ICSOFT 2008

Third International Conference on
Software and Data Technologies

Proceedings

Porto, Portugal • July 5-8, 2008

Volume: PL / DPS / KE

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Proceedings of the
Third International Conference on
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Organized by
INSTICC – Institute for Systems and Technologies of Information, Control and Communication

Co-Sponsored by
WfMC - Workflow Management Coalition – Process Thought Leadership

In Cooperation with
IICREST – Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology

Edited by José Cordeiro, Boris Shishkov, AlpeshKumar Ranchordas and Markus Helfert

Printed in Portugal

ISBN: 978-989-8111-51-7

Depósito Legal: 277777/08

http://www.icsoft.org

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SELECTED PAPERS BOOK

A number of selected papers presented at ICSOFT 2008 will be published by Springer-Verlag in a CCIS Series book. This selection will be done by the Conference Co-chairs and Program Co-chairs, among the papers actually presented at the conference, based on a rigorous review by the ICSOFT 2008 program committee members.

FOREWORD

This volume contains the proceedings of the third *International Conference on Software and Data Technologies* (*ICSOFT 2008*), organized by the Institute for Systems and Technologies of Information, Communication and Control (*INSTICC*) in cooperation with the Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology (IICREST), and co-sponsored by the Workflow Management Coalition (WfMC).

The purpose of this conference is to bring together researchers, engineers and practitioners interested in information technology and software development. The conference tracks are "*Programming Languages*", "*Software Engineering*", "*Distributed and Parallel Systems*", "*Information Systems and Data Management*" and "*Knowledge Engineering*".

Software and data technologies are essential for developing any computer information system, encompassing a large number of research topics and applications: from programming issues to the more abstract theoretical aspects of software engineering; from databases and data-warehouses to management information systems and knowledge-base systems; Distributed systems, ubiquity, data quality and other related topics are included in the scope of ICSOFT.

ICSOFT 2008 received 296 paper submissions from more than 50 countries in all continents. To evaluate each submission, a double blind paper evaluation method was used: each paper was reviewed by at least two internationally known experts from ICSOFT Program Committee. Only 49 papers were selected to be published and presented as full papers, i.e. completed work (8 pages in proceedings / 30' oral presentations), 70 additional papers, describing work-in-progress, were accepted as short paper for 20' oral presentation, leading to a total of 119 oral paper presentations. There were also 40 papers selected for poster presentation. The full-paper acceptance ratio was thus 16%, and the total oral paper acceptance ratio was 40%.

In its program ICSOFT includes panels to discuss aspects of software development, with the participation of distinguished world-class researchers; furthermore, the program is enriched by several keynote lectures delivered by renowned experts in their areas of knowledge. These high points in the conference program definitely contribute to reinforce the overall quality of the ICSOFT conference, which aims at becoming one of the most prestigious yearly events in its area.

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. I would like to personally thank the Program Chairs, namely Boris Shishkov and Markus Helfert, for their important collaboration. The local organizers and the secretariat have worked hard to provide smooth logistics and a friendly environment, so we must thank them all and especially Ms. Monica Saramago for their patience and diligence in answering many emails and solving all the problems. Last but not least, we thank the invited speakers for their invaluable contribution and for taking the time to synthesize and prepare their talks.

A successful conference involves more than paper presentations; it is also a meeting place, where ideas about new research projects and other ventures are discussed and debated. Therefore, a social event including a conference diner was organized for the evening of July 7 (Monday) in order to promote this kind of social networking.

We wish you all an exciting conference and an unforgettable stay in the cosmopolitan city of Porto. We hope to meet you again next year for the 4th ICSOFT, to be held in the charming city of Sofia (Bulgaria), details of which will be shortly made available at http://www.icsoft.org.

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Polytechnic Institute of Setúbal / INSTICC, Portugal

AlpeshKumar Ranchordas

INSTICC, Portugal

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APLYING THE KoFI METHODOLOGY TO IMPROVE KNOWLEDGE FLOWS IN A MANUFACTURING PROCESS

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

Abstract: Development of methods to integrate Knowledge Management (KM) in organizational processes is an open issue. KM should facilitate the flow of knowledge from where it is created or stored, to where it is needed to be applied. Therefore, an initial step towards the integration of KM in organizational processes should be the analysis of the way in which knowledge is actually flowing in these processes, and then, to propose alternatives to improve that flow. This paper presents the use of the Knowledge Flow Identification (KoFI) methodology as a means to improve a manufacturing process knowledge flow. Since KoFI was initially developed to analyze software processes, in this paper we illustrate how it can also be used in a manufacturing domain. The results of the application of KoFI are also presented, which include the design of a knowledge portal and an initial evaluation from its potential users.

