Context Based Knowledge Management in Healthcare: An EA Approached

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ABSTRACT

While an enterprise architectural approach is appropriate for business and IT alignment it also has potential with respect to the design and implementation of healthcare applications by effective representation of healthcare processes. Our research is to develop an enterprise architectural framework for managing contextual knowledge by exploiting object location deduction technologies in healthcare processes that involve the movement of patients. Such a framework is intended to facilitate healthcare managers in adopting location deduction technologies for patient care resulting in improvements in clinical process management and healthcare services.

Keywords

Enterprise architecture, service automation, knowledge management, healthcare process integration and context based technology.

INTRODUCTION

In practice enterprise architectural descriptions within organizations have several layers [1]. Usually the layers comprise three parts, business, application and technology [2]. Lower layer functionalities provide practical support for further higher layers [3]. Modelling support in these layers is available however appropriate selection of modelling concepts for each layer is very necessary for business (in this case healthcare) and IT alignment [4]. Appropriate selection of modeling concepts for facilitating a conceptual view is also essential for representing processes, applications, activities, components, objects and processes relations in a systematic way [1]. Enterprise architecture (EA) is an appropriate approach for representation of healthcare processes onto different layers for designing and implementing suitable healthcare applications involving the movement of patients [1]. Healthcare processes' representation and linking with each other in conjunction with healthcare functionality and IT alignment are necessary for considering an appropriate framework [2]. Enterprise architecture thinking would facilitate a methodology for representing and linking of healthcare processes [3]. Hence, in the first part of this research enterprise architecture is considered for analyzing and modeling healthcare processes and their relationships in different organizational layers.

Handling of processes within an organization is considered and addressed many times for optimization purposes in commercial settings of organizational operations. Business activities involve the handling of various processes [5]. There are various process models available from static, rigid to flexible and very flexible in respect of organizational behaviour [6]. Appropriate handling of processes in relation with human activities is very difficult task [7]. Some models have a predefined structure of information flow to address process integration [7].

The fast pace of information flow and complex information systems may reduce human integration within organizational systems. Humans are a very important resource of any organization [7] and the intensity of human involvement may vary from organization to organization [5]. In healthcare settings human involvement is not only important but also it is sensitive in nature [8]. Moreover it is a very demanding resource [8]. Optimizing the use of processes within healthcare settings is crucial [9]. Appropriate process automation may address the proper integration of human involvement in healthcare settings [8]. It may save resource usage and reduce the risk of unattended patients in hospital settings [8]. In healthcare settings

significant numbers of processes involve humans [5]. Humans vary in respect of their time for performing any task [5]. This human variability affects events within healthcare [8].

Proper staff utilization and dealing with change events is critical for addressing improvements in patients' services [5]. If the control mechanism of a process can be increased for hospital management then it certainly improves quality of work with improved practices [8]. Healthcare organizations struggle to increase appropriateness in resource allocation for patients' processes in conjunction with high level of patients' satisfaction [8]. Handling of interdependent processes is a complex task because one process may interact with another process behaviour [10]. In this research these complex processes of healthcare for patients' movement will be considered in the context of their improvement through automation.

Information about the location of objects (including patients) in healthcare processes can facilitate process improvement through automation [5]. In sensitive organizations like hospitals, where object safety such as patient and professional medical treatment is of high value can improve their services through process automation [8]. Due to the sensitivity of the medical treatment process automation is a highly complex task [8]. Mobile technology has a vital role in providing process automation for dynamic object movement environment [9], [11], [12], [13], [14], [15]. Although process automation can provide effective service and resource management, however recognizing a process that can be automated is itself a significant problem in the healthcare environment [16]. Selecting or devising an appropriate model for process automation is a complex task [17]. If any model can provide an appropriate mechanism of selecting these processes and also facilitate the design of the process chain for process automation then it will help the healthcare industry to improve their services [18]. In this research an enterprise architecture approach is used to model healthcare process automation using mobile technology.

RESEARCH OBJECTIVES

A. Identify key aspects of healthcare processes that involve the movement of patients using enterprise architecture concepts.

B. Identify knowledge factors in healthcare processes utilising knowledge management concepts and relate these with object location context.

C. Design an approach for knowledge management in patient based healthcare processes by investigating location context through mobile technology.

D. Develop an enterprise architectural framework for healthcare processes which involve patients' movement by linking healthcare processes, location contextual information and knowledge factors.

