Impacts of Usability on the Interoperability of Electronic Healthcare Systems

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ABSTRACT: Information Communication Technology (ICT) has become an essential component in healthcare because it enhances interoperability amongst healthcare practitioners by facilitating the seamless and meaningful exchange of information within and across diverse healthcare institutions at the point of care. Consequently, healthcare providers have timely access to patients' information which enables them to manage patients' health in a timely manner. However, interoperability amongst electronic healthcare systems is still a challenge. One of the major obstacles to interoperability of electronic health systems is the problem of usability. Specifically, the ability of healthcare providers to accept and use electronic healthcare systems for information exchange successfully depends on how well the user interface of the electronic healthcare systems have been designed. Thus, a poorly designed user interface, missing critical functionalities in the electronic healthcare system or an inadequate match between the features of the user interface and the user tasks contributes to medical errors, decreased user performance and satisfaction as well as inefficient healthcare such as missing information important to diagnoses. Consequently, healthcare practitioners find it difficult to accept and use electronic healthcare system for patients' care and meaningful information exchange. Hence, this paper appraises the impacts of usability on the interoperability of electronic healthcare systems. The paper also examines the ways of ensuing usability amongst interoperating electronic healthcare systems.

KEYWORDS: electronic healthcare system, healthcare, interoperability, usability, user interface.

1   INTRODUCTION

The adoption of Information and Communication Technology (ICT) in the healthcare domain has significant promise of enhancing interoperability amongst healthcare practitioners. One visible aspect of this is the possibility of facilitating the seamless and meaningful exchange of information within and across diverse healthcare institutions at the point of care. Nevertheless, the ability to ensure interoperability in the healthcare system is as complex as it is essential. Obviously, this requires creativity and innovation that can make the process and system usable at all times. As such, achieving interoperability should be a shared responsibility for all stakeholders. Furthermore, the emergence and widespread deployment of electronic healthcare systems to manage patients' care has become a significant trend in healthcare. Electronic healthcare systems such as Electronic Health Records (EHR), Electronic Patients Record (EPR), Electronic Medical Records (EMR), telemedicine services, web health portals, e-prescription services and Computer Based Patients Records (CPR) are widely used to support clinical decision making, high quality of patients care at lower cost, enhanced access to medical information as well as increased patients privacy and safety [1]. Another benefit of electronic healthcare systems is to facilitate interoperability amongst healthcare providers for better information management as well as safe and effective patients' care [2]. Consequently, interoperability has the potential of cutting down cost, reducing errors, improving efficiency

and health. In addition, interoperability across systems and care settings can engender better decision making amongst physicians and allows healthcare providers to spend quality time with patients. More importantly, interoperability has the ability to accelerate innovation and free up technology resources in hospitals so that the community can focus better on improving care. However, interoperability amongst multiple and heterogeneous electronic healthcare systems remains a challenge [3], [4]. One of the hindrances to interoperability of electronic healthcare systems is the problem of usability amongst stakeholders in the circle of care [5]. For instance, systems that discount important user characteristics and tasks, poor user interface, deficiencies in the user interface such as information displays that do not represent data and information appropriately and missing critical functionalities are major barriers to the acceptance and use of electronic healthcare systems for meaningful information exchange [6]. Thus, healthcare providers find it hard to deploy electronic healthcare systems for meaningful information exchange. As a result, this has overwhelmed the healthcare domain with increased medical errors as well as inefficient patients' care. Hence, the access to timely, concise, and clear information on diverse electronic healthcare systems remains a challenge for healthcare providers. Thus, the healthcare domain is plagued with increased medical errors as well as inefficient patients' care. Therefore, this paper appraises the impacts of usability on the interoperability of electronic healthcare systems. The paper also examined the ways of ensuring usability amongst interoperating electronic healthcare systems.

2   CONCEPT OF ELECTRONIC HEALTH

Electronic health (e-health) is defined as an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies [7]. In a broader sense, this term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using ICT [8]. The various forms of electronic health systems include the following [1].

- Electronic Health Records (EHR): This is a generic term for all electronic patient care systems.
- Personal Health Record (PHR): This is usually managed and controlled by patient; and it is mostly Web-based.
- Patient-Carried Record (PCR): These are information contained on a token or card that a patient carries.
- Electronic Medical Record (EMR): These are electronic record with full interoperability within an enterprise such as a hospital.
- Computer-Based Patient Record (CPR): These are lifetime patient record that includes all information from all specialties.
- Mobile Health (mHealth or m-Health): Mobile Health involves the use of mobile devices to collect and aggregate patient health data. M-health also provides healthcare information and real-time monitoring of patient vitals to practitioners, researchers, and patients via mobile devices
- Medical research using Grids: Medical research using Grids involves powerful computing and data management capabilities to handle large amounts of heterogeneous data.
- Healthcare Information Systems: Healthcare Information Systems involves the use of software solutions for appointment scheduling, patient data management, work schedule management and other administrative tasks surrounding health.

