A Practice Based Examination of Standardization, and its Relationship with the Design and Use of Healthcare IS

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Abstract

Standardization represents an important concept for developing closer integration within the healthcare sector. While prior research has examined standards from the perspective of technological interoperability and business processes, there is limited research examining interface design standards for a healthcare information system (IS). This research in progress addresses this gap by empirically investigating the nature of such standards and their implications for a healthcare organization. The study adopted an interpretive case approach and collected data collected from a leading hospital in Saudi Arabia. Preliminary results indicate that IS facilitates collaborative work practices within a healthcare organization by inscribing in itself the standards for such collaboration. Further such standards are instantiated in terms of a configuration of functional information technology (IT) affordances, which can represent design standards. The research also identifies a preliminary set of functional IT that can form the basis of a more detailed ontology for IS design standards for the healthcare context

Keywords: Hospital Information Systems, Healthcare IS, Standard(s)/Standardization, Functional Affordance, Theory of Practice, Interpretive Case Research.

1. INTRODUCTION

There has been a recent increase in Information System (IS) implementation and use in the healthcare sector (Dougherty & Conway, 2008; Lobach, Anstrom, Russell, Woods, & Smith, 2007). There have also emerged technical, ethical and legal guidelines and issues related to Electronic Health Record (EHR) systems. For example, the Health Insurance Privacy and Accountability Act (HIPAA) and other privacy-related regulations must be adhered to providing operational constraints for IS development (Berner & Moss, 2005; Charette, 2006; Meystre, Friedlin, South, Shen, & Samore, 2010; Vest & Gamm, 2010). Consequently, issues related to digitization practices are a primary concern for the healthcare sector, and the IS discipline (Chaudhry et al., 2006; Sood et al., 2008).

A recent trend in the research of healthcare information technology has been towards a closer integration of the different organizational players within the sector (Blaya, Fraser, & Holt, 2010; Charette, 2006). However, such integration requires the achievement of certain levels of standardization within the design, implementation, and use of IS (Blobel, 2000; Klein, 2002; Stegwee & Rukanova, 2003).

Standardization is defined as a process that unifies work activities to a specified set of procedures across an organization's boundaries, to develop collaboration and improve performance (Davenport, 2005; Münstermann, Eckhardt, & Weitzel, 2010; Schäfermeyer & Rosenkranz, 2011).

The literature on system standardization emphasizes the importance of operational, technical, and design standards for smoother communication and interoperability among systems (Blobel, 2000; Blobel & Holena, 1997; Klein, 2002; Schäfermeyer & Rosenkranz, 2011). Healthcare related studies point out a variety of a well-developed set of standards, such as the Digital Image and Communication in Medicine (DICOM) standard, and the Health-industry layer Level 7 (HL7) (Blobel & Holena, 1997; Klein, 2002; Yang, Liu, & Li, 2010). Despite these, developing integrated systems remain a key challenge. A reason for this could lie in the fact that standards are not stable in nature and constantly evolving due to technology advancements as well as the organization's environment (Klein, 2002; Münstermann et al., 2010; Wüllenweber, Beimborn, Weitzel, & König, 2008). Therefore one can argue that continuing to understand the nature and influence of standardization could hold key for more efficient and useful healthcare IS.

Conceptually standardization becomes pertinent because of the unusual context that a healthcare organization represents (Davidson & Chiasson, 2005; Häyrinen, Saranto, & Nykänen, 2008; Klein, 2002; Li, Liu, Yang, & Yu, 2014). A large section of the Healthcare professions (e.g. doctors, nurses, pharmacologists) are bound to strongly defined fields of practice that extends beyond the organization. Therefore each of these professions has strongly defined norms, guidelines, and code of conducts that are strongly influenced by the local and global practices external to a particular organization (Charette, 2006). Consequently work processes within healthcare organizations require collaborations amongst these different fields of practice. Such collaboration need to necessarily comprise of significant boundary-spanning activities (Currie & Suhomlinova, 2006). For such boundary spanning to be effective, there needs to be a significant amount of standardization of these work processes, particularly in terms of the boundary objects that inscribe such interaction (Barki & Pinsonneault, 2005; Li et al., 2014; Swaminathan, 2001). It may be argued that IS represents such a boundary object and facilitates the collaboration between practices by inscribing in it the standards for such interaction. Such standard one would imagine evolves through recursive interactions of the boundary spanning agents of the individual practices and the affordances that IS provides them.