E. Evaluation of context based knowledge management framework through a hospital based case study.

CLINICAL PROCESS MANAGEMENT

Patients' processes can vary according to structure, instances and context. Handling clinical process instances on a continuous basis with their parameterized values of patients' activities and events is a relatively critical task [5]. In process management selection of appropriate activities in such a manner that it reduces the complexity of whole patients' process is very typical [5]. Activities in healthcare can be associated with the location context of an object [9]. Objects, especially patients, and their related clinical details are subject to change their location for performing any medical operation within healthcare settings [19], [20]. It is a significantly difficult task to handle processes where objects are dynamic in nature according to their location [21], [22], [23]. Hence, formal representation of clinical processes and their classification in ontology that contain all noteworthy processes is appropriate [24], [25]. This formal clinical process classification can help to devise the control mechanism for appropriate handling of the dynamic objects [24]. Control mechanisms of the objects can manage the change events appropriately [25]. In clinical process management this appropriate change event handling supports proper resource usage and increases the ability to improve clinical services [5]. In this research, these clinical processes are mapped using enterprise architecture concepts and then these processes through their layers will be associated with technology automation and context for healthcare services improvement.

KNOWLEDGE MANAGEMENT

Information plays a significant role for continuous operation of any organization and knowledge plays a critical role for continuous growth of any organization [7]. Information properties are frequently referred to as: complete, relevant and timely [7]. Information is the backbone of any organization for smooth running of their day-to-day operation but knowledge is a critical factor for the continuous success of any organization [6]. Knowledge is frequently defined in a business context as actionable, based on a person's experience and relevancy in any given circumstances [6]. Knowledge is a critical factor for organizational growth that is typically ignored in various industries especially in the healthcare sector [6]. This is a basic

reason for defective or lack of supportive methodological architecture that results in inefficient knowledge management and problematic knowledge management implementation [9]. This is major hurdle preventing organizational learning [23]. Which is why, most frequently it fails to develop, exploit, and capitalize on the organizational knowledge for healthcare process changes [26]. If these critical factors are identified through enterprise architecture layers then its analysis will facilitate linking and integrating the entire technology change process.

LOCATION CONTEXT

In this era of mobile computing the context awareness infrastructure and its application is highly important to achieve any organizational goal [6]. The location judgment of any entity is a relatively easy task but several objects within any organization can be bound in the process of executing the various organizational functions with continuous change of their location [19], [20]. This continuous, objects' location change and judgment of their context is relatively complex [19], [20].

Location deduction refers to finding out or giving physical location reference to an object [21], [22], [23]. Most of the time an object has two references (longitude and latitude) in respect to its location [21], [22], [23]. But in local settings it can work within customized ways through different sensor technology use. In this situation location reference parameters depend on signal strength system installation and local covered area map. [21], [22], [23]. In some scenarios objects may have a third reference (height) which refers to sea level in global systems but in local settings (such as flooring within a building) it can refer to a static base point reference [21], [22], [23]. Location deduction, while any object in motion, is one of the mobile technology research areas. Motion deduction and object position could be handled through assigning various properties with respect to object location [24]. This context assigning to an object gives information to a system about an object in many ways [25]. Context aspect can have many parameters and the object itself could contain many contexts for only one position at any particular time that makes this scenario complex [27]. Different signal technology can be used for deduction of the position of an object; it depends on the scenario and usability of an object position [25], [27]. The context aspects with signal technology give rise to security and confidentiality issues for handling the IT application and its use in a real environment [25]. In this research, patients/staff data will be considered in the proposed framework for context handling in healthcare. Confidentiality and security issues will be considered in handling the healthcare data. Signal technologies that have been considered include Bluetooth, GPS and electronically handled hardware devices such as RFID (Radio Frequency Identification) [27]. RFID can be further distributed into simple and active RFID, with this technology deduction of objects' location and any change in their positions with respect to time is possible [28], [29]. In this research project the location context will be dealt with through RFID technology to address the deduction issues of an object.