Healthcare information are usually stored in heterogeneous distributed electronic healthcare systems. This information need to interact and be accessed by healthcare practitioners in a uniform and transparent way, anywhere and anytime, as required by the treatment path of the patients for improved patients care. Hence, there is a need for interoperability of electronic healthcare systems.

3   INTEROPERABILITY IN HEALTHCARE

In general, ISO/IEC 2382 defines interoperability as the capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units [9]. In addition, interoperability is viewed as the ability to initiate action to complete exchange of meaningful information reliably and quickly among independent systems or components without errors [10]. Furthermore, interoperability is defined as the ability of two or more components, applications or systems to exchange and use information [11]. In the context of healthcare, interoperability is viewed as the ability of Information and Communication Technology (ICT) applications and systems to exchange, understand and act on patients and other health-related information and knowledge, among linguistically and culturally disparate health professionals, patients and other actors and organizations within and across health system jurisdictions in a collaborative manner [12]. From the definitions above, it can be deduced that interoperability in healthcare has two major parts namely:

- Syntactic interoperability: The ability of two or more systems to exchange information.
- Semantic interoperability: The ability of the systems to use the information that has been exchanged.

Syntactic interoperability facilitates the exchange of data amongst different systems or applications and much rely on Information and Communication Technology, without concern of data meaning [13]. Thus, the purpose of syntactic interoperability is to ensure data transmission without concerns for the meaning of data. Semantic interoperability on the other hand refers to the exchange of understandable and usable information amongst different systems or applications on the basis of shared, pre-established and negotiated meanings of terms and expressions. Thus, one of the major benefits of interoperability in healthcare is that it provides improved support for emergencies. This is because doctors usually treat patients in emergencies without their history. However, with the use of interoperable systems, doctors can view the medical history of their patients in diverse databases. Hence, healthcare providers will be able to get up-to-date information about patients for diagnosis and treatments. Consequently, interoperability allows the complete medical history of a patient to be easily accessed by a physician at the point of care regardless of the location of either the patient or the physician. This reduces suffering and saves lives. In spite, of the numerous advantages of interoperability to healthcare, interoperability of healthcare systems is yet to be achieved in most countries of the world as a result of the complexity of the healthcare domain, security and privacy issues, the prevalence of legacy systems and usability problems [14]. Hence, healthcare systems globally are plagued with increased cost, medical errors, and decreased quality of patients care. However, this paper examines the impacts of usability on interoperability of healthcare systems.

4   USABILITY IN HEALTHCARE

Usability is described by how easy it is for users to accurately and efficiently accomplish a task while using a system. According to this definition, usability expresses how well the user's goal is feasible with a system in a specific context. The context of use constitutes the broader framework in which a system is operated. It concerns the system's particular users, their tasks and the system's environment of use as depicted in Fig. 1.
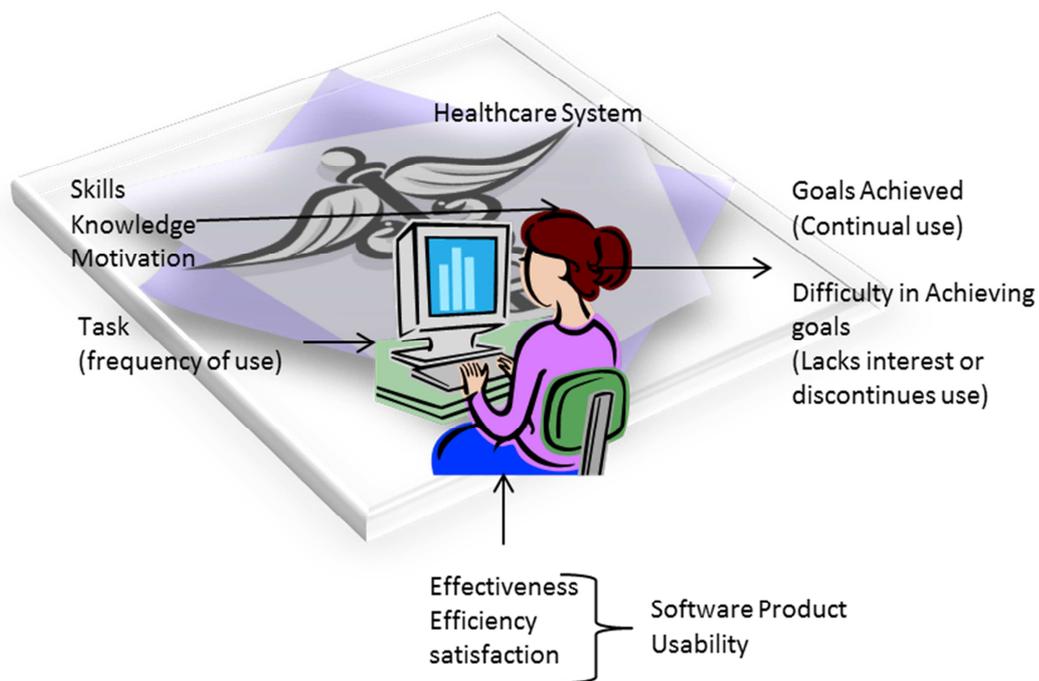
Fig. 1.   A Framework for Usability in Healthcare