If one accepts the above perspective, the conceptual importance of examining the idea of standardization becomes apparent. In particular it would be interesting to understand what standardization represents, how it evolves and what are the implications for design, use and integration of IS. An examination of research suggests that standardization, as it pertains to healthcare is multi-faceted, including technology as well as behavioral and procedural standards (Bijlsma et al., 2014; Klein, 2002; Li et al., 2014; Lobach et al., 2007). These non-technological bases for standards can be argued to have key implication about the standardization of interface design. In particular, the design capabilities inscribed within such interface need to conform to standards underlying collaboration within an organization. This need becomes more paramount in the context of the healthcare organization, which is inherently a conglomeration of heterogeneous practices (Häyrinen et al., 2008). This research in progress article reports the preliminary exploration into the nature of such interface design standards. This initial report is based on an interpretive analysis of empirical data collected from healthcare professionals affiliated to a large hospital in Saudi Arabia. Specifically the research is guided by the following research question:

1. What is the nature of interface design standards that help develop collaborative space within a healthcare organization?

The rest of this study is structured in the following way. First we elaborate on the existing literature on standards relating to technology. Next we describe our methodological approach, and the theoretical narrative that emerges from our empirical investigation. We conclude with a discussion of the contributions and implications of this research.

2. LITERATURE REVIEW

The key to efficient provision of healthcare is the design and implementation of Healthcare IS increase information sharing and interconnectedness within and among organizations (Davidson & Chiasson, 2005;

Haux, Ammenwerth, Herzog, & Knaup, 2002; Li et al., 2014). As argued earlier, such integration brings to forth the importance of standardization. The International Organization for Standardization (ISO), defines Electronic Health Records (EHR) as "a means to the repository of patient data in digital form, stored and exchanged securely, and accessible by multiple authorized users"(Häyrinen et al., 2008, pp. 293-294). Although there have been many benefits to using healthcare IS, numerous challenges hinder the process of developing an integrated system such as political, strategic or structural barriers (Barki & Pinsonneault, 2005; Ettlie, 1988; Hitt, Hoskisson, & Nixon, 1993).

The importance of the role of standardization in achieving integration and collaboration across boundaries in boundary spanning practices is well known(Blobel, 2000; Klein, 2002; Stegwee & Rukanova, 2003). Research also highlights the benefits of standardization, and how it can improve industry performance, increase efficiency and enhance quality (Münstermann et al., 2010; Ramakumar & Cooper, 2004; Schäfermeyer & Rosenkranz, 2011; Swaminathan, 2001; Wüllenweber et al., 2008). In the field of healthcare, for instance, the industry developed an interface standard, called health industry Level 7 (HL7). It is a conceptual model that characterizes and standardizes the internal functions of communications related to the healthcare industry (Blobel & Holena, 1997). Research recommends adopting HL7 standard as it can provide a point-of-care management to healthcare organizations (Lobach et al., 2007). Another standard model is the digital image and communication (DICOM), a de facto standard involved in the exchange of medical images (Bijlsma et al., 2014; Klein, 2002; Yang et al., 2010).

Recent studies suggest standardizing care processes to support the implementation and system use, such concepts related to guidelines and protocols in the context of healthcare organizations. Moreover, standardized clinical pathways can improve medical quality and allow system integration across a healthcare organization (Li et al., 2014). Related studies also list standardization as one of the critical requirements of a system implementation in an organization (Barki & Pinsonneault, 2005; Swaminathan, 2001). For example, terminologies, data structures, languages, and infrastructures must be standardized to allow databases to be built. Standardizing the process chain across a boundary spanning organization also facilitates information sharing and activity integration across different departments (Barki & Pinsonneault, 2005; Hitt et al., 1993; Münstermann et al., 2010). Other studies suggested that development and propagation of technology standards such as data communication standards, can facilitate the emergence of a fully integrated healthcare IS (Chowanetz, Legner, & Thiesse, 2012; Li et al., 2014; Ramakumar & Cooper, 2004; Yang et al., 2010).

