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Selected Papers Book

A number of selected papers presented at ICEIS 2007 will be published by Springer, in a book entitled Enterprise Information Systems IX. This selection will be done by the conference Chair and program co-chairs, among the papers actually presented at the conference, based on a rigorous review by the ICEIS 2007 program committee members.

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MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

FOREWORD

This volume contains the proceedings of the Ninth International Conference on Enterprise Information Systems (ICEIS 2007) organized by the Institute for Systems and Technologies of Information Control and Communication (INSTICC) and the University of Madeira, in collaboration with ACM/SIGMIS and AAAI. Furthermore, the conference was sponsored by the Portuguese Foundation for Science and Technology (FCT).

ICEIS has become a major point of contact between research scientists, engineers and practitioners in the area of business applications of information systems. This year, five simultaneous tracks were held, covering different aspects related to enterprise computing, including: "Databases and Information Systems Integration", "Artificial Intelligence and Decision Support Systems", "Information Systems Analysis and Specification", "Software Agents and Internet Computing" and "Human-Computer Interaction". All tracks describe research work that is often oriented towards real world applications and highlight the benefits of Information Systems and Technology for industry and services, thus making a bridge between the Academia and the Enterprise worlds.

Following the success of 2006, ICEIS 2007 also had a number of satellite workshops, related to the field of the conference. This year we collaborated in the organization of the following ten international workshops: 7th International Workshop on Pattern Recognition in Information Systems; 1st International Joint Workshop on Wireless Ubiquitous Computing; 5th International Workshop on Modelling, Simulation, Verification and Validation of Enterprise Information Systems; 5th International Workshop on Security In Information Systems; 4th International Workshop on Natural Language Processing and Cognitive Science; 4th International Workshop on Computer Supported Activity Coordination; 3rd International Workshop on Model-Driven Enterprise Information Systems; 1st International Joint Workshop on Technologies for Collaborative Business Processes and Management of Enterprise Information Systems; 1st International Workshop on RFID Technology - Concepts, Applications, Challenges and 1st International Workshop on Human Resource Information Systems.

This year, ICEIS 2007 received 644 paper submissions from more than 40 countries in all continents. 72 papers were published and presented as full papers, i.e. completed work (8 pages/30' oral presentation), 198 papers reflecting work-in-progress or position papers were accepted for short presentation, and another 131 contributions were scheduled for poster presentation.

These numbers, leading to a "full-paper" acceptance ratio below 12%, and a total acceptance ratio below 65%, show the intention of preserving a high quality forum for the next editions of this conference. Additionally, as usual in the ICEIS conference series, a number of invited talks, presented by internationally recognized specialists in different areas, have positively contributed to reinforce the overall quality of the Conference and to provide a deeper understanding of the Enterprise Information Systems field.

A book of Selected Papers will be published, following the conference, by Springer in the newly created series "Lecture Notes in Business Information Processing" (LNBIP). This series brings the successful LNCS approach to areas such as business information systems, e-business, B2B integration, Enterprise applications and industrial software development.

The program for this conference required the dedicated effort of many people. Firstly, we must thank the authors, whose research and development efforts are recorded here. Secondly, we thank the members of the program committee and the additional reviewers for their diligence and expert reviewing. Thirdly, we thank the invited speakers for their invaluable contribution and for taking the time to synthesise and prepare their talks. Fourthly, we thank the workshop chairs and the special session chairs whose collaboration with ICEIS was much appreciated. Finally, special thanks to all the members of the local organising committee, especially Jorge Cardoso, whose collaboration was fundamental for the success of this conference.

This year, the organization will distribute two awards to papers presented at the conference: the best paper award and the best student paper award, mainly based on the classifications provided by the Program Committee members.

We wish you all an exciting conference and an unforgettable stay in the lovely island of Madeira. We hope to meet you again next year for the 10th ICEIS, to be held in Barcelona - Spain, details of which are available at http://www.iceis.org.

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I.P.Setúbal/ INSTICC, Portugal

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I.P.Setúbal/INSTICC, Portugal

Jorge Cardoso
Universidade da Madeira, Portugal

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SPECIAL SESSION ON BUSINESS INTELLIGENCE, KNOWLEDGE MANAGEMENT AND KNOWLEDGE MANAGEMENT SYSTEMS

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JUAN PABLO SOTO
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KNOWLEDGE FLOW ANALYSIS TO IDENTIFY KNOWLEDGE NEEDS FOR THE DESIGN OF KNOWLEDGE MANAGEMENT SYSTEMS AND STRATEGIES

A Methodological Approach

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Keywords: Knowledge Management, Knowledge Flow Analysis, Process Engineering.

