

# Towards Process Support in Information Technologies for the Healthcare Sector:

## The Context-Aware Methodology

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### Abstract

*Health Information Technology denotes an enormous potential to improve health care cost effectiveness and quality of care. However, health information technology has been failing to demonstrate its foreseen benefits, and its involvement in the care process is limited to specific fields. Several disadvantages of health information technologies have been reported. Partly due to the autonomy of most clinical departments, few health care processes have been modelled comprehensively enough to provide a basis for specifying software requirements to health information technology designers. Alternatively, health information technology designers have focused on supporting the work of individual care team members by taking existing paper-based tools, as their models. The result is that most health information technology does little for process support. Health information technology usability, and adoption in daily practice is closely related to the systems' semantic and technological interoperability. The trend in the health information technology field has been to push as much information as possible to the users, with a view to finding a solution. In this paper is discussed how the context-aware methodology can contribute as a solution to this problem, by enabling process support.*

### Keywords:

Context-awareness, healthcare, workflow, information technology, process support.

### Introduction

The potential of Health Information Technology (IT) to improve health care cost effectiveness, and quality of care, has been acknowledged for decades [1, 2]. However, health IT has been failing to demonstrate its foreseen benefits, and its involvement in the care process is limited to specific fields. Several disadvantages of health IT have been reported [3-7]. Additionally to the factors that contributed to such results, another reason may be found on the focus of health IT on improving individual tasks rather than supporting value added care processes. By supporting individual tasks, IT is focusing on the provider. This is a significant contribution to a lower quality and high cost health care. On the other hand, process focused care is centred on the patient. It integrates the team work (e.g.

patients, physicians, nurses, caregivers, managers, and administrative personnel) to provide high quality, and efficient care, throughout the full process. Value added care processes are the goal of the patient centred health care.

Health IT orientation to individual tasks reflects the focus of health care itself: The majority of clinical departments behave as discrete and independent sets of physicians, nurses, and other health personnel instead of a single team [8]. Partly due to the autonomy of most clinical departments, few health care processes have been modelled comprehensively enough to provide a basis for specifying software requirements to health IT designers. Alternatively, health IT designers have focused on supporting the work of individual care team members by taking existing paper-based tools, as their models. The result is that most health IT does little for process support [9]. By *process support* the authors refer to the support of interdisciplinary cooperation along with the patient pathway.

Hospitals are dependent on a wide and reliable communication infrastructure for exchanging different kinds of data, such as patient reports, lab tests and working shifts, together with text, voice and alarm services. The management of this information is difficult and requires considering a wide variety of problems that should be avoided in order to properly meet the needs of hospital professionals. In such scenario, context-aware systems present themselves as a promising approach for health IT designers.

This paper is divided in four section. In the first section, Introduction, is described how the lack of standardize process models is affecting health IT. In the Background section, is presented a brief literature review on evidence that some of the health IT, currently implemented in clinical practice, is unsuitable to its purpose, and is instigating a negative stigma in healthcare workers towards technology. In the third section, is presented the context-aware methodology, and, in the last section is discussed how this methodology can contribute to process support, and improvement of operational management.

### Background

Several reports of unsuccessful implementations of health IT can be found in literature, such as [10-25]. Hereafter, the most relevant reports are briefly described.

Dünnebeil et al. [18] studied the physicians' resistance to adopt health IT as a barrier for its diffusion, and explored the factors that influenced the physicians' attitude towards IT. The authors argue on the importance of standardization and process orientation as facilitators of health IT implementations [18]. Ash et al. [23, 24], also reported on unsuccessful health IT implementation due to resistance to change by the staff. This was identified to be a problem, especially when change was thrust upon them. Various predictable and unpredictable positive and negative behaviours were reported as a result [23, 24]. In this studies, the effort to establish standards and mandatory treatment processes are pointed as a major influence factor in the adoption of health IT.

The effects that EHR systems have on physicians' professional satisfaction was studied by Friedberg et al. [25]. It was reported that for many physicians, the current state of EHR technology significantly worsened professional satisfaction in multiple ways [25]. Poor EHR usability, time-consuming data entry, interference with face-to-face patient care, inefficient and less fulfilling work content, inability to exchange health information between EHR products, and degradation of clinical documentation were prominent sources of professional dissatisfaction [25].

