

# A Conceptual Framework for Business Process Engineering: A Case Study

Željka Car, Hrvoje Belani

Department of Telecommunications  
Faculty of Electrical Engineering and Computing  
University of Zagreb  
Unska 3, Zagreb HR-10000, Croatia  
{zeljka.car, hrvoje.belani}@fer.hr

Antun Carić

Research and Development Department  
KATE-KOM, d.o.o.  
Drvinje 109, Zagreb HR-10000, Croatia  
acaric@kate-kom.com

**Abstract**— this paper discusses a conceptual framework for the requirements engineering process for e-school applications offering a service to the information society. The e-school application is considered a fusion of the electronic business and mobile business contexts, containing three dynamic Web-interfaces and an SMS-interface. Implementation of this service requires changes in the school business process it supports. This paper presents a requirements engineering framework which aims at resolving the feedback loop between the application and the business process. The presented framework has been defined in order to help simultaneously develop an application which provides the service and ensures the necessary identification of school business process changes and their models. The framework also provides a mechanism for efficient service deployment and its future evolution without adverse effects on the underlying business process. Presented is a case study for an e-school notification service implemented within this framework.

**Keywords**- e-school, school business process, requirements engineering framework

## I. INTRODUCTION

Requirements engineering has been established as a software engineering discipline because of the recognized need for a systematic approach to the earliest phases of software application development [1]. Components of requirements engineering include requirements development and requirements management [2]. Efficiently capturing the business process that supports the developing application is critical to successful software requirements development [3] [4].

The conceptual framework proposed in this paper is designed to coordinate requirements engineering activities to obtaining a high level of concurrency in development and to ensure efficient co-development of both the future targeted applications and the relevant business process. A corresponding case study is presented, although the authors claim generality of the framework for similar cases where the development and implementation of the business process support system implies changes to the process itself. The presented requirements engineering framework was successfully applied in an e-school application case study. This case study was chosen due to the increased interest among schools in exchanging notifications

regarding information [5]. SMS and e-mail were recognized as the main notification assets, extended with the support of rich Web interfaces.

The paper is organized as follows: in the rest of this section, traditional school issues and e-school aspects are discussed. In Section II we present a conceptual framework for business process engineering, while section III emphasizes the impact of the prototype on the school business process. Section IV describes the e-school notification service implementation of the presented framework. Section V elaborates upon experiences from the e-school case study. Final conclusions are given in section VI.

### A. Traditional School Issues

Every educational system, in addition to its core activities of teaching and learning, relies on a set of business procedures and regulative. These procedures fall within the scope of the school business process. An example of a traditional school business process segment which models the responsibility of a student to accept all given tasks and do homework is shown in Figure 2.a. The parents' role in this particular process is to be informed about their child's grades and learning progress.

Although significant ICT investments and recommendations have been made for the Croatian educational system in the last few years [6], there are still a number of issues to be properly dealt with. These include:

- the lack of an general e-school system architecture, according to the technical standards and existing business processes,
- the lack of conditions, rules and procedures for e-school implementation
- inadequate tools and practices used in e-learning and e-teaching, and
- The presence of a gap between big and small schools.

Furthermore, parents, as a part of these communities, arguably wish to be timely informed about their children' activities as well as to have a usable tool with which they can actively participate in the education of their children.

## B. The e-School Information System

In response to the issues mentioned above, a general overview of applications for educational process support has recently been proposed and widely discussed in Croatia [6]. Although there are numerous areas of interest, the main focus of the case study described in this paper is on the e-school application [7]. Generally, e-school is regarded as an information system for school-related information storage and exchange. Such systems are specific due to mandatory role-based information access and their confidentiality.

The main purpose of the system is the automation of school activities and processes, systematization and unification of syllabuses, and more active parent participation in the educational system [8]. The ultimate goal of the entire educational information system is achievable only when all the comprising applications have been developed and implemented with the following features in mind.

- Each application must be developed efficiently and left open for future integration.
- Special attention must be paid to the underlying business process. Each application must cover a strictly defined process segment without influencing other segments.