1 INTRODUCTION

To assist organizations to manage their knowledge, different strategies and systems (Knowledge Management Systems, KMS) have been designed. However, developing them is a difficult task; since knowledge per se is intensively domain dependent whereas KMS often are context specific applications. The lack of appropriate methodologies or theories for the extraction of reusable knowledge and reusable knowledge patterns has proven to be extremely costly, time consuming and error prone (Gkotsis, Evangelou et al., 2006). Additionally, an actual concern is that KM approaches should be well integrated to the knowledge needs of knowledge workers, and to the work processes of organizations (Scholl et al., 2004). Before developing a KM strategy it is advisable to understand how knowledge transfer is carried out by people in the different processes where the strategy will be applied.

This paper presents the use of the KoFI methodology developed to identify and analyze knowledge flows in work processes, to improve a manufacturing process. The goal of this paper is to illustrate how this methodology can help to detect knowledge deficiencies in a process, and can also help to design strategies to solve them; in this case a knowledge portal was designed. Hence, in the next section the manufacturing process where the methodology was used is described, after that in Section three we illustrate the different stages followed to improve that process. Then, in Section Four a knowledge portal, designed as a result from the findings obtained after applying the methodology, is described. Section Five depicts the results of a preliminary evaluation of this portal; finally conclusions are outlined in Section 6.

2 THE MANUFACTURING PROCESS

To test the KoFI methodology it was used in an industrial company dedicated to the manufacturing of cans. We focused our work on a department where eight processes are carried out. It was decided to centre on one of the most important process: the one in charge of transforming the aluminum rolls into the first versions of the cans (known as

"Formation area"). In this test 41 people were involved, including the department manager, the responsible of each area of the department, and the operating personnel, which were integrated by leader mechanics, productive processes mechanics, and machine operators.

Nineteen employees were interviewed by using the long interview technique. The duration of the interviews ranged from 30 minutes to 2 hours, depending on the level of responsibility of those interviewed. Additionally, a total of 119 documents and systems were also analyzed.

3 APPLYING KoFI TO THE PROCESS

The KoFI methodology is divided in three phases (Rodriguez-Elias et al., 2007a): a) *the process modeling phase*, consisting of the definition and modeling of the process, using a process modeling language which provides elements to represent the knowledge involved in the process; b) *the process analysis phase*, which involves the identification and analysis of knowledge sources, topics, and flows, as well as the problems affecting the flow of knowledge; and c) *the knowledge flow support tools analysis phase*, consisting of the analysis of the tools that might be useful knowledge flow enablers.

In this paper we will focus on the process analysis phase. Information about how to perform the other two phases can be found in (Rodriguez-Elias et al., 2007b) for the process analysis phase, and in (Rodriguez-Elias et al., 2007c) for the knowledge flow support tools analysis phase.

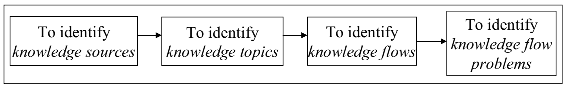

Figure 1: The four steps of the process analysis phase of the KoFI methodology.

The analysis phase of KoFI is composed of four steps, as shown in Figure 1, which are performed in an iterative way, since each step might provide information useful for the others preceding it.

The first step is to identify the knowledge sources involved in the process. This includes the identification of all those sources of information or knowledge that could be being used or could be useful for performing the different activities composing the processes. Those sources could include the people consulted by the personnel in charge of the process, the information systems supporting the process, or documents.

The second step focuses on the identification of the main knowledge topics or areas related to the activities performed in the process. For instance, knowledge required to perform the activities, or created from them. The knowledge related to the sources found in the preceding step should be identified and classified. An important result of this step might be the identification of important knowledge topics not stored anywhere, or that might be stored in sources not used or difficult to find.

