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What Makes an Information System More Preferable for Clinicians? a Qualitative Comparison of Two Systems

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Abstract. Two different information systems with respect to their ability to afford clinicians' needs in the chemotherapy medication process were implemented in a large Dutch academic hospital. A commercially available Computerized Physician Order Entry (CPOE) system was not appreciated because clinicians believed that it could not support complex chemotherapy process. Later, a home-grown IT system with the capability of prescribing chemotherapy medications based on standard care protocols was appreciated and fully used by clinicians. We evaluated both systems from their users' perspective to find the sources of clinicians' preference and to trace them back to their Systems Development Life Cycle (SDLC).

Keywords. Chemotherapy, information system, implementation, design, requirement analysis, qualitative research, user involvement, CPOE, SDLC

1. Introduction

There has been an ongoing discussion in the world of health information technology why and how an information system that was adopted in a healthcare setting successfully, fails to be adopted or is adopted sub-optimally in another setting [1]. Is it related to information systems' design, meaning that a System Development Life Cycle (SDLC) fails to address *user requirements,* which are very specific for every target organization? Or, is it because of the implementation methodologies, which also should be specific for every implementation site [1, 2]?

There is evidence to support the critical role of both design and implementation processes. Studies, for example, revealed that most of the successful implementation and use of decision support systems have been from those institutions that developed their own systems [3]. But, how system *development and design* can be such [if not the most] important factor in determining successful IT adoption and use?

Erasmus University Medical Center (Erasmus MC) implemented a CPOE system in all inpatient wards. Although the system was appreciated and used in most wards, it was not considered appropriate for prescribing chemotherapy medications. Clinicians in hematology and oncology wards continued to use paper-based medication system

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hoping their required changes come in the CPOE system redesign. Few years later, a home-grown IT system with the ability of prescribing chemotherapy medications using standard care protocols was implemented in all hematology/oncology wards of Erasmus MC. The system was appreciated and was fully used by clinicians. In this paper, we looked into the questions that "what made the second system more preferable to clinicians?" and "what lessons can we learn?"

2. Background and Methodology

Chemotherapy work can be considered a type of medication process; only it is more complex and takes longer. The complexity in the chemotherapy process comes mainly from the fact that chemotherapy medications have narrow therapeutic windows, necessitating more accurate dose calculation and adjustments, and because multiple parties are involved, making the process more vulnerable to coordination problems and inefficiencies [4]. Guiding patients throughout long-term care protocols as well as keeping high quality prescription records are also very important for chemotherapy process.

Erasmus MC is a 1237-bed tertiary academic hospital in Rotterdam, The Netherlands. A commercially available CPOE system (Medicatie/EVS® V 2.30) was implemented in all inpatient wards in 2003-2005. The system had the capability to generate alerts on drug overdoses, interactions, and double medications. We interviewed system users throughout the hospital; among them we conducted semi-structured interviews with 2 physicians and 2 nurses from the hematology/oncology department as well as with the project leader, between 2006-2007. The interviews were voice recorded, transcribed, coded, and analyzed for the emerging themes on *supportive* and *non-supportive* features of the system in the medication process. More information about our qualitative methods of data acquisition and analysis can be found in [5,6].

In 2007 a home-grown information system, named Kuren, was implemented in all the hematology and oncology inpatient and outpatient clinics, using the same implementation strategy as of the CPOE system. Kuren was designed by a Pediatric oncologist and before being implemented in adult hematology/oncology departments, its early version had been developed gradually and implemented in the pediatric oncology department of Erasmus MC for about 5 years. The system was designed specifically to plan chemotherapy courses based on medical protocols, to adjust chemotherapy medication doses based on patients' biometric indexes, and to provide decision support in following chemotherapy protocols. One year after the system implementation, we conducted 7 semi-structured interviews with system users (including 4 physicians, 2 nurses, and the project leader). During the interviews, we asked the interviewees to explain what characteristics of Kuren makes it more suitable for chemotherapy prescription process and if possible to compare Kuren with the paper based system and with the CPOE system. The interviews were voice recorded and transcribed. The transcripts were analyzed to find specific reasons for preference of Kuren and to find out more about possible non-supportive features of the CPOE system in chemotherapy process. More analysis on data was conducted by comparing of the preference reasons of Kuren to the non-preference reasons (non-supportive features) of the CPOE system in order to trace the source of differences to system design.

3. Findings

Both systems were implemented through more or less the same implementation strategies. The implementation of the CPOE system was seen overall in the hospital as success. However, the situation with respect to hematology/oncology wards was different. Although, the CPOE system had the capability of being used for prescribing chemotherapy medications, the clinicians thought this functionality couldn't support the complex chemotherapy process. Therefore, they preferred to continue to use paper-based system and wait for a better functionality of the system. On the other hand, although the interviewed clinicians reported a few problems in working with Kuren, they all liked the system and were very happy with the way it supported the chemotherapy process. Our data analysis revealed 13 reasons for Kuren preference that could be traced back to 3 differences in the SDLC of the systems (Table 1).

Table 1. Specific reasons because of them clinicians preferred Kuren, and their source in design process.

