

Healthcare Knowledge Management Through Building and Operationalising Healthcare Enterprise Memory

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Abstract. In this paper we suggest that the healthcare enterprise needs to be more conscious of its vast knowledge resources vis-à-vis the exploitation of knowledge management techniques to efficiently manage its knowledge. The development of healthcare enterprise memory is suggested as a solution, together with a novel approach advocating the operationalisation of healthcare enterprise memories leading to the modelling of healthcare processes for strategic planning. As an example, we present a simulation of Service Delivery Time in a hospital's OPD.

1. Introduction

The role of information technology in healthcare is well-established, yet the practice of medicine is becoming so complex that it is consistently pushing the sophistication of information technology tools and techniques to newer frontiers. Lately, there is a growing demand from the healthcare community to leverage upon and transform the vast quantities of healthcare data and information into value-added, 'decision-quality' knowledge. Indeed, the healthcare enterprise is coming to terms with the prevailing sentiment that in an IT-driven world, knowledge is one of the enterprise's most significant asset.

The task at hand now is to identify a knowledge environment that supports mechanisms to not only create or even capture viable healthcare knowledge and experiences but also to operationalise them to positively impact the healthcare enterprise. This brings into relief the need to establish the role and significance of the emerging methodology/technology of *Knowledge Management* in healthcare.

In this paper, we present a case for the possible synergy of knowledge management techniques in the healthcare domain. Capitalising on knowledge management services and processes, we propose the concept of the *healthcare enterprise memory*—akin to organisational memories—that can support the sharing and reuse of individual and enterprise-wide knowledge, experience, and lessons learned. We show that a healthcare enterprise memory can provide a number of knowledge-oriented services, such as automatic dissemination of knowledge, reuse of knowledge and experience, support of intelligent knowledge management services, timely provision of knowledge and experience, transforming information to action, connecting and converting knowledge and above all *healthcare modelling*. We conclude that the synergy between healthcare enterprises and knowledge management brings about a win-win situation, thereby realising a knowledge-theoretic healthcare environment.

2. Understanding Knowledge Management in a Healthcare Context

In a healthcare context, *Knowledge Management (KM)* is the formal management of knowledge for facilitating the creation, identification, acquisition, development, dissemination, utilisation, and preservation of a healthcare enterprise's knowledge using advanced technology [1, 2]. KM also involves converting knowledge from a healthcare enterprise's sources (individuals, groups, data and text) and connecting healthcare participants (healthcare professionals, management and patients) with that knowledge [3].

A typical KM framework [4] consists of a number of processes in a cyclic arrangement. For our discussion, we regard *creation* as the initial process of the KM framework:

1. *Create*: Responsible for the creation of healthcare knowledge, possibly through trial-and-error or blind variation and selective retention methods.
2. *Identify*: Determines the existence of useful healthcare knowledge from the knowledge created in the earlier process. This can be achieved through mining efforts similar to that of data mining and knowledge discovery.
3. *Collect/Acquire*: Once useful knowledge has been identified, next follows the process of acquiring the knowledge.
4. *Organise/Develop/Preserve*: This can be viewed as a form of 'knowledge processing' whereby the knowledge is transformed, represented, and organised in a defined format.
5. *Share/Disseminate*: Provides the mechanisms to disseminate the stored knowledge to all participants of the healthcare enterprise and possibly to other healthcare enterprises.
6. *Adapt*: This process is typically the responsibility of healthcare professionals in their practice. Upon introspection of the 'created' knowledge healthcare professionals may then need to tailor it to ensure appropriateness, currency and accuracy.
7. *Apply/Utilise*: This process is, again, the responsibility of healthcare professionals. The success of a healthcare KM framework depends on its success in providing knowledge that is effective in meeting the demands of the healthcare enterprise.

In order to face various internal and external challenges in the healthcare environment, KM-based applications, such as healthcare enterprise memories, could be mobilised to facilitate the management of healthcare knowledge.

3. Healthcare Knowledge Management Using Healthcare Enterprise Memory

Central to most practical, context-sensitive KM solutions is the *Healthcare Enterprise Memory (HEM)*—a structure similar to an organisational memory [5]. HEM can be envisaged as a systematic confluence of various knowledge bases, managed by a common infra- and info-structure that can be operationalised to deliver a variety of knowledge-driven strategic services. HEM provides the functionality to store, share and re-use individual and organisational knowledge, experience, and lessons learnt [6].

