Improving Usability, Safety and Patient Outcomes with Health Information Technology
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Improving Access to Healthcare with On-Line Medical Appointment System

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Abstract. Access to medical care is in many countries an obstacle to timely health care and new technological options for improving the access are not fully utilized. In this project Business Process Modelling and Notation (BPMN) is applied to obtain an efficient, flexible and low cost medical appointment system for a medium size medical centre.

Keywords. Appointment scheduling, Business process reengineering, healthcare access.

1. Introduction

The use of healthcare services is significantly impacted by access to the services, and a multitude of issues influence the behavior of the individual. Ronald Anderson et al. provided a conceptual framework for analyzing access and equity in health care [1] stressing that improving access to care is best accomplished by focusing on contextual as well as individual determinants. Contextual determinants are measured on an aggregate level and encompass community characteristics, health organization and provider related factors in recognition of the importance of community, the structure and process of providing care [2]. Individual determinants consist of biological imperatives (sex, age, genetics) influencing the need for health services, and social factors determining the status of a person, along with the ability to cope with presenting the problem and dispose of resources to deal with the problem (education, occupation, ethnicity) [1].

A key enabling factor to access health care services is in the contextual determinant health organization when establishing the contact. Traditionally medical appointments have been made over the telephone or by showing up in person at a clinic. Schedulers or secretaries have answered calls and by verbal communication this method has allowed for maximum flexibility in dealing with complicated cases. As these methods depend on schedulers the ability to make an appointment is limited not only by the available time slots, but also by the number of phone lines and schedulers. However, web-based appointment systems have been popular, and several studies have conducted satisfaction surveys [3].

Health institutions often acquire Web-based medical appointment systems as software as a service (SaaS), but proprietary scheduling systems are also seen as integrated

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into patient portals on provider's web sites. Implementation processes of standard software solutions are often challenged by integration problems of technical as well as organizational and cultural nature. Business process reengineering can be an approach to to identify possibilities for improving the design of medical appointment systems: from "as is" to "to be." The aims of this process redesign are to improve the process of making medical appointments for small or medium size medical clinics or centers – a critical aspect to increase healthcare quality, efficiency, flexibility and decrease cost.

2. Material, theories and methods

Business Process Management (BPM) is a method that demonstrates ability to deliver improvements in organizational performance, service quality and regulatory compliance. When a business process is coordinated and logically sequenced, which is the case in most health care systems, it will produce value to a client or customer. Hence it is the hypothesis that the health care systems can benefit from applying BPM approaches.

An advantage is that BPM provides a shared language to Information Technology (IT) specialists and business stakeholders communicating with each other. BPM puts more emphasis on the use of information technology as a tool to improve business processes. Two often quoted rules from Bill Gates says: "The first rule in any technology used in a business is that automation applied to an efficient operation will magnify the efficiency. The second is that automation applied to an inefficient operation will magnify the inefficiency". His focus on contextual issues indicates that learning how to design and improve processes is important, not only building an IT system [4]. This contextual focus can be obtained by utilizing Business Process Modelling and Notation (BPMN) as it supports both technical users and business users to manage healthcare processes by providing a notation that business users and technical users understand. The BPMN specification provides a mapping between the graphics of the notation and the underlying constructs of execution languages, particularly Business Process Execution Language (BPEL) [5].

The purpose of process redesign is to identify possibilities for improving the design of a process: from "as is" to "to be". Each process redesign generally improves one side of the devil's quadrangle [4], and detriments of others along the dimensions of cost, flexibility, time, and quality, which are the basic measurements for assessing business activities. Companies compete in the marketplace by one or more of the measurements. The devil's quadrangle can help the healthcare industry to be aware of particular problems in term of time, quality, cost, and flexibility as performance indicators.

The proposed medical appointment system is designed for small or medium size medical centers (clinics) with a reception assisting the user to administer data sets. Make or modify appointment is the chosen target process for this project. The design process is improved by using the Business Process Modelling and Notation (BPMN) method. The strengths and weaknesses was analyzed using several heuristic design principles and the devil's quadrangle model from Dumas [4].

3. Results

The medical appointment process has been improved by introducing an online medical appointment system. It has a highly efficient set of management tools to synchronize, computerize and systematically record data assisted by the use of Internet websites.

