

# Using BPMN to Model a Patient Safety Promulgation Service Based on a Clinical Process

Way-Ren Huang<sup>1</sup>, Ruo-Chia Tseng<sup>2</sup>, Yung-Fu Hsu<sup>1</sup>, Tso-Ying Lee<sup>3</sup>, Woei-Chyn Chu<sup>1,\*</sup>

<sup>1</sup> Institute of Biomedical Engineering, National Yang-Ming University, Taipei, Taiwan.

<sup>2</sup> Department of Molecular Biology and Human Genetic, Tzu Chi University, Taipei, Taiwan.

<sup>3</sup> Nursing Department, Cheng Hsin General Hospital, Taipei, Taiwan.

Received 16 March 2015; received in revised form 20 April 2015; accepted 02 May 2015

## Abstract

In this paper, we used business process modeling standards to enhance the development of a patient-safety promulgation process with a web service. A web service that is related to a work process is typically in an organization that has been designed, built and stored in a web service repository. The purpose of using a web service is that it can be shared with multiple functional units within an organization via an Intranet. This paper further develops this approach and discusses the use of a visual modeling language to describe a clinical workflow clearly. The final outcome is business process re-engineering and is presented as a business process modeling notation. The workflow management we designed integrates a process for each functional unit in the organization to customize the workflow requirements that suit their needs. 748 cases had been notified among 13 months, the system play its role well even when notify proceeding had been changed.

**Keywords:** workflow management, web service, business process modeling notation

## 1. Introduction

In the early 20th century, we witnessed progress in modern manufacturing facilities, which could mass-produce and deliver products to large audiences in an unprecedented manner and speed. Although this type of advance can be attributed to the development of telecommunication and advanced intelligent information technologies, establishing an optimal working environment and managing the required amount of work efficiently pose major challenges for business organizations. The reason for this challenge is because of the unstructured and unpredictable nature of demand and supply [5].

Developments in e-Commerce that are associated with the automation of the integration of heterogeneous systems and agent choreography can potentially answer some of the challenges in clinical workflow development. Workflow Management (WFM) or Business Process Modeling Notation (BPMN) has placed a large amount of attention on the need to improve the business process as well as the productivity of many organizations [6][9]. Having this approach move through the work force and allowing people to work in an optimal environment to produce a maximum output is increasingly important in business [3].

A business process is a series of business activities that describe how organizations produce and deliver special services to users, customers, or markets [8]. WFM is the way to

manage the flow of activities or events, which then pass to appropriate partners to produce the required products or services. It is an effective way of decreasing the risks of time delays, costly amendments, insufficient resources and human errors. However, traditional WFM concepts are difficult to implement without the assistance of information technology [4]. We describe a traditional (before) and e-commerce (after) promulgation process in Fig. 1. Therefore, we use the BPMN to define, create and control a workflow by running it through a workflow engine. Thus, the BPMN includes a process design, a process enactment and a system configuration [6].

In our study, we propose the use of a promulgation process of web services to support the workflow management. In the proposed promulgation workflow management (PWM) design, we describe promulgation architectures with a BPMN, and we use a Business Process Execution Language (BPEL) to approach the web service.

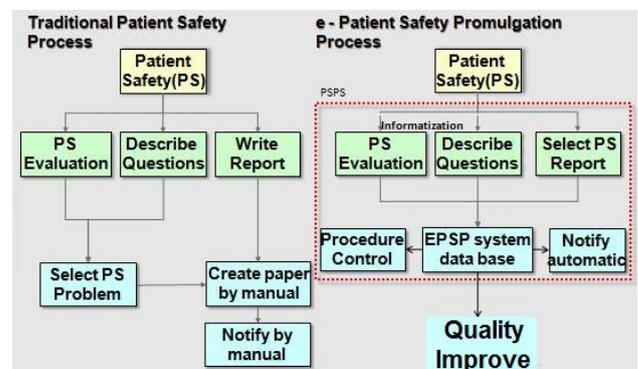


Fig. 1 Architectural diagram of the relationships of traditional and electronic patient safety architecture

## 2. Methods

Design science is a technology-oriented paradigm that has its roots in engineering and the sciences of the artificial. Whereas natural science attempts to understand reality, design science attempts to create things to meet certain desired goals [1].

Generally accepted activities in design science are to Build and to Evaluate. Build is the process of constructing an artifact to meet specific goals while Evaluate concerns how well the constructions achieve the purpose. Typical results in design science include construct, model, method and instantiation [2]. The following three languages have been considered to have adequate support for the workflow

modeling that is required in clinical settings: BPMN, Unified Modeling Language (UML) and the XML Process Description Language (XPDL). According to our experience, we chose BPMN because of its simple and clear diagrams, its formalizations, its native support for web service invocations, and the availability of workflow engines.