Effective healthcare knowledge management is achieved by the HEM in a number of ways such as through automatic dissemination of knowledge, reuse of knowledge and experience, support of intelligent knowledge management services, timely provision of knowledge and experience, and the transformation from information to action. [2, 7, 8]

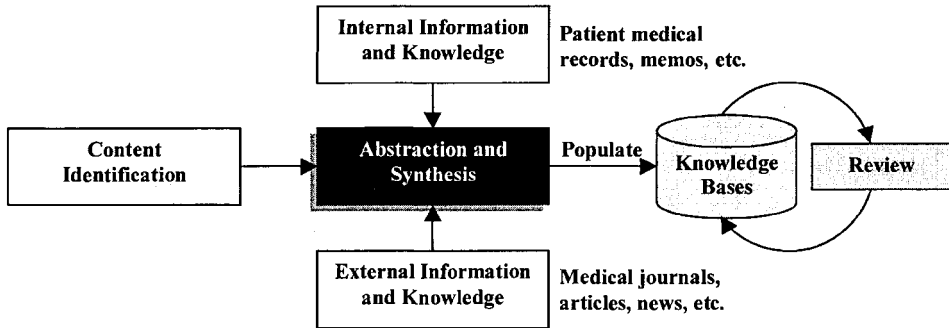


Figure 1. A Knowledge Base Creation Environment [1]

4. Building a Healthcare Enterprise Memory: A Model

The term ‘building’ here refers to the modelling of an HEM with emphasis on knowledge representation, ontologies and creation of knowledge bases. In simple functional terms, an HEM can be created through the process of identifying, capturing and leveraging formal (e.g. texts and documents) and informal (e.g. experience and lessons learnt) medical knowledge from internal and external sources (see Figure 1).

According to Figure 1, the healthcare knowledge bases are to be populated by the abstraction of internal and external healthcare information/knowledge based on certain content identification criteria. The synthesis process transforms the abstracted knowledge into a formal representation scheme that renders it operable by computer systems. Finally, the emergent knowledge bases undergo a process of review or update to ensure the validity and consistency of the extracted knowledge.

For our purposes, we propose a four-layer HEM model:

1. *Object Layer*: Consists of various healthcare information and knowledge sources. The sources may be formal (machine-readable) and/or informal (human-readable).
2. *Knowledge Description Layer*: Enables uniform and intelligent access to object-level resources. The main purpose of this layer is to facilitate accurate selection and efficient access to relevant healthcare knowledge in a given task context and situation.
3. *Application Layer*: Models and executes processes and tasks. The HEM’s services can be realised in different ways, ranging from dedicated programs (which perform a well-defined task) to flexible query interfaces. These include medical protocol models and healthcare work process management systems [9].
4. *Services Layer*: Providing specialised services to healthcare professionals or the public through the use of various applications.

Figure 2 illustrates a complete scheme of an HEM with a mapping of its four layers to KM processes, to KM technologies and to various AI technologies.

5. Operationalising Healthcare Enterprise Memory

Traditionally, healthcare policies are derived by taking into account on-the-ground information, resource constraints, lessons learnt and domain knowledge. However, the effects of any devised policy cannot be ascertained until it is applied and data (spanning over a considerable period of time) concerning its effects is obtained and analysed. We propose a novel and knowledge-driven approach to healthcare policy making whereby the