Abstract: This paper presents a methodological approach to identify knowledge needs in organizational processes. The methodology is oriented to facilitate obtaining requirements to design knowledge management systems and/or strategies. This approach has been applied for different purposes, including identifying relationships between the knowledge and sources involved in the activities of a process, the mechanisms used for managing knowledge in those processes, and the main problems affecting the flow of knowledge. In order to exemplify the usefulness and applicability of the proposed approach, a case study is described, in which the methodology was successfully applied to analyze a software development group. From this case study different possible solutions to some problems observed in the maintenance process were proposed.

1 INTRODUCTION

Many Knowledge Management (KM) initiatives fail when they are implemented in organizations (Stewart, 2002). One of the causes of this is that those initiatives do not consider the real needs of the knowledge workers (Wiig, 2004), that means, the people that will use the knowledge to better accomplish their actual work. In order to a KM system or strategy be succesful, it must be aligned to the real work processes of the organization where it will be implemented (Maier & Remus, 2002).

KM systems (KMSs) must facilitate knowledge workers to obtain the knowledge they require from where it is created or stored; or to capture and store the knowledge created in the activites performed by those workers, to make it avalable for future use. From this view, we must first understand how knowledge is actualy flowing in the work processes, to later identify possible improvements to facilitate the knowledge flow (Nissen, 2002). Once identified the different forms in which knowledge is flowing through a process, it should be easier to identify the problems affecting that flow, and, as a consequence, to propose possible solutions to improve the flow.

This paper presents a methodology that has been succesfully applied to identify knowledge management needs in work processes, through the identification and analysis of knowledge flows. The remains of this paper is organized as follows: in the next section the methodology is described. Later, section three presents a case study that exemplify the applicability and usefulness of the methodology. Section four discusses some lessons learned from the case study, to finally conclude in section five.

2 A KNOWLEDGE FLOW ANALYSIS METHODOLOGY

To define successful KM strategies is important to take care of the real work processes of organizations, and the technical infrastructure used to support them (Jennex & Olfman, 2005; Maier & Remus, 2002). Therefore, before defining KMSs or strategies, it is important to understand how knowledge is involved in those processes. Based on this, we have defined a methodology to identify and analyze knowledge flows in work processes, first introduced in (Rodríguez-Elias *et al.*, 2005b). The methodology is called KoFI (Knowledge Flow Identification), and is based on process engineering techniques, such as process modeling (Curtis *et al.*, 1992).

Process modeling can be used as a means to analyze and understand the knowledge that is used or generated in organizational processes, and the mechanisms through which that knowledge flows (Bera *et al.*, 2005; Hansen & Kautz, 2004). However, process models are not just to understand the process, they are also useful to obtain requirements for approaches focused on improving it (Cox *et al.*, 2005).

The KoFI methodology was defined to help in three main forms: 1) to identify, structure, and classify the knowledge base of the studied process, 2) to identify the technological infrastructure that support the process and that is affecting the knowledge flow, and 3) to identify requirements to improve the knowledge flow in the process.

2.1 Description of KoFI

The KoFI methodology is oriented to help analyze specific work processes. Therefore, before applying KoFI, is required to define the specific process to be analyzed. To help on this analysis, the process must be modeled. Those models should be done with a Process Modeling Language (PML) that allows the explicit representation of the knowledge and knowledge sources involved in the activities of the process. The process models are later analyzed following a four step process, as is shown in figure 1. The first step is focused on identifying the main knowledge sources involved in the process. The second step is oriented to identify the knowledge that is used or generated in the activities of the process. Later, in step three the flow of knowledge between activities, and sources is identified and analyzed. Finally, the problems that are affecting the well flow of knowledge are defined.

The process followed for applying the methodology is iterative, since each stage may provide information useful for the others before it. As well, the process model can be evolving while it is being analyzed in the different stages of KoFI. Next we provide some directions about how each stage can be carried out.