The above described work identifies common signs that the implemented technology lacks process support. To complete care processes, health personnel work as a team, performing high risk tasks under uncertainty and time pressure. Therefore, processes that are not modelled and re-engineered consistently and without a careful analysis will replicate the existing inefficiencies and, ultimately, worsen them or create new ones which may lead to loss of patient safety [26]. Processes that are designed having a full understanding of: what they are meant to do, how resources act on it, e.g. their responsibilities and competences, how information is generated and required, and how they interact with other processes, provide the necessary knowledge for health IT to reduce inefficiencies and manage complexity.

## Materials and Methods

Let us start by defining context. To define context, we had to investigate some of the definitions given by the research community [27-31] over the years, and concluded that the most suitable definition for our research is [32]:

*“Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant for the interaction between a user and an application, including the user and applications themselves.”*

This definition shows the importance of which information is relevant or not in a context-sensitive system. A context-sensitive system could, therefore, be defined as a system allowing interactions between multiple entities using relevant information. In [32] they state that: *“A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task”*. This def-

inition shows that a context-sensitive system can change its behaviour and send some relevant information according to the context, which reflects our view.

The trend in the health IT field has been to push as much information as possible to the users, in order to provide more sophisticated and useful services while, at the same time, making users more available. During a preliminary research study on the Aware Media system [33], they suggested a classification that splits the above listed information along three main axes:

- Social awareness: 'where a person is', 'activity in which a person is engaged on', 'self-reported status';
- Spatial awareness: 'what kind of operation is taking place in a ward', 'level of activity', 'status of operation and people present in the room';
- Temporal awareness: 'past activities', 'present and future activities' that is significant for a person.

A context-aware system, as shown in Figure 1, comprises two main modules:

- Context engine: This module interfaces with other information systems and devices to collect raw data. These are then fed to an analyser to classify raw data and generate context data.
- Rules engine: This module acts as filter between the data and the user. By applying a set of pre-defined conditions that define what, when, and to who the information must be presented. Such rules can be defined manual or automatically.

The adoption of context-aware systems based on these definitions is growing in a variety of domains such as, smart homes, airports, travel/entertainment/shopping, museum, and offices, as mentioned in [34].

## Discussion and Conclusions

Health IT usability, and adoption in daily practice is closely related to the systems' semantic and technological interoperability. Such requires that the systems provide a comprehensive platform for process support. On the other hand, to provide this platform is required structured knowledge that is not currently available in the EHR systems in use in most Norwegian hospitals. The technological interoperability can be achieved by describing clinical guidelines using standardized languages. The context-aware methodology described above, can support both the knowledge and technological interoperability required.

A context-aware system can collect data not only from the EHR, but also from the other IT existing at the hospital. Such data can be then made available in different patient settings, and processed, according to rules, to generate new knowledge. A context-aware system can also learn from the user interaction with the system to automatically improve his/her experience. In this manner, a context-aware system is able to provide process support by analysing process related data from two categories: (1) what is done; (2) how it is done.

The progression of a patient in a clinical process is determined by the completion of the tasks that compose the same process.