Unfortunately while existing research is insightful, the focus is more toward understanding standards in terms of technology platforms and work processes. This study argues the need for research that examines healthcare IS standards from an interface design perspective. Consequently there is a necessity for examining the nature of interface design standards and its relationship to organizational work processes.
In the remaining part of the manuscript we describe our empirical study and the insights gained from applying such theoretical perspectives.

3. METHODOLOGY

This research used an interpretive case study approach following guidelines from Walsham (1995,2006). Data was collected from King Faisal Specialist Hospital and Research Centre (KFSH&RC), a government hospital located in Saudi Arabia. The hospital was established in 1975, and it runs a 936- bed tertiary care facility. Moreover, the total personnel of the hospital are 6,946 (KFSH&RC, 2013).

Data Collection
We have completed forty-seven semi-structured interviews of health care professionals. The duration of these interviews ranged between 30-50 minutes. Interviews were tape-recorded and transcribed (sixteen doctors, fifteen nurses, seven pharmacists, and nine personnel from the IT department). These healthcare personnel were able to provide personal case stories that helped us formulate a preliminary interpretation of the situation. Furthermore, direct observation, as a part of the interpretive design is important in analyzing details in the field (Li et al., 2014). Through our interviews, we were able to observe how doctors and nurses interact between each other as well as with the system during their working hours. It was critical to record and observe the physical items that hindered the progress of IT in the hospital.

In addition to the interviews, the first author had a supervised accessibility to the current healthcare IS. We also had access to the simulation system used for the mandatory training workshops. The hospital administration also provided us with different documentations from recent legal reports to media literature such as ICIS flyers and handouts.

Data Analysis

Drawing on Walsham's (1995,2006) guidelines on interpretive research, we used an inductive qualitative approach to analyze and interpret the collected data (Walsham, 1995, 2006). The data analysis was done in two stages. During the first stage, each author interpreted the data individually. The second stage involved modifying these data interpretations through recurring meetings that consisted of multiple iterations of conceptualization and re-interpretation of the data. The interviewees had extensive experience about the Integrated Clinical Information System (ICIS) in place, and divulged personal case stories that helped us better understand the phenomenon in hand. Interviewees were asked a variety of open-ended items, which allowed participants to answer questions in a more complete manner that revealed additional information that was not anticipated by the researcher.

Given the practice-centric premise driving this research, the study adapted theoretical perspectives from practice-based studies of boundary spanning organizations (Feldman & Orlikowski, 2011; Levina & Vaast, 2005, 2013; Ulrike Schultze & Orlikowski, 2004). Another theoretical perspective that was adopted was derived from the concept of functional affordances (Markus & Silver, 2008). Functional affordances represent a relationship between a technology object and a specified user. This relationship identifies the extent to which a user can use this object given his/her capabilities and objectives(Markus & Silver, 2008). The existence of such affordances provides a user with a sense of the potential of the technology object, and provides certain conditions for its appropriation. Using such theoretical perspectives from existing IS research as our analytical lens helped in framing the data. It also helped in developing an insight into the nature and use of IS across boundary spanning practices. In the next section we describe the results of the analysis.