We constructed Promulgation Workflow Model (PWM) architecture (Fig. 2) between a clinical process (Fig. 3) and a BPMN in the build phase, and as expected, this architecture was quite straightforward. For example, the main process showed the general concept of the promulgation process; a sub-process or tasks may be used to model the clinical activity, the gateways for various clinical decision points and a pool or lane for clinical roles (e.g., nurse, head nurse, supervisor nurse, director associate, director, and quality manager (administrators)).

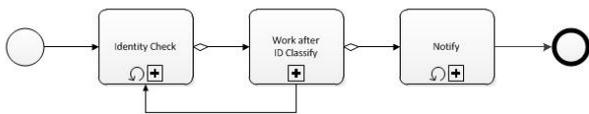


Fig. 2 The main process of the promulgation workflow model (PFM)

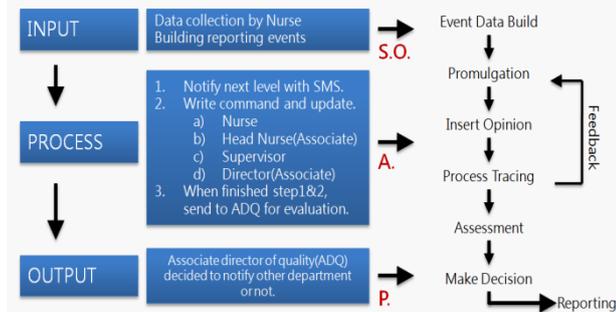


Fig. 3 This framework integrated the concept of a clinical pathway (based on the Subject, Object, Action, and Plan) and the workflow

Our System uses MSSQL as the database server and C # and Business Process Execution Language (BPEL) as the web design languages. In this implementation, we attempt to utilize the current hardware resources of the organization.

### 3. Results

In the clinical promulgation process of a hospital scenario, when an accident event occurs, the duty nurse must write all of the contents of the accident event and notify her/his executive and then follow-up on the process or event. If the event occurs during the promulgation process, then there are several opinions that will be filed on the event by different people. Finally, when the inner department's promulgation process is completed, the administrator must decide on the end of the process or let it into the outer department's promulgation process (Fig. 3).

It is difficult for medical nurses to accomplish these tasks, especially when they are in a health care environment. This difficulty will increase the time delays and human errors and decrease the quality of the medical care and the patient satisfaction. Furthermore, it is difficult for those people who must file their opinions. However, the additional requirement for a nurse to work more carefully and precisely is likely to increase

their work stress and, consequently, the numbers of mistakes made [7].

#### 3.1. Architecture of BPMN

For the above reasons, the design of the PWM architecture must be easy and clear to promulgate the accident events. For these reasons, we design a simple major process in the BPMN, which is shown in Fig. 2. We only define three sub-processes, which are Identify Checking, Work and Notify.

Identify Checking is the first sub-process, which is used to confirm the user identification and to take a user's commission for the next sub-process (Fig. 4).

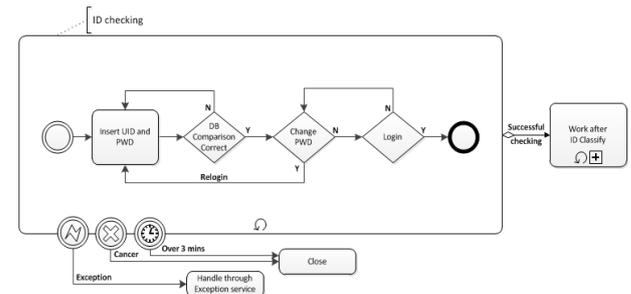


Fig. 4 The sub-process of ID checking

Then, the sub-process of Work (user management) runs when the identification is successful upon checking. The sub-process of Work classifies the users into three basic categories, which are based on their usages, their security clearance levels and the functional tasks of the process (Fig. 5).

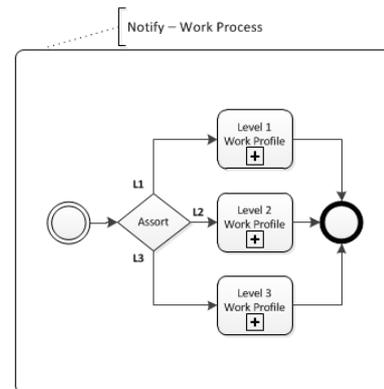


Fig. 5 The sub-process of Work

The first category (Level 1) is the end-user (duty nurse), who initiates the promulgation process, builds the event details, and signs the event number (Fig. 6).