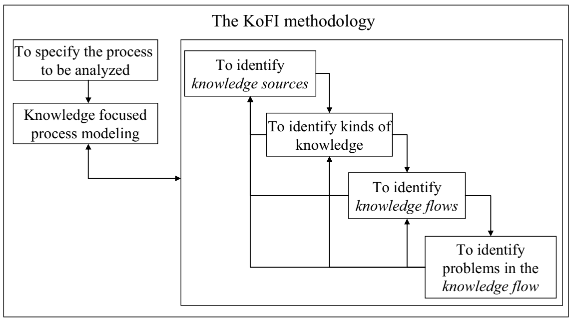

Figure 1: Stages of the KoFI methodology.

2.1.1 Knowledge Focused Process Modelling

There exists many PMLs designed for very different purposes (Curtis *et al.*, 1992). Frequently, PMLs for business process in general are used to model knowledge flows (Hansen & Kautz, 2004; Strohmaier & Tochtermann, 2005; Woitsch & Karagiannis, 2002). Traditional PMLs can be used to identify some issues related to knowledge flows implicitly, such as the information sources required, generated, or modified by an activity (Abdullah *et al.*, 2002; Davenport & Prusak, 2000). It is, however, important that a PML used to analyze knowledge flow provides explicit representation of issues such as the knowledge consumed or generated in activities, the knowledge required by the roles participating in those activities, the sources of that knowledge, or knowledge dependencies (Bera *et al.*, 2005; Papavassiliou & Mentzas, 2003). Unfortunately, there is a lack of PMLs which focus on the identification of knowledge involved in the processes (Bera *et al.*, 2005). One way to address this situation is to adapt existing PMLs so as to integrate the representation of knowledge.

It is recommended that the process be modelled at different levels of abstraction (Checkland & Scholes, 1999). First, a general view of the process can be defined with a general and flexible process modelling technique. To perform a detailed analysis, a more formally constrained language should be used (Conradi & Jaccheri, 1999). It can be also helpful to use a PML designed for the type of process that will be analyzed, since such a language provides primitives to represent specific elements involved in that type of processes; and the explicit representation of those elements facilitate their analysis. In our case, we have used Rich Picture (Monk & Howard, 1998), and the Software Process Engineering Metamodel (SPEM) (OMG, 2002).

Since the focus of this paper is not on the modelling languages, just some examples will be presented in the third section; more detailed examples can be found in (Rodríguez-Elias *et al.*, 2007). In this section we will limit our-self to just present the main activities that are carried out in each stage of KoFI.

2.1.2 To Identify Knowledge Sources

The first step, after modelled the first version of the process, is identifying the main documents and people involved in the process. It is important that the sources identified be organized and classified. To this end, a taxonomy can be defined. In fact, defining taxonomies is one of the first steps in the development of KMSs (Rao, 2005). An ontology can be also developed to help defining the relationships between the sources and the other elements of the process. This ontology can be used to structure the knowledge base of the process (O'Leary, 1998).

2.1.3 To Identify Knowledge Types

This stage starts by analysing the knowledge sources identified in the first step; then, the types of knowledge that can be obtained from the sources found is defined together with the knowledge that the people involved in the process may have or require. In this step, a taxonomy and an ontology can also help to classify the types of knowledge and define their relationships with other elements of the process. The ontology must define means for relating the knowledge sources with the knowledge areas or topics that can be found in them.

2.1.4 To Identify Knowledge Flows

In the third step, the process model is used to identify how the knowledge and sources are involved in the activities performed in the process. The main activities of the processes must be identified, also the decisions that people performing those activities must make. The process models are used to analyse how the knowledge flows through the process while people involved perform their activities; for example, what sources they consult, or what documents are generated from doing the activities. It is important to identify either flows of knowledge between activities or between sources. For instance, knowledge generated in one activity that is used in others; or knowledge that is transferred from one source to another. An example of the last can be the transfer of knowledge of a person to a document.

2.1.5 To Identify Knowledge Flow Problems

In the fourth step the knowledge flows identified are analysed to find the problems that could be affecting them. For example, if the information generated from the activities is not captured, or if there are sources that could help to perform some activities, but are not consulted by the people in charge. To do this, we propose to use *problem scenarios*. A problem scenario is a story that describes how a problem is happening (Rodríguez-Elias *et al.*, 2005b). Particularly, this story must show how the problems detected affect the *knowledge flow*. Once described the problem scenario, one or more alternative scenarios must be defined to illustrate possible solutions, and the manner in which those alternative solutions may improve the flow of knowledge. Problem and scenario definition are useful means to obtain design requirements to develop tools to address the problems found (Carroll & Rosson, 1992; Cox *et al.*, 2005).