4. CASE DESCRIPTION

The case focuses on the work processes involved in the technology used in KFSHS&RC. At the point of our data collection, the organization had an existing integrated Healthcare IS, which is formally called the Integrated Clinical Information System (ICIS). This was launched in 2007 and has been in use since then. ICIS is a comprehensive system, which includes the different practices and aspects of the hospital. Such as scheduling management, laboratory and radiology information systems, pharmacy practice, emergency department, medical records, nurse documentation, and physician order entry (AlSekait, Chakraborty, & Chatterjee, 2015; KFSH&RC, 2013). The system is as an example of a successful IS implementation. System users seemed to have an overall positive perception about it. As one-doctor mentions*: "I like ICIS much better than the past system I used to work on in King Fahad Medical City".*

Other doctors and nurses describe the system as*: "Very easy system indeed", "very friendly and comfortable to use", "It makes my job much easier", " very straight forward. I like using it"*

We found evidence of the existence of a number of distinct fields of practice (e.g. doctors, nurses, pharmacologists, and an IT department). Each field is bound with well-defined boundaries and very distinct separation of roles based on the practice's identity. As a system developer highlights: *"The nurses have different tasks than the doctors such as assessments duties, vital science, and other requirements".*

Given the existence of these distinct practices, work processes within the hospital require extensive interactions between these fields of practice. Most of the users confirm their constant collaboration between the different practices, as one respondent mentions: *"Nurses and doctors work different ways but still they are working together and the doctor would check with nurse constantly and vice-versa".*

An objective of the preliminary analysis was to try to understand the nature of these practices. Figure 1 illustrates our conceptual understanding of the multiple work practices within KFSH&RC (See Figure.1 in appendices).

There is an inherent hierarchy based on the roles within the doctors' fields of practice. For example, doctors can be consultants, fellows, residents, interns, or medical students. Depending on their position, networks, and professional expertise, members of this practice (agents) produce different kinds of resources (cultural and social capital) as well as economic capital (money, time, technology). For example

the consultants sit at the top of the hierarchy and typically accumulate social and economic capital. Consequently, they also accumulate symbolic capital due to the power they have among others. While the agents within the doctor's fields of practice have different status, they retain (except perhaps for the medical students) a higher prestige over the other fields of practice. Similarly, the nurse practice has its own agents and structure. Nurses are differentiated in their position and title. For example, a nurse can be a head, chief, or a beginner nurse. As a hospital's nurse mentions: *"When I don't know how to do something in system, I go ask another nurse or a doctor for help*"

Agents from both these fields of practice collaborate and interact intensively in performing tasks related to their workflow. The pharmacy practice represents another key field of practice. The agents in this practice interact with the other fields of practice principally to process medication requests. However, agents from the pharmacy practice also engage in dispensing course of treatments, and profiling medications. The majority pharmacists corroborate in this process, as one pharmacist explains: *"I can see in the system which doctor placed the medication, the course of treatment and the dosage amount"*

As can be understood from the previous discussion, each practice has its own hierarchy, chain of command and norms for work. A significant aspect of the work processes within the hospital was the collaborative interaction between these practices. Such interaction required significant boundary panning activities. Research suggests that IS often enables such boundary spanning by providing boundary spanning objects in the form of technological artifacts and boundary spanning functionalities(Levina & Vaast, 2005). In KFSH&RC, ICIS provided such boundary spanning capabilities. ICIS facilitated this collaboration by embedding in itself the features that provided the agents of different practices, the affordance for collaboration. The bundle of these features represents desirable design elements and functional standards for the IS. For example, one of our respondents state: *"Before we get the system, the pharmacy was done manually. It wasn't included in the older system. But now, ICIS includes the pharmacy and all other departments in it".*

Preliminary Findings

To understand the role of IS in boundary spanning practices, this part of the analysis focused on the critical parts of the workflow related to patient throughput (see figure 2 in appendices). In particular we focused towards understanding specific tasks, task objectives of the doctors, nurses and pharmacologists. As mentioned before, the exploration of work processes in KFSH&RC indicated extensive collaboration between the fields of practice. It also was apparent that ICIS (the focal IS) played a large part in facilitating this workflow. Literature on boundary spanning suggests that recurrent interactions structure the use of technologies in practice. These structures enact the rules and resources, which shape the use of the technology(Levina & Vaast, 2013). Therefore, we also examined the nature of interaction between the boundary spanning agents during the performance of their tasks.