Since it is expected that the applications implemented will introduce process changes, and also as a result of the necessity of application and process co-development, application impact on different processes must be allowed. In the process of developing such applications, the requirements engineering discipline is much more than just the start of the standalone business process support system development. Every impact on the process and its changes should be analyzed for the benefit of a future educational platform design. Since the applications will be implemented subsequently, one application could change the process supported by a previously implemented one. Therefore, the process must be introspected and changes defined by the relevant rules.

## II. CONCEPTUAL FRAMEWORK

In this section, we propose framework within the requirements engineering discipline. It covers business process capture and modeling, elicitation of business and technical requirements for the application and the proposal of the process changes requested for satisfactory application implementation. The framework was originally developed for a particular case study, but is not strictly limited to its domain. Figure 1 shows the essential process elements of the framework.

*Business process capture, analysis and model development.* Business process capture, analysis and model development include the following. The initial boundaries of the (school) business process are identified and a basic understanding of the process is acquired. The process is then described and modeled. The process actors are analyzed and service user groups are identified. The activities performed by each user group are recognized and modeled. The requirements elicitation techniques used in this stage are observations, interviews and brainstorming sessions. For better process insight, a particular class was identified in one high school [5]. All lesson materials,

references, books, homework assignments and exchanged information within a defined time period were screened.

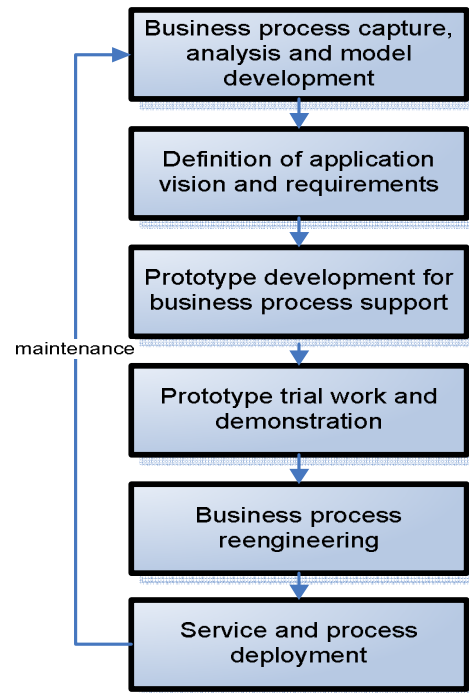


Figure 1. Conceptual framework for business process engineering

*Definition of application vision and requirements.* To define the vision of an application and its requirements the following is done. Stakeholders' requirements are gathered and mapped into service features to produce high-level functional specifications. Questionnaires are prepared and distributed to the identified user groups. This activity should be based on a clear vision and a promising business model. Any discussion with authorities should be initiated here. In our case study, this was the Croatian Institute for Education Development.

*Prototype development for business process support.* A service prototype is designed and implemented according to the requirements specification. The prototype aims at gathering and verifying complete user requirements and provides more concrete features such as a notification service. 'Demonstrations and discussions with teachers and parents clearly showed that the main issues and problems they focused on changed throughout the school process. In the early school years, their attention was mainly on homework assignments, while later it moved to absences from school. Up to this point, the Croatian Ministry of Science, Education and Sports has been involved and financially supported the project.

*Prototype trial work and demonstration.* Trial work is not only important for application functionality and performance verification but for the school process as well. Process weaknesses are emerging, so proposals for process changes must be explicitly defined and clearly presented to all process actors. The regularized rules must contain original process description and functional requirements of the new service and