3 A CASE STUDY

This section presents examples of the application of the methodology in a real case. The examples are extracted from the study of a software maintenance process performed by the information systems development department of a research center.

The study started by identifying the maintenance process. This was done based on interviews to the personnel of the department, observation, and analysis of documents. This information was used to model the process. First, we used Rich Picture to obtain a general view of the process. Examples can be found in (Rodríguez-Elias *et al.*, 2005b).

Frequently, Rich Pictures are used to illustrate the main activities of a process, the information elements generated, modified or used in these activities, the roles participating, and the main fears, concerns, etc. of the people carrying out those roles (Checkland & Scholes, 1999; Monk & Howard, 1998). In our case, we adapted Rich Pictures to illustrate also the main knowledge or skills required in each activity, and the knowledge and skills that each role should have to perform the activity. The models developed in this stage were useful to start identifying sources of knowledge involved (people, documents, etc.), the knowledge required in the activities, and the one each role of the process have.

To develop a more formal and detailed model of the process, we used SPEM (OMG, 2002) and an extension of it that we have proposed in (Rodríguez-Elias *et al.*, 2007). The diagrams developed following this extension to SPEM, helped us for different purposes; first, they were helpful to start classifying the knowledge involved in the process by grouping it in packages. Figure 2 shows an example, where it is illustrated the sequence of some of the activities performed by a software engineer, and the main groups of knowledge involved; for instance, the experience of the engineer and the information contained in the documents used in these activities. Later, we used knowledge package diagrams to illustrate specifically the knowledge areas or subjects involved in that sequence of activities. Knowledge areas were defined as sub-packages that were later detailed defining the specific knowledge subjects grouped in that area.

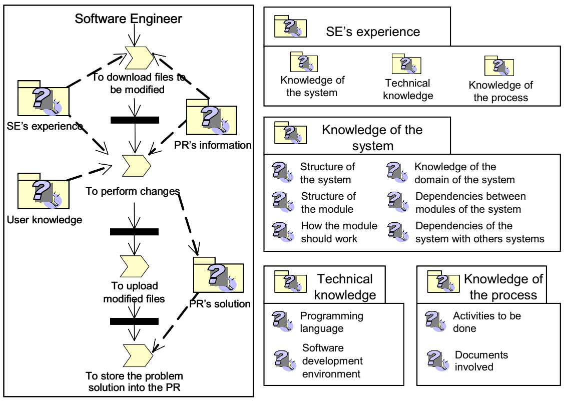

Figure 2: Example of knowledge package diagrams.

We first defined general knowledge areas or subjects in order to define a general model of the process. Based on this general model, we latter defined specific knowledge subjects, such as those related to a specific application. For instance, when we were analyzing the knowledge related to the finances system, we changed the reference to the system in the model of figure 2, to the finances system, or the programming language area, to the specific programming language used to develop the finances system. Based on this we identified the main sources where knowledge about the finances system can be obtained, perhaps documents describing its structure, people with knowledge of the application domain, etc.

The knowledge packages were used as a basis for developing a knowledge taxonomy to classify knowledge into types, areas, and subjects. Then, the next step was to identify the relationships between the knowledge sources, and the knowledge that can be obtained from them. For this, we used diagrams as the shown in figure 3. These diagrams help illustrate the knowledge areas or subjects that can be consulted in knowledge sources; perhaps documents.

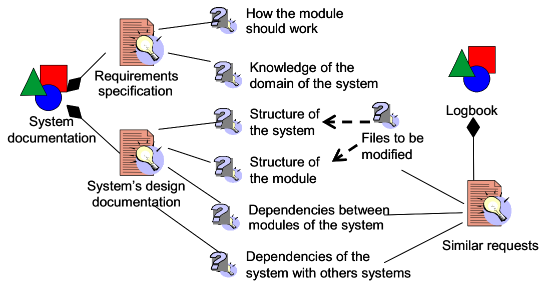

Figure 3: Example of a class diagram showing relationships between sources and knowledge areas.

The third step was the identification of transfers of knowledge between activities and sources. This was done basically with two types of diagrams. First, the transfers of knowledge between activities were analyzed in activity diagrams as the one of figure 4. These diagrams can illustrate the documents generated or modified in one activity that are used in others. This can help to get an idea about the information that is translated in those documents. To define explicitly the knowledge that those documents have, we used the type of diagram that was show in figure 2. For instance, in figure 4 can be seen that the problem report contain information used in different activities, as well, this project report is used to capture the solution given to the problem reported. Therefore, it is used as a knowledge repository, which can transfer knowledge between activities, between people, and in time, since it will be possible to know in the future how a specific problem was solved.