These two initial steps also include the classification of the sources and topics found, which can be made through the definition of a taxonomy or an ontology of knowledge sources; which are considered an important initial activity towards the development of KM systems (Rao, 2005). It should be possible to relate the different sources to the knowledge that can be obtained from them, and vice versa, i.e. relate the knowledge to the sources from where it can be obtained, or where it is stored.

The third step focuses on identifying the manner in which knowledge is flowing through the process. To accomplish this, it is required to analyze the relationships between the knowledge sources and topics, to the activities of the process. This includes the identification of the activities where the topics and sources of knowledge are being generated, modified, or used. It is important to identify knowledge dependencies, such as knowledge topics generated in an activity and required in other; and knowledge transfers mechanisms, such as knowledge transferred from one activity to another through a document, or through an interaction between different roles or persons.

Finally, the fourth step of the analysis consists of identifying and classifying the main types of problems detected and which affect the knowledge flow. KoFI proposes to do this by defining *problem scenarios* (Rodriguez-Elias et al., 2007a), a technique based on explaining a problem in the form of a story describing a common situation. Once described the problem, one or more alternative scenarios are also proposed to illustrate the manner in which such a problem could be addressed. Those alternative scenarios are finally used to extract the main requirements to propose the KM strategy to follow, or the KM system to develop. The following subsections describe how these steps were carried out in the manufacturing company.

3.1 Identifying Knowledge Sources

In the first step of the analysis, the identified sources were very diverse. To facilitate its management, and following the recommendations of the KoFI methodology, once the different sources were identified, we proceeded to classify them. To do this a taxonomy of knowledge sources was defined; it included four categories of sources:

1) **Documents**, groups of all those sources which consist of physical or electronic documents. It includes three subcategories: a) *process's documents,* b) *technical documents*, and c) *organizational documents*.
2) **Information Systems**, refers to the sources consisting of information systems used in the company. This category includes two subcategories: a) *query systems*, and b) *transactional systems*.
3) **People**, groups all the different types of people involved in the process. It has been divided in four subcategories: a) *staff*, b) *specialists*, c) *external clients*, and 4) *internal clients*.
4) **Others**, groups those sources not included in the preceding categories. Particularly it includes two subcategories: a) *problem analysis tools*, and b) *simulation tools*.

Each source was described by assigning it a unique identifier, a name, a description, its type and category, its location, its format, and the main knowledge topics which could be obtained from it.

3.2 Identifying Knowledge Topics

The identified knowledge topics were also very diverse, ranging from organizational behavior to special machine maintenance. The topics identified were classified in three categories, according to their utility in the activities of the process.

1) **Product Line Activities** which includes knowledge about the operation of machines, about processes, and about quality of the processes and products. It is divided in four subcategories: a) *product quality*, b) *machine maintenance*, c) *operation*, and d) *information technology (IT) application*.
2) **Organizational Culture**, is all that knowledge that employees must have about the company, its internal organization and norms, etc. It includes only one subcategory which is *knowledge of the company*.
3) **General Knowledge** groups all those topics and areas of knowledge that the employees might have, and which is not directly related to the process operation. It is subdivided in four subcategories: a) *resource management*, b) *IT management*, c) *personnel management*, and d) *other individual knowledge*.

Once identified, the main knowledge topics were described assigning them a unique identifier, a name, a description, its classification, and information to know where such topic could be useful, and why and how knowing it could benefit the organization or the person who knows about it. With the knowledge topics descriptions, a knowledge dictionary was developed for the process.

3.3 Identifying Knowledge Flows

In this step we modeled the knowledge required in each activity of the process, the knowledge that each role needs to perform these activities, and the knowledge sources consulted or generated in each activity, following an adaptation of the Rich Picture technique (Monk and Howard, 1998). Figure 2 presents an example of this type of diagrams, in which there are represented the knowledge required in the "Lift trucks operation and management" process carried out in the company studied. The figure shows the role in charge of such activity, the experience, skills and knowledge it provides to the activity, and the main source of knowledge used in the activity, which is an application for managing security rules and regulation of the company.

