An Integrated, Web-Based, and Automated Healthcare Institution Quality Management (HIQMA) System

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***Abstract*—This paper describes HIQMA, an integrated, web-based, and fully automated healthcare institution quality management system. HIQMA includes many applications, starting with a quality handbook for the individual beneficiary organizations and not ending by the development of service guidelines. It is based on a result-proven design approach that will enhance medical and healthcare services. The different stakeholders are provided with a common framework for designing, implementing, evaluating and improving these services. The system is scalable in the sense that additional professional development tools based on the worked service guidelines can be implemented.**

Keywords—healthcare; quality management system (QMS).

I. INTRODUCTION

Constant upgrading of the quality of healthcare centers is a key priority at institutional, national, regional, and international levels. Recent charted European agreements placed the objective of increasing the attractiveness of healthcare institutions and promoting medical tourism [3] as a key objective along with quality improvement requirements (e.g., the EU-OECD agreement on healthcare indicators [1], EUPHORIC Project [2], etc.).

To achieve such key objectives, most of the current systems follow the classical methodology of cyclic planning, implementation, assessment and review, and examine the process as a relative and contextual concept. That process is depicted in Figure 1 [4]. The above approach is usually taken to avoid the creation of a pervasive and unequivocal definition of healthcare quality. An effectual Quality Management System (QMS) targets the systemic development and communication of a customer-focused mission, strategies, and action plans. Thereby, listening and responding to customers' needs and expectations, empowering employees to keep improving and increasing their satisfaction with their work processes and environment, and gathering and analyzing Key Performance Indicators (KPIs) to enhance organizational and process results are of immense importance for the good governance of an institution [5].

Consequently, an integrated web-based Healthcare Institution Quality Management (HIQMA) system is required to improve the medical and healthcare services. The system attributes include many applications, starting with a quality handbook for the individual beneficiary organizations, continuing with the reformed professional training and advisory service concepts, and ending with the developed service guidelines. In addition, scalability and customizability are intrinsic requirements of the system. These attributes ensure that different stakeholders are provided with a common framework for designing, implementing, evaluating and improving these services.

This paper describes the functionality of HIQMA system as well as some of its attributes and services. Section II describes the system in details. Section III outlines the governance and standard compliance dimensions. Section IV presents some results and impact assessments. Further enhancements are described in Section V.

Figure 1. Classical methodology of cyclic planning.

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II. TOOL DESCRIPTION

Managing quality performance requires a comprehensive approach that has a dynamic nature in terms of agility and customization. This becomes highly important when dealing with healthcare institutions as they must carefully consider and control their activities to ensure all quality requirements are met. The integrated web-based automated HIQMA system that we built has been designed to assist such organizations in implementing and maintaining this comprehensive approach by delivering tools structured around the ISO 9000 family of international standards for quality management taking into consideration the special needs and features for healthcare services [6].

HIQMA is a centralized management system that provides a portal to critical quality information and facilitates quality performance improvement through requirement tracking, notifications and real-time management reporting. It has been designed to streamline and automate quality management processes of any medical organization and assist in the effective implementation of wide quality initiatives on a "use per need basis". The software system is 100% web-based, highly configurable QMS that helps organizations track, analyze, and report on quality management in addition to streamlining existing processes and enforcing their application.

The system was deployed for the first time in Lebanon in early 2011. Since then, the system has been deployed in 7 medical institutions covering 3 private hospitals with 100+ bed capacity, 2 polyclinics and 2 medical labs. As a part of the system's development and evolution plan, a new version of the software is installed every 6 months in all locations. Typically, the new software releases include bug fixes, further enhancements and new features. In an attempt to ensure customer satisfaction and continuous quality improvement, an annual on-line customer survey is conducted. The survey is comprised of 20 questions covering 4 distinctive areas: functionality, compliance, efficiency and quality control. A quantitative scale of 1-5 is used with 1 being poor and 5 being excellent. In the first survey conducted in early 2012, a total of 5 institutions responded to the survey and an average score of 3.90 was recorded. In the second survey conducted in early 2013, a total of 7 institutions responded to the survey giving the system an average score of 4.36. This suggests that the system has evolved nicely and is a viable candidate for wider deployment and adoption by other medical institutes. In the next sections, the main features of the system will be described in further details.