System Design Differences	Specific Reasons on Kuren Preference
Proximity of development site to implementation site	▪ Quick and easy communication of feedbacks from system users to system developers
User requirement driven design	▪ Reduced workload of clinicians (they did not have to fill in may forms and there was less double work) ▪ Easy to use (e.g., navigation through the system was considered easy) ▪ Flexibility (e.g., it was easy to perform changes to patient's already planed care) ▪ Reduced possibility of mistakes in clinicians' work (the system did exact and accurate dose calculation based on patients biometric indexes) ▪ Easy to find different pieces of patient information in the system ▪ Offering general overview of patient care (the general scheme of patient care was represented in one screen) ▪ Ability to link different pieces of patient information together (in a time related pattern) ▪ Providing decision support aid (providing information for clinicians on how to fulfill a step in a care process based on standard care protocols)
Process oriented design	▪ Support applying standard care protocols (physicians could choose a standard care protocol to follow or built their own protocols by combining different standard protocols) ▪ Support an overview of patient care (by connecting current patient care to past care as well as planned care) ▪ Support synchronization and coordination of the stakeholders where sequence of actions was important (e.g., through the system nurses knew which patients they should expect and what preparations they needed to do for patients before chemotherapy courses arrive at daycare center.) ▪ Support communication between the different stakeholders (e.g., the system provided biometric indexes measured by physicians to pharmacists in case they needed to double check the doses.)

3.1. Proximity of Development Site to Implementation Site

Following implementation, a system enters into maintenance phase in which not only possible errors with the system during its working life are recognized and eliminated, but also the system is tuned to its working environment. Some of the advantages of Kuren were related to the fact that it was developed onsite. Every comment and/or required change to the system could easily and quickly be communicated to the ICT department where the designer and the programmer could sit together to figure out how to adapt the system accordingly. In technical terms such a setting shortened SDLC. The situation was opposite for the CPOE system. The project team had the responsibility to collect the comments and problems of clinicians in working with the system and to communicate them to the system vendor. Twice a year all the countrywide clients of the CPOE vendor gathered in one city where they had the chance to discuss on the required changes to the system. The vendor then had to figure out how the system should or could be adapted in a way to be respondent to its users' needs in different working environments. Such structured way of SDLC inevitably prolonged the change process. By the time the changes were made to the system, users had already found their way out by *working around* the system [7].

3.2. User Requirement Driven Design

A thorough user requirement analysis and user involvement is fundamental and prior step to every good system design. We could trace back some important differences between the two systems to the way their user requirements were analyzed and the result were fed into system design and redesign processes. The designer of Kuren was an oncologist, someone with thorough knowledge of chemotherapy work requirements, and someone who has enough experience in working with the paper-based system that was going to be replaced by Kuren. He, moreover, was in close contact with other users and could relatively easily get their feedbacks. This setting created a short cycle of evaluation and consideration of users' requirements in the design and re-design processes of the system. The result therefore was a specific system for clinical context of Erasmus MC that could respond to many of the clinicians' needs. Considering users' concerns in adjusting the system moreover created a sense of system ownership among the users and brought their commitment and close collaboration as a result. Such setting never existed for the CPOE system. Many of our interviewees had complains and/or concerns about the CPOE system. In fact, many of those complaints were never considered in the system re-design and remained as the system's inflexibility and less user friendliness characteristics. An oncologist noted: "*the CPOE system had an alerting system on drug-drug reaction but you had to calculate and combine the chemotherapy medications every time. You had to fill in the information every time. There was no information for physicians and nurses for example about side effects and the way the courses had to be administered.*" Contrary to Kuren, entering a new chemotherapy course and/or specifications about a course into the CPOE system could not be done without the help of a technical person.

3.3. Process Oriented Design

One of the Kuren's basic characteristics, which pleased its users, was its ability to tie different stakeholders' work into a single multidisciplinary care process. This was done at least by four means: First, the system supported using standard care protocols thus reduced variation in care practice concerning who should do what, when, and how. Second, it was connecting different episodes of patient care in the past to planned care episodes in the future along a timeline, giving a general overview on patients past, current, and future care. Third, it improved communication between different parties throughout the process; thus the clinicians did not have to make many phone calls for the purpose of information gathering. Fourth, by providing necessary information from one party to the other, the system helped different stakeholders to synchronize and to coordinate better in their interdependent work. On the contrary, we detected many communication problems between the clinicians in working with the CPOE system [7]. The CPOE system, in general, could not support inter-professional work [6] and the patient care process as a whole appropriately. An oncologist explained: "*The CPOE system was based on taking only a single chemotherapy course every time you visit a patient. You could not take a chemotherapy strategy for the patient [at once]. You could basically make a mistake by taking a wrong course for a patient. You also did not have an overview on patient care*".

4. Discussion

The two evaluated systems were considered successful. Kuren was the system of preference for hematologists/oncologists because it could support the complex chemotherapy process and managed its user requirements better. The advantages of Kuren were built into the system through a *user requirement driven* and *process oriented design* as well as due to *its onsite development*. Our finding in this study demonstrates the fundamental impact of an appropriate SDLC strategy on successful adoption of IT systems. They underscore the importance of *user involvement* and a comprehensive *user requirement analysis* in an IT system preference and success. A thorough understanding of a care process is required to design a system to support it. Such thorough understanding (especially if the process is a multidisciplinary one) will only develop gradually and through a close collaboration between system users and its developers. The study did not evaluate the financial aspect of onsite system development.

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