Bourdieu (1977) suggests that agents engage in producing or re-enforcing practice structures through the collaborative use in field and Habitus (Bourdieu, 1977). Depending on their role, position, and capital, agents accumulate different resources (capital) throughout the practice. Habitus engage in processing the distribution of these resources through the use of IS (Levina & Vaast, 2005). For example, pharmacy agents are authorized to distribute drugs from the hospital (social capital) only when doctors place a request assigned to a specific patient (authority distribution). The recursive interaction relations between agents and Habitus create structures for the practice. IS facilitates this construction by standardizing the process structure, and enabling the collaboration between the different practices (U Schultze & Boland Jr, 2000). An examination of ICIS and the boundary objects indicates that the standards for internal work process and collaboration are inscribed in the design features exposed to the users. Therefore, analysis was undertaken to examine the specific nature of these design features and also the affordances they provide. Table 1 provides a preliminary report of this analysis into the relationship between agent tasks, collaboration between fields of practice, and the affordances provided by the IS (See Table.1 in appendices).

Table 1 also provides a narrative about the role of IT features in allowing agents to collaborate and pursue their tasks. For example, IT capabilities allow the collaboration and information exchange between the doctor and nurse practice through the (patient lookup)

function, by allowing shared access to medical history of a patient. Many doctors mention: *"Nurses must log all the assessments preformed on the patient in the system because the first thing we do when we see a patient is checking those records", "Everything about the patient's health is found in the system. Such as current and past symptoms, course of treatment, patient's test results, clinical results, x-rays, or any lab work done"*

We see similar IS enabled collaboration in the patient diagnoses function. Many doctors highlight: *"we must log everything in the system", others add, "while diagnosing, we must add notes then place medication, or ask for lab-work".* Moreover, enabling the reporting functionality, allows all agents involved to exchange patient's information, chart a specific report, and track a patient's progress. As a hospital's nurse highlights: *"I can generate requested reports for a doctor in a matter of seconds".*

Another critical aspect mentioned in table 1 involves the pharmacy practice. By having a medication-request and preventive care functionality, the doctor and pharmacy practices were able to collaborate and access common data and processes. Doctors describe the prescription filling process stating: *"When I request patient's medication, the pharmacist can see that I am the one requesting it and for whom",* they also add *"the system will inform me about the medication and dosage amount".*

The system also prevents human errors from happening by setting alerts and reminders if one user missed to provide critical information. In the words of one doctor: *"The system works in such a way and such a manner that prevents human error to occur…if I forgot to put the dosage amount of the given drug, alerts pop up asking me to provide the amount…when I prescribe drugs that contradicts each other, the system wont allow me and pop an alert stating the issue and recommending an alternative drug".*

The above narrative indicates the system features that facilitate the various work functions, and are often used within the organization. However it is interesting to note that they represent a subset of all the features made available in the system. This suggests the importance of these features in facilitating the collaboration between the agents of the different fields of practice. Consequently one can argue that such features provide certain functional affordances, which provide users with a sense of the potential of the technology object, and provide certain conditions (facilitation of collaboration between the agents of the different practices, in this case) for its appropriation (Markus and Silver 2008). The last column in the table identifies the affordances that emerged as salient. This research suggests that these affordances represent design objectives for the system interfaces and can represent generic standards for interface design. We also suggest that the identified functional affordances represent an initial set of desirable standards for a healthcare IS that facilitates the communication and collaboration among the boundary spanning practices. In the next section, some implications of these findings are elaborated upon.

5. DISCUSSION AND FUTURE RESEARCH

The findings in the previous section, while preliminary, provide certain conceptual contributions toward examining an IS within a hospital context. First of all, this research suggests a particular perspective based on practice theory, which explicitly acknowledges the existence of distinct practices within such an organization. The research argues that work processes within hospitals therefore necessarily require collaborations between such fields of practice, and consequently development and inscription of standards for such collaboration. IS plays a critical role by providing the artifact for inscription of standards and become objects that facilitate boundary spanning amongst the fields of practice. The preliminary analysis of the data provides indications of such a process within KFSH&RC. The existing IS (ICIS) is found useful, and is used extensively because of its exposure of technology features that explicitly facilitate interaction between the agents of the different practices, through the provision of important related functional affordances. For example, agents from the doctor and nurse practice were found to extensively share boundary objects-in-use such as reporting tool, and common interfaces for updating patient records.