DISCUSSION

Healthcare organizations such as hospitals are modifying their functional philosophy to become enterprise-based organizations [30]. Healthcare systems often sustain the medical staff and improve their daily routine through IT projects implementation, facilitating steady growth [31]. Through healthcare organizations, especially multidisciplinary hospitals, adopting modern information technology with proven concepts from commercial business organizations, may help to decrease costs and improve quality of medical processes [6], [30]. Hospitals have many complex process structures, similar to commercial organizations [6]. These processes may be routine processes, for example patients' admission and patients' scheduling for their operation dates while other processes may occur in certain circumstances for example when a porter does not turn up on time for a particular patient's transition. These processes can be organized and maintained through automated technology services [32]. A healthcare organization such as hospital needs to manage these objects in a more detailed way. A process involving patients' treatments at different locations and times can be detailed by deterministic patients' movement within the hospital [32]. However when unforeseen situations occur, these deterministic patients' movement cannot cope without an automatic location detection system.

Patients' movement management is a very important function in healthcare settings and can be analysed and mapped through business organization process modelling. It is especially vital for smooth and constant flow of patients for their medical treatment within a hospital [8]. In situations when exception conditions result in process execution being threatened then integration and detailed knowledge about objects is very necessary [5], [9], [23], [24], [33], [34]. Moreover objects may constantly change their status through other objects' behaviour [5], [19]. For normal behaviour of the overall system, it is necessary to deduce location within their context and integrate all objects to optimize a process [31].

METHOD OF INVESTIGATION

The investigation utilises a qualitative approach combining literature review as well as document analysis, observation, and analysis of paramedic experience in the healthcare setting. This is used to identify key aspects of healthcare that involve the movement of patients. These are discussed in enterprise architectural concepts [1], [2], [35].

Similarly knowledge factors in healthcare processes are identified and discussed in terms of knowledge management concepts [30], [31]. Based on this an approach for improving healthcare processes through linking location contextual information and knowledge factors will be designed. This framework is intended to integrate healthcare processes, procedures and activities through location-based knowledge resulting in systems that improve healthcare.

A case study approach will be used to evaluate the framework by producing a prototype location context knowledge management framework within the hospital environment for selected patient processes.
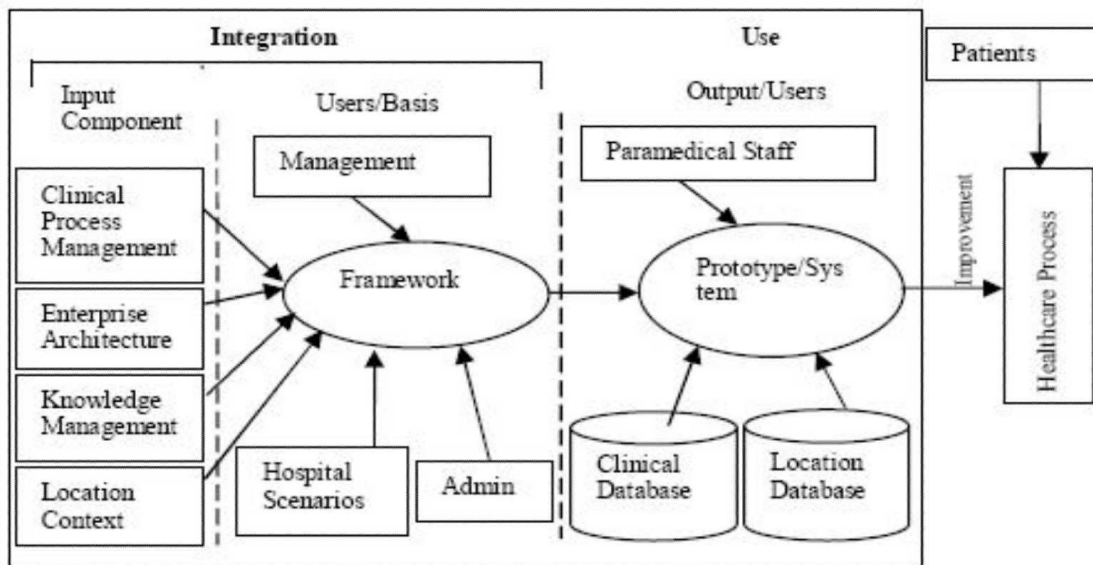

Figure 1. Context Based Knowledge Management for Healthcare

A UK hospital is being used for this evaluation and they have agreed to provide the required information for analysis, modelling, and partial prototyping.

EXPECTED OUTCOME OR FUTURE WORK

This research project will result in a framework for healthcare management, which will help to make decisions in adoption of location deduction technology for patients' movement for medical treatment. Hospitals will be able to understand the role of these technologies in enhancing knowledge management. This framework will provide appropriate structure for knowledge management in healthcare in conjunction with patients' movements. This framework will exploit object location deduction technologies for improving healthcare services.

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