A. Web-Based Application

From a technical perspective, the system is web-based, with all of its features and their respective functionality accessible through any web browser. It can be hosted inside the healthcare institute's Local Area Network (LAN) with open or closed access from outside the institute's premises. The system can also be hosted online using any preferred hosting service provider. In addition, it offers a deployment model for organizations preferring to outsource hardware and software maintenance. Worldwide roll-out of the system can be completed in less than 6 hours enabling users with a URL, username and password to access the system from – virtually – any Internet access point. According to recent findings, web-based interfaces reduce the learning curve of medical or administrative staff who can begin to work with the system shortly after installation and incorporate it in their daily tasks and activities [7].

B. Centralized Activities Management and Customization

Through a friendly Graphical User Interface (GUI), the system provides the user with a workplace that is easy to work with through a variety of summary screens, task menus and drop-down lists. These features are accessed by a regular user according to his/her assigned privileges and/or role(s).

A regular user may access a user specific task summary screen that summarizes the responsibilities in sequential order. Users can be presented with this screen upon login, ensuring single click access to their most critical information. Management personnel have access to a personalized menu that provides visibility over current activities and pending assignments of the medical staff tasks. Management system coordinators and senior personnel have access to a complete listing of tasks by location, department, region or corporation as a whole.

The system tracks "who" is doing "what", "when", "where" and "how". It doesn't just store this information; rather, it automates such information through notifications and tracking mechanisms. All tasks, forms and assignments can trigger an email notification to the appropriate responsible person. Every email notification includes a hyperlink that sends the user directly to the task detail screen within the system. This screen provides further instructions, downloads, as well as fields, to record activity completion and uploads related documentation. The system ensures nothing falls through the cracks with an escalating email notification feature. The system can be configured to escalate the email notification of tasks pending completion. This feature is extremely flexible and can be configured to send any number of emails to any number of people to ensure tasks are completed on time.

C. Embedded Forms and Processes

The application is pre-loaded with numerous forms, checklists and common processes for all the necessary activities that are common in almost all healthcare institutions. The availability of such material will help the user complete needed tasks and activities in a controlled manner where human mistakes are minimized. Detailed process description is always displayed whenever the user invokes or triggers any activity which involves that respective process. If multiple processes are involved within a specific operation, then all of them will be made available to the user for consultation and cross-checking. This makes the application a fail-proof approach, ensuring all quality compliance requirements are met.

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D. Flexible Reporting

The HIQMA system is designed to streamline the flow of information throughout the healthcare institution. Institutions can mirror their hierarchical structure within the database, and this enables data to flow from a site, to a department, to a unit, to institute-wide, to regional or other locations in the case of multi-center organizations. Each location, division, department or other type of unit can manage its structures independently, and can have varying levels of hierarchy.

Data within the system will roll-up to appropriate management levels instantly in real-time without the need for lengthy manual traditional processes and procedures. The system has a centralized reporting tool that makes sharing information easy. Users at all levels of the organization can generate reports that summarize performance status and requirements. All reports can be generated in the most popular formats (HTML, PDF, .DOC or .XLS). Reports can be configured online through the web-based interface. A screen-shot capturing the reporting panel is shown in Figure 2.