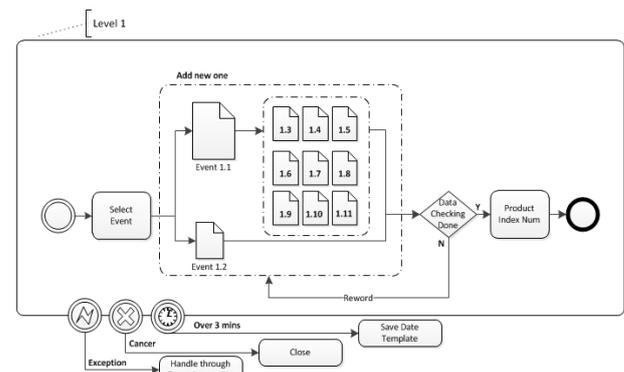


Fig. 6 The sub-process of Level 1

The second category (Level 2) is the director associate, supervisor, head of unit or department nurse. Their responsibilities are to manage the flow of the business function and to control the information and the accessibility of the system to each employee (Fig. 7).

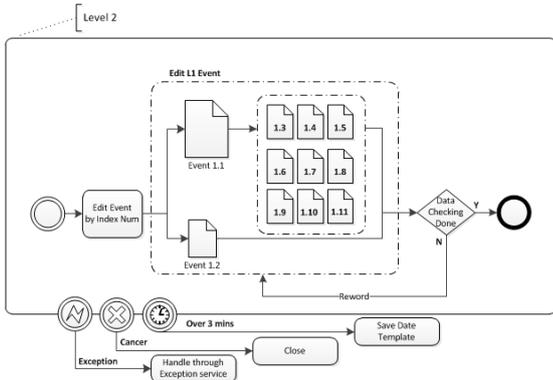


Fig. 7 The sub-process of Level 2

Finally, the third category (Level 3) is the administration staff, who supports and maintains the PWM system. They can break/cancel the process at any time and can decide whether the process ends in the department or not (Fig. 8).

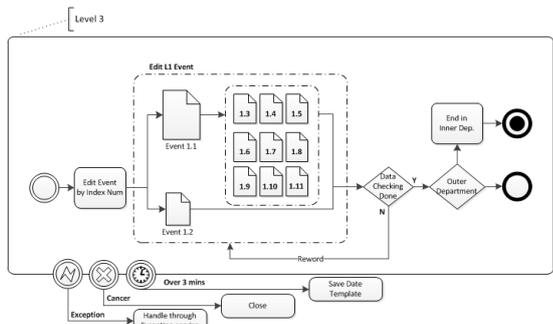


Fig. 8 The sub-process of Level 3

When the system checks whether the Work process is complete, the promulgation process will begin the process of sending message services and then will notify those who should receive notification (Fig. 9).

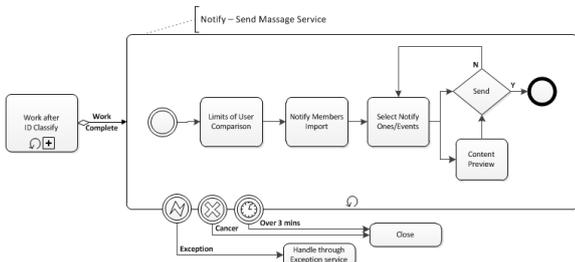


Fig. 9 The sub-process of sending a message service

The user management policy of the PWM is designed to protect private information and the assignment of security clearance to any users. The goals of the design are to help end-users work faster with greater efficiency and to make fewer errors compared with the traditional promulgation of workflow arrangements.

### 3.2. Interface Design

Based on a user friendly approach (human-computer interaction), almost all of the user interfaces are comparable to

the manual's specifications. In the system, we include the following 11 forms of accident event: Patient Accident (1.1), Remove Tube (1.2), Fall Down (1.3), Slash (1.4), Suicide (1.5), Violence (1.6), Med Err (1.7), Burn (1.8), Trans Blood Err (1.9), Operate Err (1.10), and Else (1.11). We show the real screen at 1.1, 1.2, and 1.3 in Fig. 10.