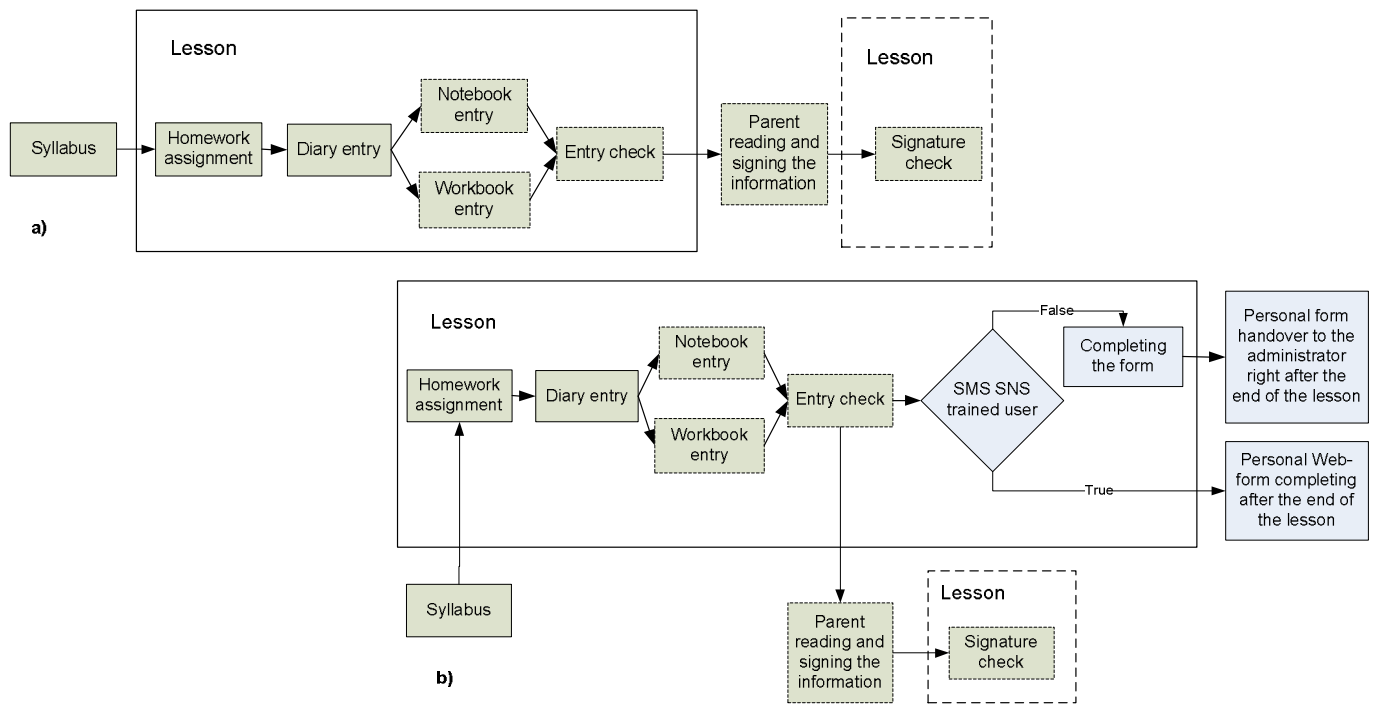


Figure 2. A business process segment for homework assignment, modeled from the: a) traditional school business process, b) improved school business process supported by e-school application

their implications on the business process. Also, each process change must be unambiguously stated and illustrated. The new process model must be easily understood by the users. It is very important to include not only computing teachers of informatics but a wide range of teachers, especially those less computer-literate, as well as school principals.

*Business process reengineering.* The only way to propose acceptable process changes is by collecting proposals directly from the process actors. Their on-topic feedback is valuable from both a technological and social aspect. Process actors can be regarded as domain experts in their field. Consequently, requirements specifications should be refined and users' feedback about process changes collected. Appropriate techniques include questionnaires, interviews, small group discussions and specialized workshops. The phase results with valid documents and directives accepted by the Institute for Education Development and approved by the Ministry.

*Service and process deployment.* Finally, the service and improved process are deployed and set into motion. Schools begin to use it by first mobilizing all the actors involved, particularly teachers. The requirements are subject to change and user groups' representatives should be involved in all the development iterations, particularly deployment. Adequate user training should be ensured and the support of service experts is highly recommended. These are the key success factors for this phase. Regular presentations of the development activities and control of the changing requirements are aimed at ensuring service quality. Any change which influences the process is promptly introduced into the new process model and discussed with the actors with the possibility of being implemented in the next cycle.