Second, the research suggests a mechanism for conceptualizing standardization and what it represents for the use of IS within healthcare. The bundle of functional affordances identified within this research explicitly facilitates successful collaboration amongst the different fields of practice and therefore represent the inscribed objectives of the collaboration. Further the bundle of technology features that are exposed in providing such affordances represent

the inscription of the standards of work within the organization and consequently represent desirable design elements (or functional standards) for an IS. It may be argued that these design elements represent standardization of work processes within the organization and are sources for the development of design standards.

Third, this research provides guidance for developing future taxonomies of design standards for healthcare IS by identifying specific functional affordances, and related technology features for a context of a successful IS (e.g. the case of the use of ICIS within KFSH&RC). For example the affordances identified in this research provide a preliminary set for standardizing design objectives. Further the technology capabilities related to such design affordances represent instantiations of inscriptions of such standards into concrete functional standards. Forth, the contextualization of these technology features and functional affordances within specific tasks and instances of collaboration suggest a granular framework for developing ontologies for such design standards.

Finally the preliminary finding of this research provides fruitful avenues for further investigation for both this research and the discipline. First, there is an indication that within this healthcare organization, the development of design standards happens through a recursive interaction between agent interactions across fields of practice and the organizational structures that facilitate such boundary spanning. Such findings of this research are based on a stable configuration within the organization, but there are indications of an evolution that must occur within the organization. A necessary next step of this research is the exploration of this evolutionary process as this could provide key to understanding how standards evolve for IS within a work practice. Second, the identification of the preliminary affordances and technology capabilities provide the seeds for a more detailed ontology of the designs standards.

Finally, this research also indicates that the intensive collaboration between the different fields of practice is also facilitated through extensive maintenance and evolution of the technology objects. These require certain boundary spanning agents that can translate functional affordances critical for agent collaboration into explicit, standardized boundary objects in use, and maintain them as well. For example a respondent remarked: *"if a system acts up and I as a user do not know how to fix it I can call the help line and they can walk me through fixing my issue, or if it requires a technician's help an IT personnel from the hospital's IT department would come wherever I am to resolve the issue".* Therefore an important aspect in any future exploration would examine the role of the IT practice as such boundary-spanning agents.