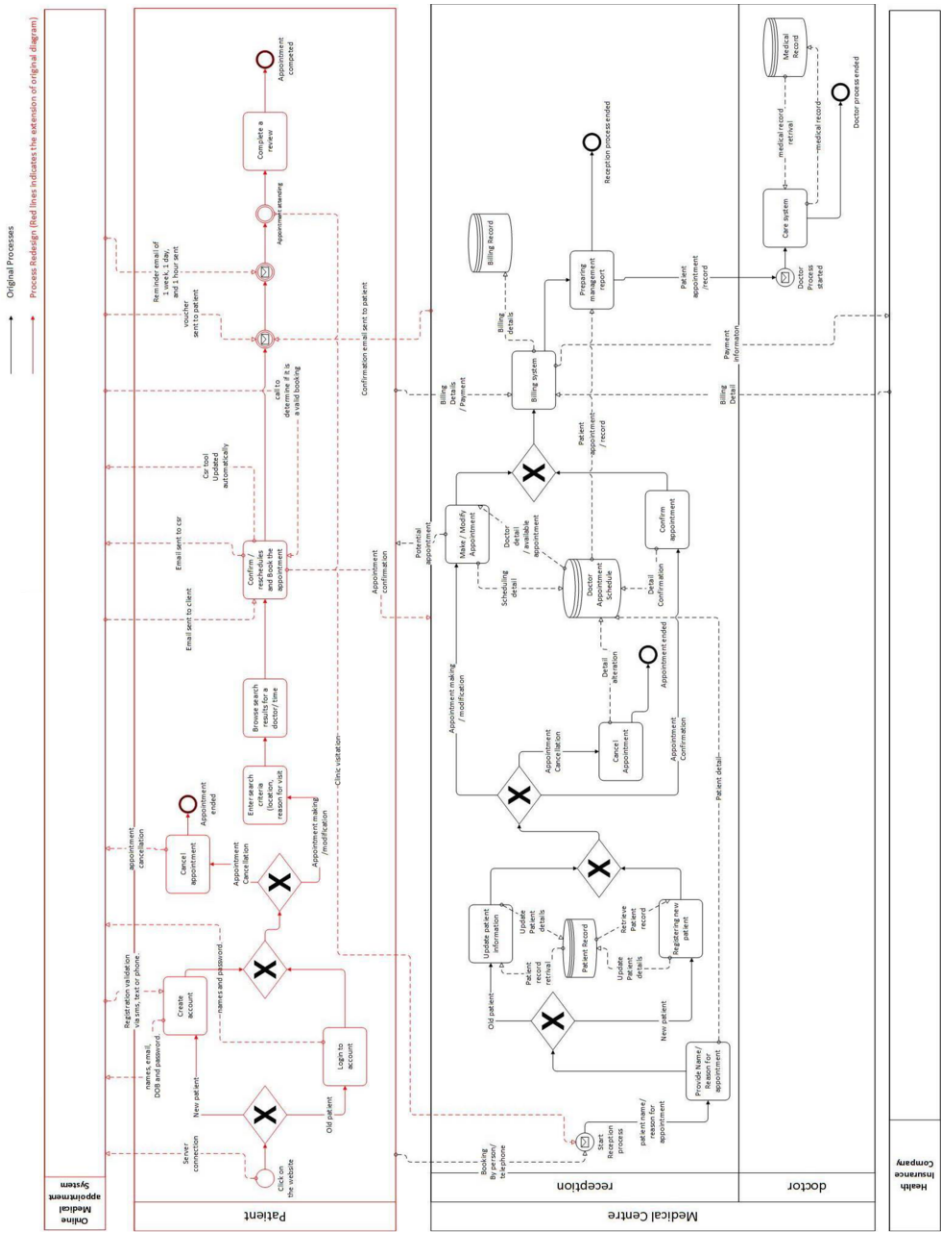

Figure 1. Medical Appointment System (BPMN workflow diagram)

Figure 1 shows the diagram of a medical appointment system of a medium size medical centre with the reception assisting user to administer a huge amount of data

The medical appointment system based on BPMN describes the process of patients making medical appointments using both traditional method and online system.

Online appointment features allow patients to make the appointment through internet, and doctors can manage their schedule online. The online schedules show information such as the doctor's working hours, specialty, available and unavailable appointment times etc. The patient uses the online system to request an appointment. Emails from doctor and the online appointment system will be sent to patient to confirm the appointment. Continuous reminders are sent until the patient meets the doctor.