### III. APPLICATION IMPACT OF THE BUSINESS PROCESS

A very important prerequisite for the deployment of the service in the case study was to have teachers slightly change their homework assignment records and other information, such as student absences. Every school has an established procedure for tracking this data and alerting parents when they consider it necessary. This kind of communication with parents is time-consuming.

One of the risks associated with service usability is directly related to the simplification of this procedure (Figure 2.b) and avoidance of additional administrative work for teachers. Another challenge is related to the general idea of e-school. Also, while dealing with particular service requirements, a whole set of future features must be taken into consideration.

The key idea is to initiate the e-school system with gradual support of the school process changes necessary for successful implementation and integration. Also, the assumed process changes should directly impact the requirement set for a particular e-school application.

An improved school business process is an extension of the traditional school process and should successfully utilize the implemented notification service with all its associated activities. An important assumption is that introducing the improved business process will not decrease the level of usability and conveniences of the actors involved. A change in the existing procedure is inevitable. Furthermore, it is important to ensure that teachers do not need to write the same information multiple times.

The SMS SNS (Short Message Service School Notification System) project was supported by the Croatian Ministry of Science, Education and Sports (t-Project No.5008).

#### IV. THE E-SCHOOL NOTIFICATION SERVICE

The case study presented in this paper deals with an e-school application offering a notification service (Figure 3.) for school-based information exchange at any point and any time mainly using SMS messages. This service enables a fast, simple and cheap means of information exchange between schools, parents and students [5]. The notification content can be about homework assignments, student absences, general notification, or information about parent- teacher meetings, etc. Broadcast possibilities are enabled by using a distributed component-based architecture [8]. Bidirectional communication is enabled where parents can ask for particular information they wish to receive via SMS while teachers can send such information about the children via SMS as well [9]. Data entry is achieved using secure Web interfaces [10] [11]. The service enables customizing parents' profile and receiving only information of interest.

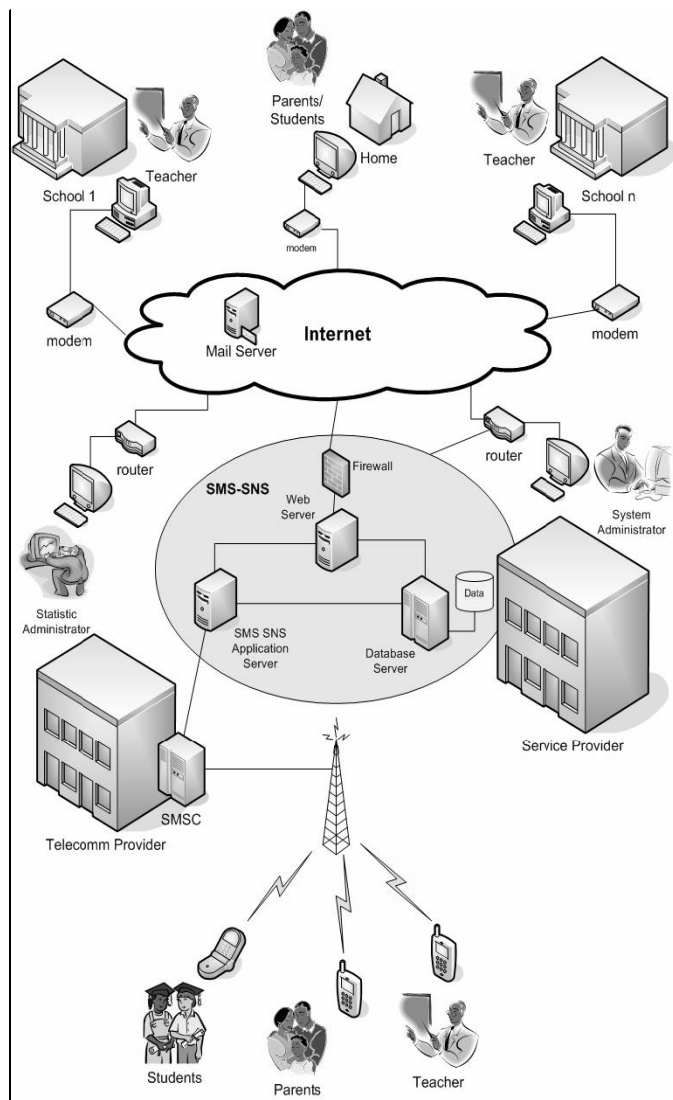


Figure 3. SMS SNS physical architecture model for large area [12]