The transfers of knowledge between knowledge sources were illustrated in diagrams where the sources participating, the knowledge being transferred, and the activity where the transfer is taking place are showed. These diagrams are not presented here for space limitations.

After the identification of the main knowledge flows we started the definition of problem scenarios to illustrate the main types of problems affecting the knowledge flow. Particularly, the scenarios identified illustrated problems related to two main domains: experts finding and document management. The main problem that these scenarios highlighted was that, in many occasions people do not consult sources that could be useful to them, because they do not know about their existence, their location or the knowledge they could have. After analyzing the types of problems found, we started the definition of alternative scenarios to illustrate possible solutions to these problems. Based on these types of alternative scenarios, a support system can be designed, see (Rodríguez *et al.*, 2004).

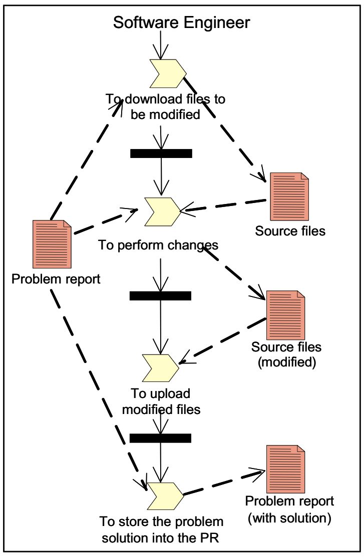

Figure 4: Example of an activity diagram showing flows of documents between activities.

As can be seen from the case study presented here, the application of the methodology was useful in different ways, which include the identification and classification of the main knowledge sources and types involved in the process and the main problems affecting the knowledge flow. The following section presents a summary of the main contributions of the application of the methodology in this study, and the lessons learned from doing it.

4 LESSONS LEARNED

We shall describe the five main lessons learned from this study: two from the researchers' perspective, and three from the practitioners' perspective.

4.1 Researchers' Perspective

- **Structuring a knowledge base**. The identification of knowledge sources and types, the relationships between them, and the way they are related with the activities and other elements of the process, helped us defining schemas to classify knowledge types and sources. The schemas were used to define taxonomies, which were the basis of an ontology of knowledge and sources. The ontology was used for structuring a knowledge map for managing the knowledge base of the process, see (Rodríguez-Elias *et al.*, 2005a).
- **Obtaining design requirements for support systems**. The identification of the problems affecting the knowledge flow, and the alternative solutions through the problem scenarios, were helpful to gather design requirements for supporting tools focused on solving those problems. For instance, a KM system was designed from some scenarios observed. A prototype of this system is described in (Rodríguez *et al.*, 2004).

4.2 Practitioners' Perspective

- **Becoming aware of the knowledge flow problems**. The members of the group studied have become aware of some of the problems they face in their maintenance process. As a consequence, they are taking actions to address some of those problems. For instance, they have developed a web portal where all the documents and information of the systems being maintained will be easily accessible.
- **Improving current tools usage**. The identification of the support tools used by the workers of the process, and the manner those tools are being used to obtain knowledge, contributed to start seen those tools as knowledge flow facilitators. This was helpful to start defining strategies for better using those tools as part of the KM support of the process.
- **Improving knowledge sharing**. Through the analysis of the models, members of the maintenance team had became aware of sources of knowledge they did not know previously, and that can be used to obtain important knowledge for their activities. Now those sources are shared with the rest of the team.

5 CONCLUSIONS

To define successful KM initiatives, it is important that they be aligned to the work processes of the organization where they will be applied. To do this, a first step is to study those processes with focus on the knowledge involved, in order to identify the real knowledge needs of the workers in charge of those processes. In this paper we have presented a methodology defined to accomplish this. The application of the methodology was illustrated with a case study. The study helped us to show that the methodology helps accomplish the three main objectives for which it was defined: the identification of the knowledge base of the process, the support systems involved in the knowledge flow, and design requirements for support systems oriented to solve the problems affecting the flow of knowledge. However, the evaluation of the effectiveness of the solutions proposed from the application of the methodology is a long term work that opens possibilities for our future work, which also include the application of the methodology to other cases in order to continue evaluating its benefits and limitations.

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