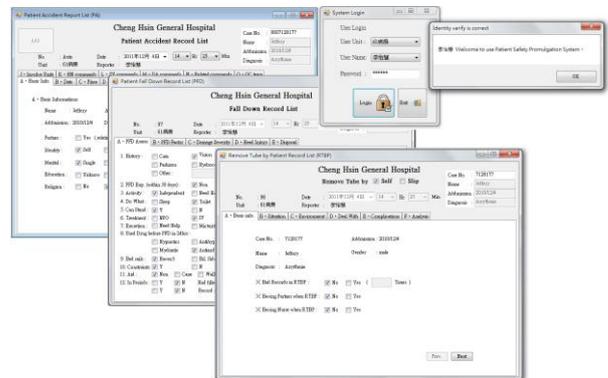


Fig. 10 Three forms at 1.1, 1.2 and 1.3

The end-user can easily use this system without considering the details of the workflow. The supervisor, director associate, head of unit or department nurse can also clearly track the process instantly (Fig. 11).

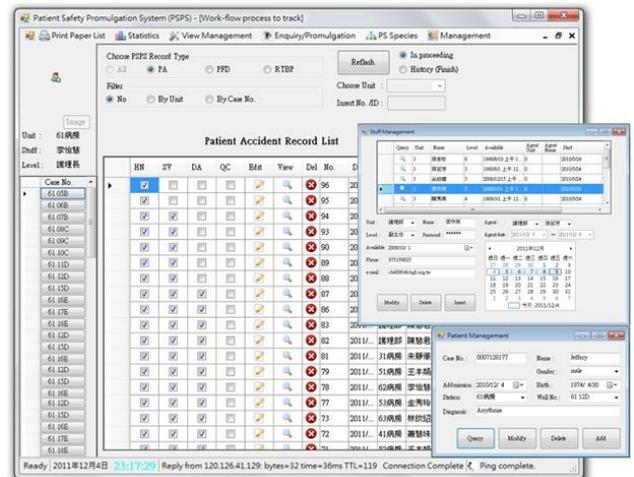


Fig. 11 Process tracking and management interface.

## 4. Conclusions

After discussion, research, development and deployment, we expect that the concept of the design can achieve the six targets that are given below, in the hospital.

- Instantaneous notification: The reporting system works according to different levels and different types to notify those who should be notified by sending a message automatically.
- Record integration: Under the system database management, the system can avoid writing the same information at the same time.
- Report integration: Calculate the month / season / annual reports automatically.
- Process simplification: The e-process is easier than the traditional process.
- Saving time: The major benefits of information technology involve saving time.
- Improve satisfaction: Good quality can improve the overall satisfaction.

We show how to remodel a clinical workflow with BPMN, and we execute the model. This approach encourages the promulgation guideline formation while shortening the modeling and execution gap. Although this paper focused in one specific application (the Patient Accident Promulgation Process), the proposed approach supports scalability and generalization. We deployed this system in its final vision in the hospital for all of the staff on Jan-1-2011.

### **Acknowledgement**

This article accepts National Yang Ming University and Cheng Hsin General Hospital research project grant (Project Number: 98F117CY17).

### **References**

- [1] A. Hevner and S. Chatterjee, *Design research in information systems*, Springer US, 2010.
- [2] A.R. Hevner, S.T. March, J. Park, and S. Ram, "Design research in information systems research," *Mis Quarterly*, vol. 28, no. 1, pp 75-105, 2004.
- [3] B. Reiner, E. Siegel, and J. A. Carrino, "Workflow optimization: current trends and future directions," *Journal of Digital Imaging*, vol. 15, no. 3, pp. 141-152, 2002.
- [4] C. Combi and G. Pozzi, "Architectures for a temporal workflow management system," *Proceedings of ACM Symposium on Applied Computing*, Nicosia, Cyprus, March 2004. pp. 659-666.
- [5] J. Chen, D. He, and W. Anquan, "e-Commerce and innovation business process reengineering," *Portland International Conference on Management of Engineering and Technology (PICMET '01)*, Coll. of Manage, vol. 1, pp. 163-164, 2001.
- [6] L. Fischer, *2007 BPM and workflow handbook*, lighthouse point, Future Strategies Inc., Florida, 2007.
- [7] R. Eley, T. Fallon, J. Soar, E. Buikstra, and D. Hegney, "Barriers to use of information and computer technology by Australia's nurses: a national survey." *Journal of Clinical Nursing*, vol. 18, pp. 1151-1158, 2009.
- [8] U. J. Gelinas, S. G. Sutton, and J. Fedorowicz, "Business processes and information technology," Cincinnati: South-Western/Thomson Learning, 2004.
- [9] W. M. P. Van der Aalst, A. H. M. t. Hofstede, and M. Weske, "Business process management: a survey," *Lecture Notes in Computer Science*, vol. 2678, pp. 1-12, 2003.