**(6), 283-295. Available at: http://www.portal.acm.org