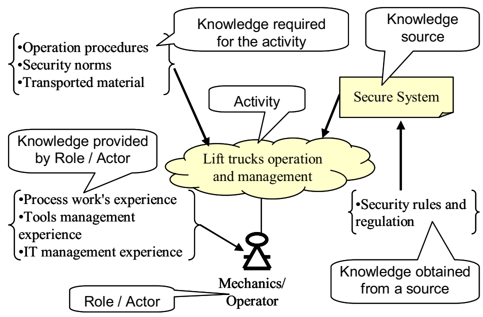

Figure 2: Example of an adapted rich picture to analyze knowledge flows.

This type of models helped us to identify the relationships between the knowledge sources and topics, and the activities of the process. The above allowed us to create a knowledge meta-model (described in Section 4), which was used as the structure for developing a Knowledge Map useful to identify the knowledge that might be obtained from each source, and the activities in which the sources or the knowledge were being used or generated. This map was used in the construction of a Knowledge Portal (described also in Section 4) proposed to solve some of the main knowledge flow problems observed, as it is described next.

3.4 Identifying Knowledge Flows Problems

The final step of KoFI proposes to identify and classify the main problems affecting the knowledge flow in order to propose alternatives to minimize or avoid them. In our study, it was observed that some areas of the process were not well supported with documentation. An additional problem was the identification of important knowledge sources that were not being used. Some reasons for the last were the difficulty for consulting some of those sources, either because they were unknown, or because they were difficult to find by employees.

To address this problem, it was decided to develop a Knowledge Portal to facilitate the access to all the available sources, according to the areas, processes, or activities for which they are useful. Additionally, the portal would provide ways for pointing out to all those knowledge areas for which no sources exist. The last should be useful to identify all those areas for which knowledge sources should be created. Additionally, it was also decided that the portal should provide access not only to documents, but also to other types of sources, such as information systems, or support tools, in order to promote the use of all the available types of knowledge sources of the company.

4 DESIGN OF THE KNOWLEDGE PORTAL

In this section we describe a meta-model developed for structuring the knowledge map used into the portal, the structure of such portal, and the design of its user interface.

4.1 Meta-Model

The meta-model comprises the knowledge types and sources involved in the knowledge generation and acquisition process (Figure 3). In it, the knowledge concepts are integrated with the knowledge topics and sources. The knowledge concepts are required, generated or modified by the activities, which are described as work definitions. The work definitions can be processes, activities or decisions. Each knowledge concept/source association contains information about the knowledge level it requires. The available format and location for consulting each source are specified.

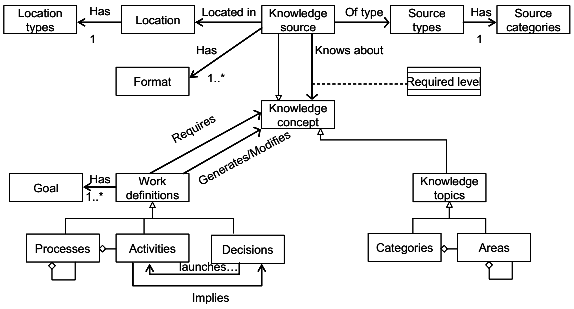

Figure 3: Meta-model of knowledge types and sources.

4.2 Knowledge Portal Structure

The meta-model was used as a base to design the structure of the knowledge portal. Figure 4 shows the resulting general structure of the portal. This structure comprises a first level in which initial interfaces (pages) are accessible (e.g. home and registration pages). The second and third levels are pages which correspond to the manufacturing areas and sub-areas of the organization, respectively. The fourth level corresponds to pages on the processes that integrate each of the sub-areas identified from the involved knowledge flows. Finally, the fifth level presents all the identified knowledge sources for the specific process of the sub-area.

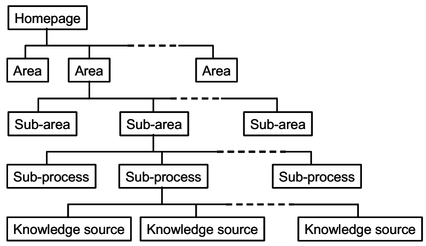

Figure 4: General structure of the Knowledge Portal.

4.3 Knowledge Portal UI Design

The design of presentation and navigational features of the user interfaces (pages) also emerged from insights identified in the analysis and initial phases of design. These include information about the identified knowledge flows, the main sub-areas of the organization, and the structure of the portal previously identified, which resulted in the options included in the menus and main layout sections of the pages. These allow users to find the required information by simply identifying the specific area in which information is generated or required, and following the resulting navigational structure (area → sub-area → process) to locate the specific knowledge source, instead of just alphabetically (or randomly) browsing through the information.