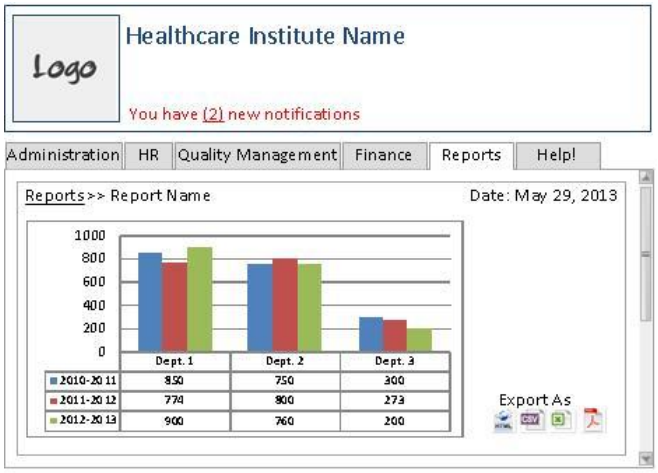

Figure 2. Reporting panel screen-shot.

E. Mobility

The user is provided with great mobility and agility where the system may be accessed from any computer or mobile device from anywhere as long as there is a connection to the hosting server (LAN, WLAN, or Internet). This provides the users with instant access to data at all times. Mobility certainly improves business performance, increases organizational efficiency and decreases response time.

F. Security

The system has a robust security management console that enables access to the modules, locations and functionality to be controlled for each user and user group. System administrators, who have access to the security module, can manage user access and the views available to user groups, as well as view the history of user visits. In addition, encryption of the user credentials and data is included upon login and throughout the authentication and authorization process.

The User/Permissions module of the system allows a top level administrator to assign permissions and roles for each user individually or as part of a security group. The functional permissions of each user are assigned based not only on the actions he/she is supposed to take, but also down to the data level he/she is required to manipulate. For example, two different users may have the same role and permissions but each can perform his/her permissions on a specified set or pool of data by department, patient, or others.

G. Multi-Lingual Suppport

The system has a dynamic user interface that is available in multiple languages. Newly translated interfaces are continually being added. The system currently supports English, French, Arabic and Farsi languages. The system technology is developed in such a way that the interface's language can be changed by the user according to the languages requested by the medical organization. In addition, data entry in multiple languages is also currently supported. Although the system does not translate data, it does provide a centralized roll-up capability of data in multiple languages.

III. GOVERNANCE AND COMPLIANCE

A. Governance

In any healthcare organization, small or large, adding, demoting, or changing forms and procedures is a procedure by itself. The users will require training on the new procedures and forms, and the printed documents require replacement to reflect new changes.

The system technical structure with respect to workplace, rules, forms, and menus takes into consideration future changes and enhancements of the business rules of the medical institution. Any updates to the forms or procedures are done directly on the system, and once committed, the institution ensures adherence to the new forms and rules instantaneously.

B. ISO Compliance

The software application is not only structured as per the ISO 9001 standards with all the modules that address each of its requirements, but also contains many unique features that facilitate on-going continuous improvements [8]. It is designed specifically for healthcare institutions implementing or maintaining a QMS based on ISO standards [9]. In addition, it drastically improves internal or third party audit results by adhering to the ISO modules summarized in Table 1 [10].

IV. RESULTS AND IMPACTS

So far, the system has been recently deployed in a number of healthcare institutions in addition to a number of medical colleges and universities. Certainly, each sector has

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TABLE I: A SUMMARY OF SUPPORTED ISO 9001 2008 REQUIREMENTS

ISO 9001 2008 Requirements	
Clause	***Title***
5.3	Quality Policy
5.4.1	Quality Objectives
5.4.2	Quality management system planning
5	Management responsibility
5.1	Management commitment
5.5.1	Responsibility and authority
5.5.2	Management representative
6.6.2	Competence, awareness and training
5.5.3	Internal communication
7.2.3	Customer communication
4.2	Documentation requirements
4.2.2	Quality manual
4.2.3	Control of documents
8.5.2	Corrective action
8.5.3	Preventive action
7.6	Control of monitoring and measurement devices
8	Measurement, analysis and improvement
8.2	Monitoring and Measurement
8.2.3	Monitoring and measurement of processes
8.2.4	Monitoring and measurement of product
8.3	Control of nonconforming product
8.4	Analysis of data
4.2.4	Control of records
8.2.2	Internal audit
5.6	Management review
5.6.2	Review input
5.6.3	Review output

its own flavor of the system but a number of common conclusions could be derived from their deployment and operations. Some highlights are:

- Seamlessly orientating the users to clearly understand and easily satisfy the quality needs.
- Continuing improvement in the institution by adopting quality as a philosophy. This is a crucial requirement for adopting a total quality management (TQM) approach which is essential for business sustainability.
- Presenting defined and consistent processes and guaranteeing their successful completion as long as processes are done in a timely manner according to the standards.
- Adhering to preventing instead of supervising, thus ensuring that the costs of preventive measures are less than those of close supervision or micro-management. This is a proactive step rather than a reactive one.
- Utilizing a single, institution-wide system to manage all quality management information and initiatives. This becomes especially relevant in multi-location institutions.
- Automating the tracking, management, and notification of the QMS stakeholders.
- Providing web-based tracking forms, analysis tools, and roll-up reporting to facilitate continual improvement and measurement of key performance indicators.
- Centralizing the management of quality related activities and requirements and driving the medical institution performance.
- Experiencing robust document control and management for all quality related procedures and policies.

The outlined findings are based on preliminary on-line surveys that were done by the institutions where the system was deployed and on thorough discussions with the various stakeholders through the formal review and evaluation process. The following lessons learned were also noted:

- A common – and rather classical – issue is faced in most of the institutions, which is related to the resistance to change, especially in institutions where some staff personnel have a low adaptation capability to non-paper based systems.
- Changes and updates in automated quality management systems belong in general to the service/product provider which limits the capability and the capacity of the institution to abrupt changes in running processes which might be needed in some cases where non-ordinary circumstances are present (ex: change management in risky zones).
- For institutions with low number of patients and specialties, the cost of such a system will increase the overhead and somehow lower the quality/price ratio. Usually, such institutions are oriented towards systems with fewer modules, thus leading to a limited access to all the benefits of the system.
- Institutions with simple – or no – information technology (IT) departments will face the problem of hosting and managing the system servers. Such institutions are advised to go with the cloud hosting solution to minimize the overhead and transfer the risks to the hosting service provider.

Many institutions that deployed this system found the need to update some of their forms, rules, and procedures early in the definition phase. The structured and logical methodology the system uses can spot flaws in procedures and regulations. In addition, it allows the institution to do a major review on the consistency and integrity of its existing QM system.

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V. FURTHER ENHANCEMENTS

The HIQMA system is open to a huge set of enhancements in the future. Currently, we have three main enhancement features and propositions being studied.

The first enhancement is to develop an add-on module to the system that is able to collect data from multiple institutions and organizations. This pool of data will result in a knowledge base that will allow the analysis of quality management practices on national or international levels. It will also give insights on how institutions interpret and understand quality, as well as propose best practices and procedures.

The other enhancement is to allow healthcare institutions with well-established IT departments the capability of creating and designing their own forms and workflow from a graphical interface without the need to write code.

A long-term proposition is to add a “Learn Mode” module powered with artificial intelligence code that reads and interprets the system’s technical logs to automatically propose enhancements to procedures and policies. The “Learn Mode” can be set to individual parts of the system or to the whole set of enabled modules.

VI. CONCLUSION

The good healthcare service is not only a social responsibility, but also a good contributor to economic competitiveness and welfare in a global knowledge-based economy. Many challenges face medical services, including developing and upgrading the skills of the existing workforce, promoting labor mobility, diversifying customer base, and – most importantly – planning and implementation of education and training services. All of the above require that the management of such programs be handled with care and innovation, on the one hand to maintain a quality culture in the institution, and on the other, to keep up with a the competitive edge of the services rendered.

The integrated web-based HIQMA system can meet these challenges, and more. The system tackles the details of ISO standards and medical services peculiarities, and delivers a high quality, high performance package for use by the various institutes, irrespective of their specializations. Such an approach proved to be efficient, robust, and reliable in all the sites where it was installed and tested.

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