Furthermore, usability is defined as a term that is used to describe the methods for analyzing and enhancing a software system [15]. Usability is concerned with the combination of fitness for purpose, ease of use, and ease of learning that makes a software system effective [16]. Similarly, usability is defined based on the factors highlighted below [17].

- Fit for use: This is a measure of how well a system supports the user's real life tasks.
- Ease of learning: This is defined by how easy it is for diverse user groups to learn the use of a system

- Task efficiency: This defines how efficient the system is for frequent users
- Ease of remembering: This defines how easy it is for occasional users to remember the functionalities of the system
- Subjective satisfaction: This defines how satisfied the users are with the system
- Understandability: This is concerned with how easy it is for the system users to understand what the system does

The three major goals of usability are effectiveness, efficiency and satisfaction [18]. Effectiveness is the accuracy and completeness with which specified users achieve specified goals in particular environments. For example, a user is effective if he can complete tasks making minimal amount of errors. Efficiency includes the resources expended in relation to the accuracy and completeness of goals achieved. Satisfaction is the comfort and acceptability of users and other people to the system [19]. Thus, the goal of usability is basically to determine how well the users use the system and in what way a system assists the users in achieving a particular task. Bevan [19] identified a broad approach to usability as a "quality of use." According to Bevan [19], quality of use should be the major design objective for an interactive system which enables the intended users to achieve the intended task. Thus, it is not enough for the graphical user interface of a system to be well-designed; it should also have high utility. Utility refers to the right system for the right users and the right task. In essence, usability addresses the relationship between tools and their users. Thus, in order for a system to be effective, it must allow intended users to accomplish their tasks in the best way possible.

5 BENEFITS OF USABILITY TO INTEROPERABILITY OF ELECTRONIC HEALTHCARE SYSTEMS

The healthcare domain in recent times has witnessed a rapid increase in the use of electronic healthcare systems to improve the quality of patients' care. However, an electronic healthcare system that is not effective and does not satisfies the needs of its users (healthcare providers and patients) can be a contributing factor to errors in patients' treatment. Hence, electronic healthcare systems should be designed in such a way that they are usable and accessible to all stakeholders in the circle of care. Consequently, this section examines the critical needs of usability to the interoperability of electronic healthcare systems.

5.1 USABILITY FACILITATES COMMUNICATION AMONGST HEALTHCARE PRACTITIONERS DURING MEANINGFUL EXCHANGE OF INFORMATION

One of the major goals of interoperability is to ensure that stakeholders have timely access to health related information from different vendors regardless of their geographical locations. However, patients' medical records are usually scattered across several offices and hospitals. Nevertheless, the need for collaboration and interaction among healthcare providers irrespective of their geographical location during the care of a patient is paramount. However, if the information on the interoperating electronic healthcare system is difficult to read or the needs of the users are not met, the users will find it difficult to use the system, thereby getting frustrated and thus leaving the system. However if the system meets the demands of the users, the users irrespective of their geographical locations will be encouraged to use the system for interoperability and this will facilitate communication amongst healthcare providers. Hence, usable electronic healthcare systems increase quality of care by facilitating seamless communication amongst healthcare providers. This facilitates the instant exchange of test results with other doctors, healthcare providers, laboratory, pharmacies, and clinics. Thus, usability increases the quality of patients care.