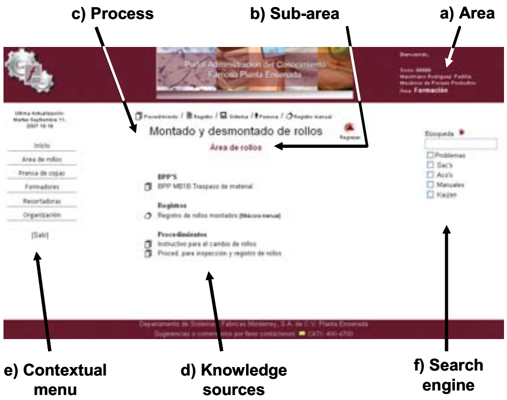

Figure 5: Example of the page contents and layout of the Knowledge Portal.

Figure 5 depicts an example of the layout and content of a page from the current prototype for the "Formation" area.

The information provided includes the name of the manufacturing area being consulted (5.a), the name of the specific sub-area (5.b), the name of the selected process within the sub-area (5.c), and most importantly, links to knowledge sources (and types) available for that process (5.d).

Additionally, the page includes a "contextual" sub-area menu to facilitate navigation through the information (5.e), which is always available while the user stays in that particular sub-area of the portal. Also, it includes a search engine (5.f) which allows a search to be performed by simply specifying a keyword on the required topic, and optionally, the "places" in which the information should be searched for.

The interface in Figure 5 represents the final destination for users looking for a particular knowledge source who, by following only three links (area → sub-area → process), arrive at the knowledge sources (either documents, systems or people) required to perform their intended activities. Finally, this design adheres to the organization's established standard guidelines for this kind of applications.

5 EVALUATION OF THE KNOWLEDGE PORTAL

We conducted a preliminary evaluation in one of the production areas to determine the impact and acceptance level of the users on the system, and to provide support for the decision-making process concerned with the continuation of the system's implementation in other areas of the organization. The evaluation considered aspects concerning perception of usefulness and ease of use (Davis, 1989). The evaluation consisted of 1) an induction session, in which the system was presented to the users, and its functionality demonstrated to them. This included examples on how to search for and retrieve knowledge sources by means of navigating through areas, sub-areas and processes, as well as through the search engine; and 2) the application of a questionnaire containing 12 questions referring to perception of usefulness (6) and ease of use (6). Each evaluation session (induction and application of the questionnaire) was done in about one hour.

The subjects of the study were 41 employees of the "Formation" area for which the prototype was developed, whose participation was voluntary. The sample was divided into 4 groups according to the natural operative processes (3 groups of ten people and 1 of eleven). The application process of the evaluation was completed in three days.

5.1 Analysis and Discussion of Evaluation Results

The subjects had positive appreciations with regard to the knowledge portal, as is reflected in their answers in the questionnaire. Figure 6 shows the answers to the questions about the perception of usefulness of the tool. The users perceived that the portal would allow them to increase their productivity and to perform their tasks more easily (82.93% "Agree" in both cases), although some of them had doubts regarding the fact that this would increase their productivity (24.39% "Have Doubts"). Only one person (2.44%) "Disagreed" that the tool would help him/her to complete his/her tasks faster.

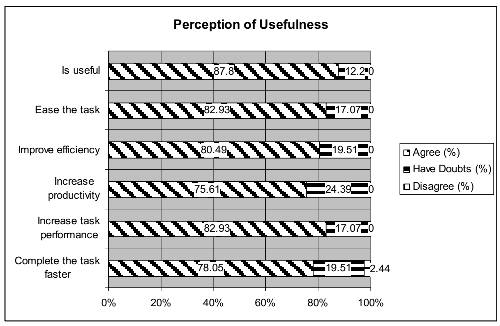

Figure 6: Perception of Usefulness.

Figure 7 shows the answers to the questions about the perception of ease of use. As can be seen, although most of the users perceived that it was easy to learn to browse through the information (85.37% "Agree"), some had doubts concerning the ease of finding information (39.02% "Have Doubts"), and even more users had doubts concerning becoming experts on the use of the tool (46.34% "Have Doubts"). A possible explanation could be that a little more than a third of the users had doubts concerning the clarity of the presented interfaces, as well as about the interaction flexibility that these provide (34.15% in both cases).