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Appendices and Annexure

Figures

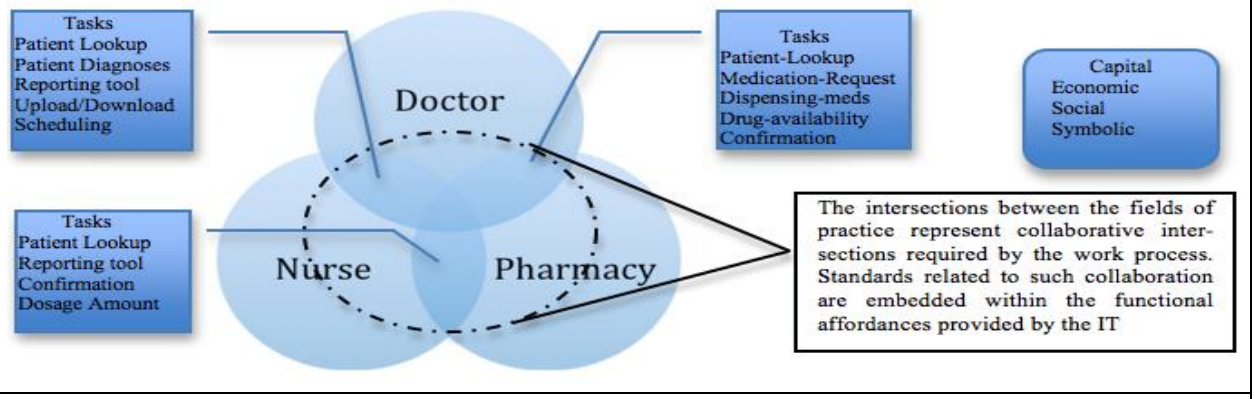

Figure 1. Fields of Practice and Boundary Spanning in a Healthcare Organization

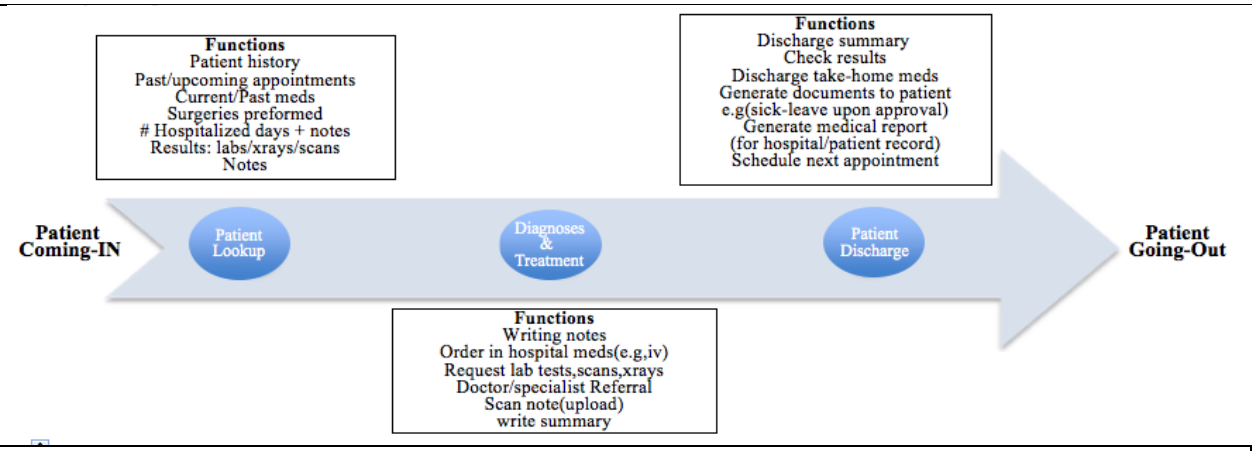

Figure 2. Hospital Workflow: Critical Patients Throughput and Workflow Practice in KFSH&RC

Tables

Function	Goals/Objectives	Actors	System Features /Capabilities	Functional IT affordance
Patient Lookup	•Access Patient records •Access medical History	Doctor and Nurse	•Patient history records •Shared Interface and data •Search tool	•Collaborative •Accessibility of common data •Patient Tracking
Patient's diagnosis	•Input new data/notes •Update Patient records	Doctor and Nurse	•Shared Interface and data • Patient diagnoses recording tool • Patient history update tool	•Collaborative •Patient tracking •Accessibility of common data/process •Communication facilitation
Medication Request	•Request Medication •Process prescription •Dispense medication •Confirm drug availability	Doctor and Pharmacy	• Prescription request/ sharing tool •Task progress update tool •Shared interface and data •Drug profiling/labelling features	•Collaborative •Accessibility of common data/process •Decision Making •Communication facilitation
Preventive care	•Prevent/Detect Human error	Doctor and Pharmacy	•System alerts/ reminders •Patient tracking tool	•Collaborative •Patient tracking
Lab-work Request	•Exchange/share data •Transfer Data •Allocate Critical Attention	Consulting Doctor and Pathologist	•Lab-work request and sharing tool •Task progress update tool •Shared interface and data •Lab-work report generation	•Collaborative •Accessibility of common data/process •Patient tracking
Reporting	•Generate reports •Choose and chart criteria	Doctor and Nurse	•Accessibility to patient's results, record and medical history •Charting tools •Reporting tools •Search tool	•Collaborative •Accessibility of common data/process •Communication facilitation •Patient Tracking
Directory Lookup	•Find contact information	Doctor, Nurse and Pharmacy	•Information Lookup (Specialist, Unit, Pharmacy/lab, personnel) •Search tool	•Collaborative •Accessibility of common data/process

Table 1. Boundary Spanning Practices, Associated Functionalities and their Use