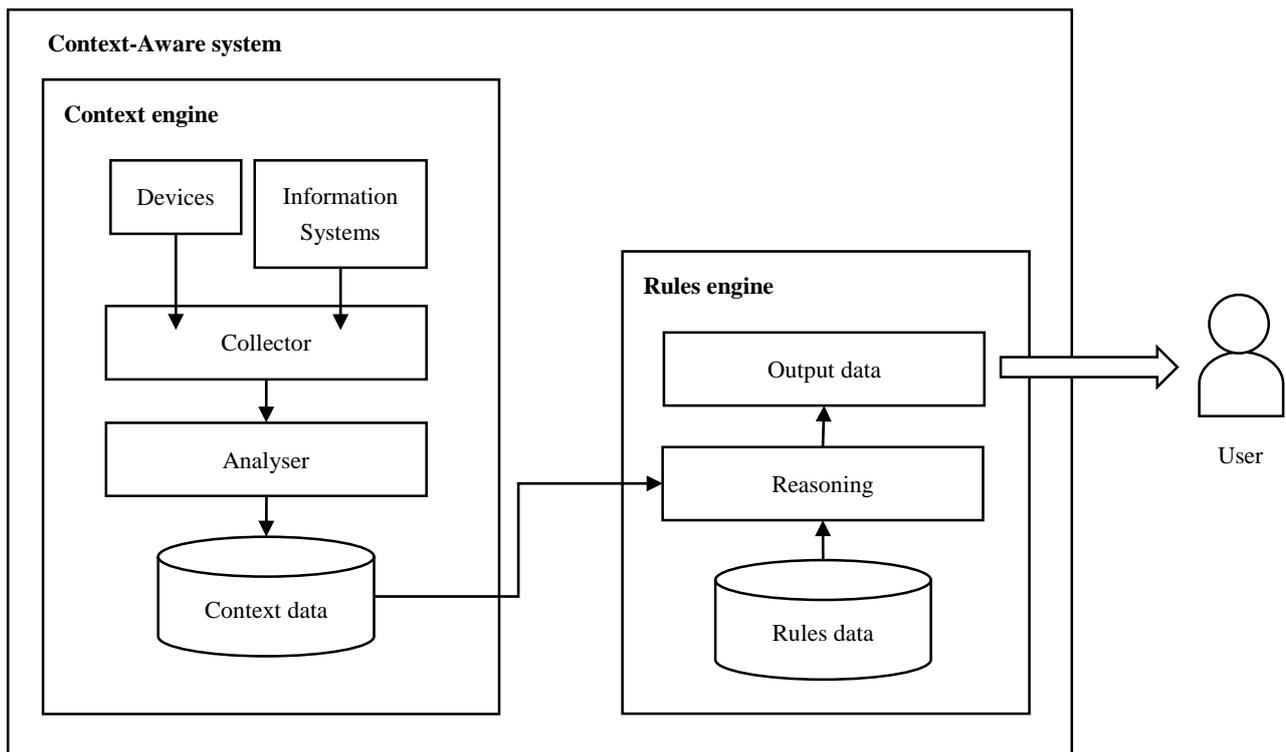


Figure 1 – Illustration of context-aware systems' basic architecture.

However, EHR systems are not always updated on the tasks' completion as different individuals evidence different work patterns. If technology is able to separate the process related data as described above, then it becomes possible to achieve adaptive workflows.

“What is done” can be described on the EHR, by translating clinical guidelines using a standardize language like OpenEHR archetypes. “How it is done” can be achieved by using machine learning techniques, fed with context data, to adjust the clinical

guideline to the individual user work pattern. The semantic interoperability is achieve through the definition of the data required to support workflow on the individual level to bring both concepts together using OpenEHR archetypes. An illustration of the system architecture is presented in Figure 2.

Context-awareness allows health IT to provide process support by manging the complexity inherent to clinical processes while supplying the technology with the process standards required to ensure usability.

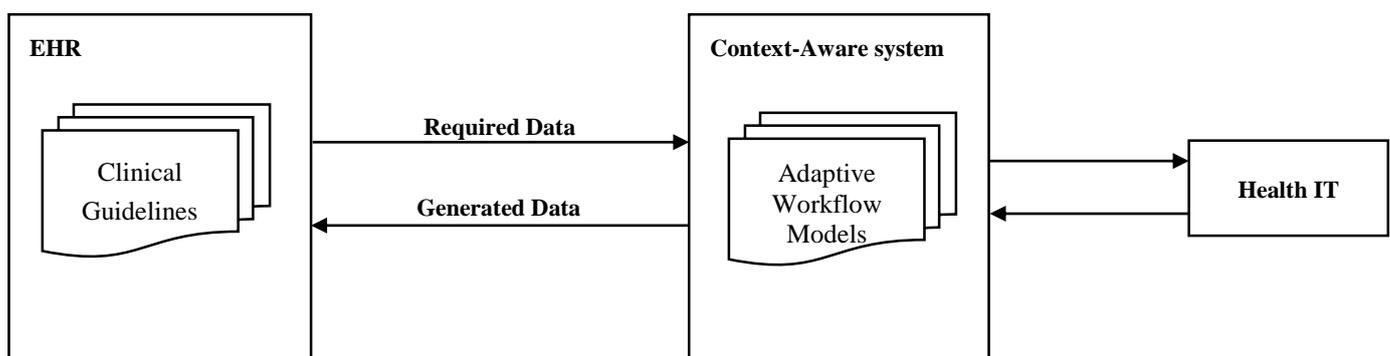


Figure 2 –Illustration of the proposed context-aware based health IT system architecture.

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