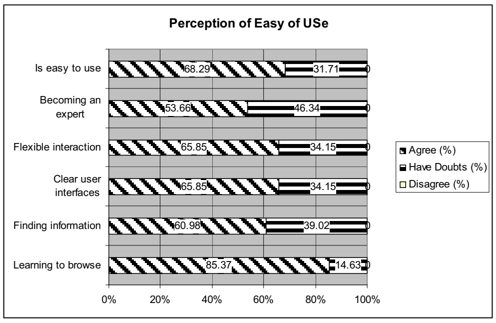

Figure 7: Perception of Easy of Use.

In general, most of the users considered the knowledge portal as a useful (87.80% "Agree" – Figure 6) and easy to use tool (68.29% "Agree" – Figure 7) for the accomplishment of their work.

6 CONCLUSIONS

In this paper we have illustrated the use of the KoFI methodology to analyze a manufacturing process in order to improve the flow of knowledge in it. The KoFI methodology was initially developed to aid in the design of KM approaches to improve software processes. In this initial application domain, the methodology was also useful to propose the design of KM tools, and to structure and create knowledge maps of the studied processes (Rodriguez-Elias et al., 2007a, 2007b, 2007c).

In the present study the processes were much more formally defined and documented than those of the previous studies we made. Also, these processes were already modeled with a common business process modeling language, which has not explicit representation of knowledge related issues. From the models we made in the study, we were able to identify knowledge requirements and sources, which were not identified from the existent process models of the company. This observation has gave us insights to argue that independently of how well defined and documented the process could be, if there is not an explicit representation of the knowledge and sources involved in the activities of the process, important sources and knowledge requirements could be lost or ignored during the analysis.

Finally this study has provided us with the initial evidence to argue that KoFI is open enough to aid in the design and construction of different types of KM approaches, and in different domains. However, more case studies are required to continue evaluating the benefits and limitations of KoFI in different settings. This constitutes part of our ongoing and future work.

ACKNOWLEDGEMENTS

This work is partially supported by UABC, project 0191 of the XI Convocatoria Interna de Proyectos, and the MELISA project (grant PAC08-0142-3315) financed by the Consejería de Educación y Ciencias de la Junta de Comunidades de Castilla-La Mancha, Spain. The authors also acknowledge the support provided by FAMOSA-Ensenada.

REFERENCES

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340.

Gkotsis, G., C. Evangelou, N. Karacapilidis and M. Tzagarakis (2006). Building Collaborative Knowledge-based Systems: A Web Engineering Approach. WWW/Internet, Iadis International Conference, Murcia.

Monk, A., & Howard, S. (1998). The rich picture: A tool for reasoning about work context. Interactions, 5(2), 21-30.

Rao, M. (Ed.). (2005). Knowledge management tools and techniques: Practitioners and experts evaluate km solutions. Amsterdam: Elsevier.

Rodríguez-Elias, O. M., Martínez García, A. I., Favela, J., Vizcaíno, A., & Soto, J. P. (2007a). Knowledge flow analysis to identify knowledge needs for the design of knowledge management systems and strategies: A methodological approach. Proc. of the 9th ICEIS, Funchal, Madeira - Portugal.

Rodríguez-Elias, O. M., Martínez-García, A. I., Vizcaíno, A., Favela, J., & Piattini, M. (2007b). Organización de conocimientos en procesos de ingeniería de software por medio de modelado de procesos: Una adaptación de SPEM. Proc. Of the VI JIISIC, Lima, Perú.

Rodríguez-Elias, O. M., Martínez-García, A. I., Vizcaíno, A., Favela, J., & Piattini, M. (2007c). A framework to analyze information systems as knowledge flow facilitators. Information and Software Technology, 50(6):481-498.

Scholl, W., König, C., Meyer, B., & Heisig, P. (2004). The future of knowledge management: An international delphi study. Journal of Knowledge Management, 8(2), 19-35.

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Proceedings of ICSOFT
Third International Conference on Software and Data Technologies
ISBN: 978-989-8111-51-7
http://www.icsoft.org