The notification service users include teachers (as content administrators), system administrators, parents and students. All registered school employees are responsible for entering school-related information into the system and can be content administrators. The role of a system administrator depends on the service business model. It can belong either to a service provider party or to the school itself. If the system is hosted by the school, teachers can also be system administrators.

##### A. Service Development

Although the notification service is simple to use, an appropriate software development process was required to implement it. The software development process used in the case study was the Rational Unified Process (RUP) [15], a rather tailor-able process [11]. Figure 4 shows the concurrent development of the e-school application and the school business process. With the conceptual framework assigned, several stages within the requirement engineering discipline were defined. Each stage was defined according to its goal and was associated with requirement elicitation techniques.

##### B. SMS SNS Web Interfaces

Although the main notification means of this service is SMS, the service also offers three Web-interfaces. The Web is considered more user-friendly and a more extensive communication medium as opposed to the inherent limitations of SMS. The service offers Web-interfaces for content providers (Figure 5.), system administrators and service users [9].

#### V. CASE STUDY EXPERIENCES

Real trial work done in one Croatian high school provided crucial experience for the ongoing e-school implementation. The School and its teachers were imposed by the existing process and overburdened with daily work. They were faced with the unavoidable challenge of change and resistance, and needed help both in application and process implementation. However, without significant support of the school staff, there is a potential risk that the system will stay empty, i.e. without relevant information, resulting in many disappointed parents.

Regarding the conducted case study, the following conclusions can be drawn: A prerequisite for service development is capturing and modeling the adequate segments of the business process to be supported. Thus, the requirements engineering discipline embedded in the framework presents more than just capturing the business process and specifying the functional and nonfunctional requirements. Additional prerequisites are:

- Proposing process changes;
- Surveying process actors about process changes and analyzing their feedback;
- Coordinating requirements engineering activities to obtain a high level of concurrency in development, and
- Ensuring efficient co-development of the process and future services.