The process redesign is a combination of incremental improvement and extension of the existing process. The online medical system will dramatically improve measures of performance, such as service, cost, speed, and quality. But it doesn't disregard the existing procedures and structures. Therefore, radical redesign is not the method of reinventing business processes. It is an extension of the existing process, because all processes are kept as shown in Medical appointment system (BPMN). There is an addition of a pool in BPMN namely "online medical appointment". And patients will be the primary person in managing their appointment booking with health practitioners. This process extension requires continuous incremental improvement, as doctor, staff and patient need to learn and adapt to the new system.

There are at least eight principles identified in this target process redesign: Control relocation, Outsourcing, Integration, Parallelism, Activity automation, Integral technology, Interfacing, Centralization, Empowerment. Four of these are particularly relevant to the medical appointment system, and are selected for further analysis and evaluation. The results are summarized in Table 1

Control relocation – Patients take control over which doctor and the time for the appointment. It improves flexibility for the patient as they can make an appointment online without restricting to business hours. It also improved patient satisfaction. However, there's a high probability of patient misusing the system.

Parallelism - Activities can be carried out in parallel especially when greater speed is required during the busy business hour. Overall, parallelism leads to improved performance, reduction of waiting times, reduce throughput time and better use of capacity.

Activity automation/ Integral technology - Online medical appointment technology is deployed to alleviate physical constraints in a business process. It reduces the time that the receptionist spends on electronic work. The online system provides a better quality of service. Activities can be executed faster, increase communication speed, increase information availability, reduce duplicated data entry, reduce human error and offer a more predictable result. However, the cost of implementation, training, and maintenance efforts related to technology can be high. Workers' reluctancy to adopt new technology may decrease the quality of the business process. Another risk is that the Internet can be unresponsive, resulting in a failure to make an appointment. Furthermore, as a patient-focused organization, Healthcare institutions may need to personalize their systems and provide special attention to those who are vulnerable and less technically advanced to ensure fair distribution of resources and care.

Table 1. Characteristics of the business process operation heuristics

	Time	Cost	Quality	Flexibility
Control relocation	Neutral	Negative	Positive	Positive
Parallelism	Positive	Negative	Neutral	Negative
Activity automation	Positive	Negative	Positive	Negative
Integral technology	Positive	Negative	Positive	Positive

The three redesign principles on each of the four performance dimensions of Devil's Quadrangle were further analysed and evaluated. The dimension of time, quality and flexibility will improve dramatically. The biggest drawback of introducing parallelism, control relocation and Activity automation/Integral technology is increasing in cost. However, if utilising other redesign principles identified in this medical appointment systems, further improving the Devil's Quadrangle and reducing the cost may be possble.

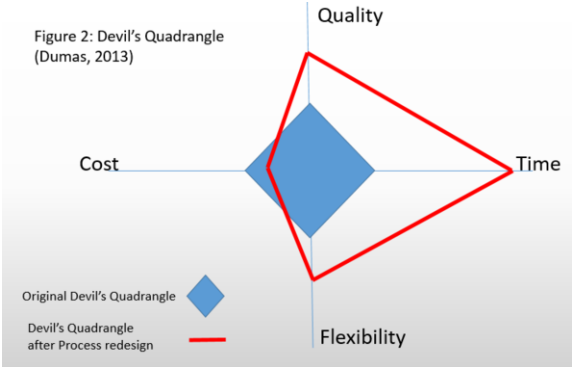

Figure 2. Devil's Quadrangle analysis of achievements of process redesign

4. Discussion and conclusion

This study addresses the use of BPM to deliver improvements in medical appointment systems. It also suggests that medical appointment process will be improved by introducing an online medical appointment system as a result of analyzing the process using BPMN. After evaluating the three redesign principles on each of the four performance dimensions of Devil's Quadrangle, we have discovered that the dimension of time, quality and flexibility will be improved significantly. Nevertheless, the biggest issue of introducing parallelism, control relocation and activity automation/integral technology is cost.

There's a need to further identify issues on the way and resolve them incrementally. Healthcare organizations should analyse the trade-off by using "as is" and "to be" process model. Whether building the system in-house or purchase commercial software, it is highly recommended to tailor the medical appointment systems process ultilising BPMN and other redesign principles identified in this study. There is a good possibility of further improving the Devil's Quadrangle may occur. Using redesign heuristics continuously is necessary in a highly complex and dynamic healthcare system.

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