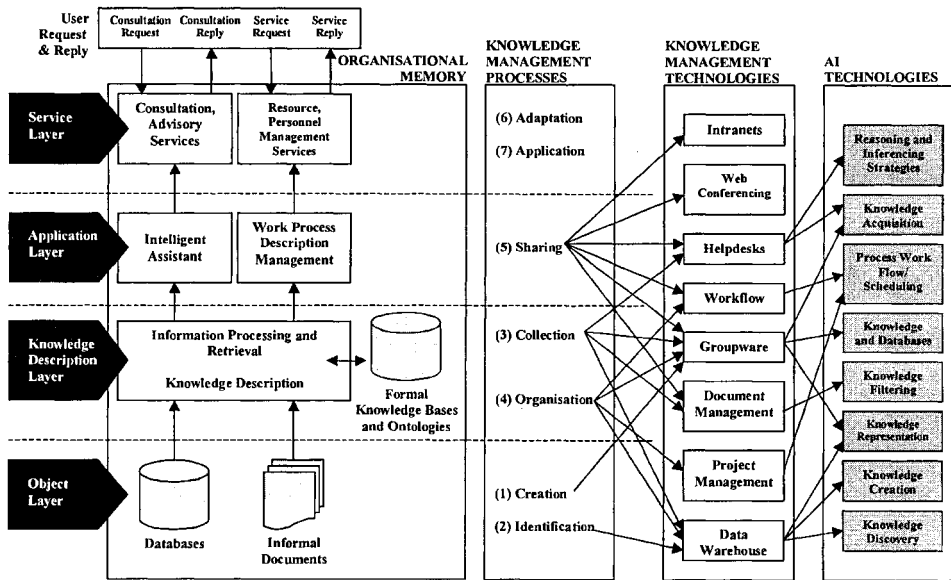


Figure 2. A model of the Healthcare Enterprise Memory, showing the mapping of the four-layers to KM Processes to KM Technologies and finally to AI Technologies

knowledge encapsulated within the HEM is operationalised to simulate specific scenarios and to analyse the effects of under-study 'policies' with respect to the simulated scenarios.

Healthcare modelling entails the development of a *healthcare process model* (addressing a specific goal or task). The modelling aspect entails the submission of different (experimental) values to the various parameters of the healthcare model and noting the influence of the parameter values towards the efficacy of the task/process being modelled. This strategy is akin, to some extent, to traditional simulation and modelling activities. However, the value-added aspect of our approach is that the healthcare model is derived from the manipulation of vast medical knowledge and outcome data contained within the HEM. Hence, it can be argued that healthcare modelling involving HEM is more informed, context sensitive, aware of relationships between disparate knowledge entities and realistic. Figure 3 identifies the process of healthcare modelling by operationalising healthcare knowledge, i.e. an HEM.

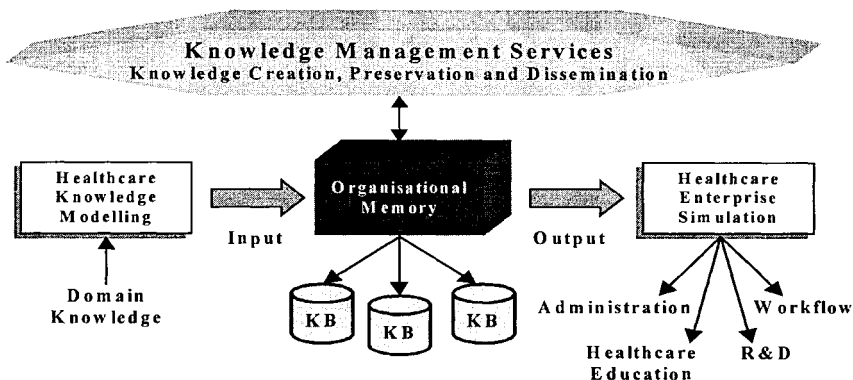


Figure 3. Illustrating the process of operationalising organisational memories

To substantiate our proposal for operationalising an HEM, we describe a modelling exercise with the evaluation of resources allocation and associated workflows in order to improve the *Service Delivery Time (SDT)* at an Out-Patient Department (OPD) of a government-based healthcare enterprise:

First, we need to examine existing workflows of the OPD for a patient seeking medical consultation. The SDT is a consequence of the fulfilment of *standard requirements* (such as the number of healthcare professionals available) in the OPD knowledge base.

To determine different SDTs, one can simulate the OPD workflow by varying the parameters in the OPD's standard requirements. Such simulations can identify the peculiarities of various standard requirements and the bearing of the various parameters in the eventual SDT. For instance, a simulation may yield that insufficient resources in terms of healthcare personnel and facilities are the main causes of *workflow bottlenecks*. In this manner, further solutions to workflow bottlenecks can be simulated by experimenting with different number of healthcare providers and noting the estimated SDTs.

6. Conclusion

The healthcare environment is generally perceived as being 'information rich' yet 'knowledge poor'. With advances in the domain of KM and the effectiveness of organisational memories, healthcare professionals and knowledge management experts could join efforts to venture towards the realisation of a 'knowledge rich' healthcare environment to enhance the effectiveness and efficiency of healthcare enterprises.

Indeed, this paper has identified the possible role of knowledge management technology in healthcare. Subsequent efforts need to focus on in-depth practical issues and applications of knowledge management techniques for meeting the ever-growing healthcare delivery demands. It is our contention that the healthcare domain can gain a lot by leveraging on existing and up-coming KM tools and techniques, and by working towards a synergy between healthcare enterprises and KM, leading to a win-win situation [10].

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