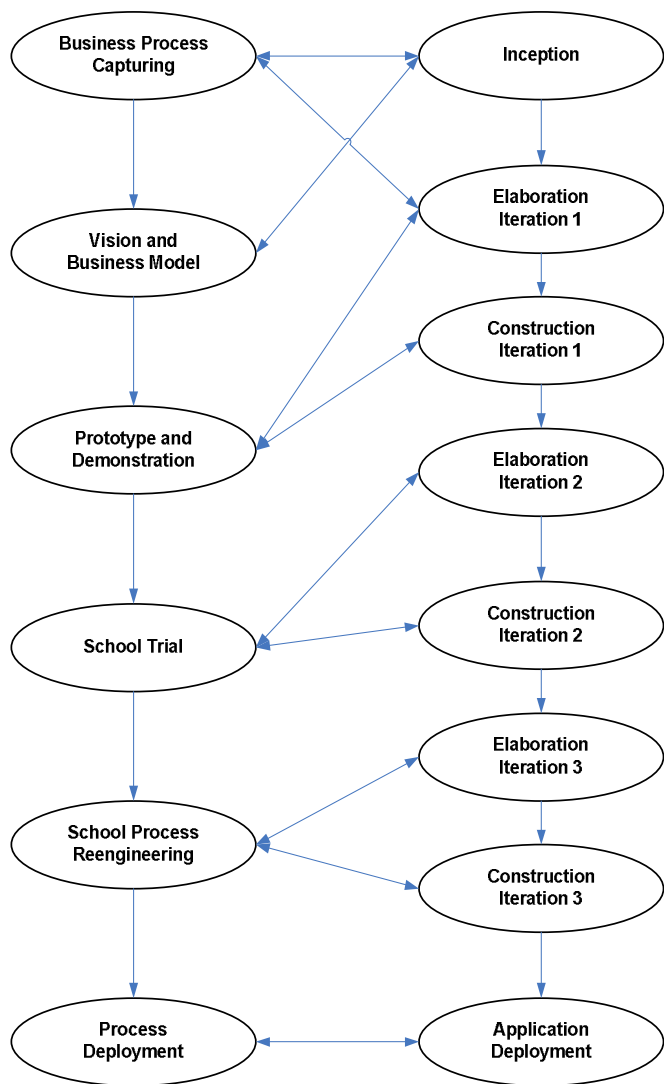


Figure 4. Simultaneous development of e-school application and school business process model



Figure 5. Content provider Web-interface, one of three Web-interfaces the service offers [12]

To propose process changes, it is necessary to demonstrate and illustrate all the service benefits to the process actors. Developing a service prototype is the best way to perform a cognitive walk-through of the changed process and application. Here, it is important to select user groups' representatives.

The questionnaires were prepared for each representative separately and all the users completed them. The interviewees elaborated upon the subject of successful service implementation and business process changes. This produced a double benefit - process improvement and more usable service implementation. Each questionnaire consisted of several parts. There were general and context-oriented parts which were common to all representatives and functional parts which differed with respect to the various view-points, aspects, problems and obstacles related to each representative separately.

Key persons from each particular user group were interviewed. Very important were the interviews conducted with school administration representatives who would propose the business process changes that need approval and acceptance. The interviews were semi-structured, with both predefined questions about a specific issue and open topics to be discussed.

Most of the challenges in the case study emerged while communicating with the users, trying to describe them all the benefits of application implementation. Their first impressions regarding the application were positive. According to the results of a performed statistical analysis, 79% of queried parents thought that their active involvement and knowledge about homework assignments contributed to better learning results. The average parent and teacher scores regarding the need and their interest in the notification service were 3.75 and 3.84 (out of 5), respectively. These results confirm the need for such a notification service. Most of the teachers' questions were about additional work they could have done in order to fully benefit from the application. The teachers were concerned about the impact of these new activities on their everyday work, on its quality, and of the additional administrative burden.

A prototype demonstration proved extremely valuable in communication with future service providers and school authorities to resolve questions regarding the business model, price, costs, etc. After the prototype demonstration, several doubts were cleared up. Practical questions and suggestions replaced assumptions and concerns.

It proved much more efficient to present a delayed reaction of the market (parents in this case) and to introduce the whole e-school environment rather than merely a particular notification service. Once the process actors gained a full image of e-school as the integrated environment of notification and supporting applications, they were able to view all the benefits of a particular service. Thus, they participated in the vision by concentrating on the practical issues necessary to improve the whole business process. This is a presumption where any additional activity and all process change propositions can be assumed as indispensable for overall process development towards higher service quality.

## VI. CONCLUSION

The given analysis of the proposed conceptual framework for business process engineering showed its suitability for similar projects having the following common characteristics:

- The capability to capture and analyze a business process and develop its model,
- A business driver for business process supported application development, and
- Business process reengineering compliance with the introduction of new applications.

The described e-school case study and the obtained field results of the service's operation and usage are promising. The implementation of the applied requirement engineering framework has been proven as justified. The authors claim its generality for similar cases where development and implementation of the business process system implies changes in the process itself.

Successful application implementation and introduction of the proposed business process changes grossly depend on the process actors' commitment and familiarity with the long term benefits of the application and the introduced changes. Business process engineering must be performed with caution and the extra load for the process actors must not be significant. As the case study indicates, their effort will most likely increase soon after the introduction of process changes and after prototype implementation. On the long-run, their effort will decrease and some other non-quantifiable benefits will occur. Consequently, the success depends mostly on the people involved, their commitment, their openness to new ideas and their ability to envision the future.

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