5.2 USABILITY ENHANCES EFFICIENCY DURING INTEROPERABILITY

Usability facilitates easy navigation and ease of learning or remembering of the various navigational schemes of electronic healthcare systems such as tabs, buttons, and hyperlinks, thereby increasing the efficiency and productivity of its users in a manner that is safe and thus improving the quality of patients care

5.3 REDUCTION OF MEDICAL ERRORS

More than one million patients are injured each year as a result of broken health care processes [20]. Also, medical errors are the sixth leading cause of death in hospitals in the United States [21]. Thus, medical errors are of great concern to healthcare. However, one of the ways of avoiding medical errors is to ensure usability amongst interoperating electronic healthcare systems. For instance, if electronic healthcare systems are poorly designed, users will be frustrated and confused and therefore are likely to make errors which can be detrimental to patients' health. Thus medical errors will be reduced by improving user interface designs which in turns more reduces interface error rates.

5.4   IMPROVED PATIENTS SAFETY

Well designed user interfaces of interoperating electronic healthcare systems contribute to an increased user performance and satisfaction as well as efficient healthcare. This in turns improves the quality of care and thus guarantees patient safety.

5.5   REDUCTION IN THE COST OF HEALTHCARE

Healthcare costs represent a significant percentage of the Gross Domestic Product (GDP) of a country. Thus, it is always said that the health of the people is the wealth of the nation. However, the implementation of electronic healthcare system for meaningful exchange of information is a popular solution to reducing healthcare costs, and thus increasing patients' care. Unfortunately, 30% of electronic healthcare system implementations fail, often because physicians cannot use them efficiently [22]. Thus, increasing the cost of healthcare.

6   WAYS OF ENSURING USABILITY AMONGST INTEROPERATING ELECTRONIC HEALTHCARE SYSTEMS

Interoperating electronic healthcare systems are struggling under the weight of too much complexity, too much time and usability problems. As a result, electronic healthcare workers are often forced to pay more attention to technology than treating patients. Therefore, usability will promote the use of explicit criteria to judge the success of an interoperable electronic healthcare system in terms of effectiveness, efficiency and satisfaction. To engender this, usability objectives, which includes suitability for the task, learnability, and error tolerance should be considered, thereby reducing the technical complexity for hospitals, healthcare systems, and healthcare workers in general. In achieving this, there is need to adopt systems engineering and human factors engineering approaches and test implementations to ensure usability. Specifically, the following briefly describes ways of ensuring usability amongst interoperating electronic healthcare systems:

- The user-interface design for electronic healthcare systems should consider the entire context of use, not just the Graphical User Interface (GUI) of the system. This is because usability depends on how well the systems can be integrated into the work processes of the healthcare providers. Furthermore, there should be agreements on the user interface consistency such as similar formats for common medical data values such as blood pressure (systolic/diastolic), consistent placement of these common values on the screen, guidelines for choice of colours and management of alerts and data interoperability among the developers of electronic healthcare systems and the users of the systems. In order words, the system should be intuitive and user friendly. This will allow healthcare professionals to do their jobs more efficiently and safely.
- Since healthcare vocabularies are developed in the context of various assumptions and targeted for multiple uses, there is usually the possibility of having multiple expressions referring to the same concept. This usually leads to conflict, ambiguity and confusion whenever information are exchanged amongst healthcare professionals. Thus, to enhance the usability of electronic healthcare systems for interoperation, a common medical terminology to avoid incompatibilities and to guarantee the consistency, reusability, and sharability of healthcare information must be incorporated into the design of electronic healthcare systems.
- User community in healthcare arena consists of diverse user groups such as physicians, nurses, laboratory technologists, pharmacists, patients etc. The expertise, skills, knowledge, requirements and expectations of these parties must be sought during the systems design. Thus, there should be no gap between the system development and the users' needs. This will facilitate the successful adoption of electronic systems for decision making and thus interoperability will be enhanced amongst diverse healthcare providers.
- The availability of audit trail systems in electronic healthcare systems is necessary to facilitate the detection of data alteration and to address potential security violations during meaningful information exchange. This will encourage the use of electronic healthcare systems for interoperation.

7   CONCLUSION

Interoperability is a key element in enabling connected and coordinated healthcare across the community the right care, at the right time, in the right place. Interoperability is also essential within the healthcare system because it facilitates the seamless and meaningful exchange of information amongst healthcare providers and patients. However, one of the major challenges to the meaningful exchange of health related information amongst electronic healthcare systems is usability problem. This problem usually impedes communication, efficiency, productivity and satisfaction amongst users of the interoperating systems, which is detrimental to patients' safety. Hence, this paper appraises the impacts of usability on the

interoperability of electronic healthcare systems and it also examined the ways of ensuring usability amongst interoperating electronic healthcare systems.

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