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SELECTED PAPERS BOOK

A number of selected papers presented at ICSOFT 2011 will be published by Springer-Verlag in a CCIS Series book. This selection will be done by the Conference Co-chairs and Program Chair, among the papers actually presented at the conference, based on a rigorous review by the ICSOFT 2011 Program Committee members.

FOREWORD

This volume contains the proceedings of the Sixth International Conference on Software and Data Technologies - ICSOFT 2011. The conference is sponsored by the Institute for Systems and Technologies of Information, Control and Communication (INSTICC), held in collaboration with the University of Seville and the Escuela Técnica Superior de Ingeniería Informática (ETSII) at the University of Seville, and organized in cooperation with IICREST (Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology), CEPIS (Council of European Professional Informatics Societies), ATI (Asociación de Técnicos de Informática), FIDETIA (Fundación para la Investigación y el Desarollo de las Tecnologías de la Información en Andalucía) and INES (Iniciativa Española de Software y Servicios).

The purpose of ICSOFT is to bring together researchers and practitioners interested in information technology and software development. The conference tracks are "Enterprise Software Technology", "Software Engineering", "Distributed Systems", "Data Management" and "Knowledge-Based Systems".

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 the most complex management information systems; knowledge-base systems; distributed systems, ubiquity, data quality and many other topics are included in the scope of ICSOFT.

ICSOFT 2011 received 220 paper submissions from 48 countries. To evaluate each submission, a double-blind paper evaluation method was used: each paper was reviewed by at least two internationally known experts from the ICSOFT Program Committee. Only 27 papers were selected to be published and presented as full papers, i.e. completed work (10 pages in proceedings / 30' oral presentation). Additionally, 62 papers were accepted as short papers (6 pages / 20' oral presentation), - for a total of 89 oral presentations – and 33 papers as posters. The full-paper acceptance ratio was thus 12.3%, while the total oral paper acceptance ratio was 40.4%. As in previous editions of the conference, based on the reviewers' evaluations and on the presentations, a short list of authors will be invited to submit extended versions of their papers for a book which will be published by Springer with the best papers of ICSOFT 2011.

ICSOFT's program includes panels to discuss aspects of software development from both theoretical and practical perspectives, with the participation of distinguished world-class researchers and practitioners; 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 is already 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 efforts are herewith recorded. Secondly, we thank the members of the Program Committee and the additional reviewers for their diligent and professional reviewing. Next, we would like to personally thank the local organizers for all their hard work to provide smooth logistics and a friendly environment. 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 dinner - has been arranged for the evening of July 19 (Tuesday) in order to promote this kind of social networking.

We wish you all an exciting conference and an unforgettable stay in the city of Seville. We hope to meet you again next year for the 7th ICSOFT, to be held in Rome, details of which will shortly be made available at http://www.icsoft.org.

Maria Jose Escalona
University of Seville, Spain

Boris Shishkov
IICREST, Bulgaria

José Cordeiro
Polytechnic Institute of Setúbal / INSTICC, Portugal

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Abstract: This paper provides a summary of a systematic literature review (SLR) which was performed to find out which quality characteristics have been seen as relevant in the literature, in the context of Software Product Lines (SPLs). This SLR, which encompasses works published between 01/01/1995 and 30/05/2008, identified 319 papers in 5 digital libraries, as well as 8 papers which were added by experts as grey literature. After analyzing the papers found, 43 were selected as primary studies. After an analysis of the 43 primary studies, we found that maintainability and reusability are the most relevant quality characteristics in this context. There is increasing interest in the evaluation and improvement of quality in the development of software which follows the SPL approach. In spite of this, no quality model specific to SPLs has yet been found which would meet with a consensus of general approval. For that reason, a standard quality model for SPLs is needed. Techniques for assessing and improving such characteristics must also be provided.

1 INTRODUCTION

The concept of quality is particularly pertinent in the context of SPL, because common software components can, and indeed must, be developed with a higher level of quality, since they are used in every single product. That being the case, it evident that quality in SPLs improves the quality in each product created. Moreover, quality improvement in an SPL can increase re-use, and will consequently reduce effort, enhance product reliability, and shorten time-to-market.

This paper provides a summary of an SLR carried out to gather the quality characteristics that have been considered relevant in the literature related to the development of SPLs, along with the techniques that have been used to deal with them. In order to ensure that it is both systematic and rigorous, this SLR has been conducted by following the guidelines provided in (Kitchenham and Charters, 2007). The complete report of this SLR can be found at http://alarcos.esi.uclm.es/SLR-SPLquality.

The paper is organized as follows: in Section 2 the review process is presented in detail. The main results obtained from the SLR are reported in Section 3 and finally Section 4 presents some conclusions and suggestions for further research.

2 REVIEW PROCESS

In this section we describe the activities performed in the "Planning the review" and "Conducting the review" phases, based on (Kitchenham and Charters, 2007).

2.1 Planning the Review

In this phase we define the review protocol, consisting mainly of: formulation of the research question, selection of sources, definition of the search string, definition of inclusion or exclusion criteria and the selection of the information extraction strategy.

The research question that we wished to address is: *"What are the quality characteristics addressed by researchers in SPL development, and what techniques are proposed for dealing with them?"*.

We selected the following digital libraries to perform the searches: IEEE Computer Society, ACM, Science@Direct, Wiley InterScience, and SCOPUS. We also considered as grey literature some papers considered relevant by experts, but which were not found in the digital sources mentioned above.

The major search terms for building the search string were: "Product Line", "Quality" and "Software". In addition, to refine the search string, we selected specific quality characteristics obtained

from pilot searches we have done beforehand and some papers provided by experts, which were considered as "grey literature" in this SLR, as well as other quality characteristics that in our opinion can be relevant in this context. The alternative spellings or terminology related to the major terms are shown in Table 1.

Table 1: Search string.

Major terms	Alternative terms
Product line	Product families OR product family OR system families OR system family OR product lines
Quality	Maintainability OR flexibility OR reusability OR modifiability OR changeability OR functionality OR usability OR efficiency OR portability OR suitability OR accuracy OR interoperability OR security OR "fault tolerance" OR recoverability OR understandability OR comprehensibility OR learnability OR operability OR attractiveness OR "time behaviour" OR "resource utilisation" OR analysability OR stability OR testability OR adaptability OR installability OR replaceability OR complexity OR extensibility OR scalability OR customisability OR availability OR reliability OR mobility OR integrability OR safety
Software	-------

The relevant information from each paper used to answer the main research question addressed by this SLR was obtained from a data extraction strategy, consisting of the following six criteria: Quality characteristics, object of study, application domain, type of proposal, research method and type of support.

2.2 Conducting the Review

Firstly, we found 319 papers. Afterward, we analysed the title and abstract and selected 76 of them. Finally, 43 papers were chosen as primary studies, by applying the inclusion and exclusion criteria. The classification of the 43 papers included in this SLR can be found in http://alarcos.esi.uclm.es/SLR-SPLquality.

3 RESULTS

In the following paragraphs we present an analysis of the results obtained for each criterion used to extract the relevant information from the 43 selected papers.

3.1 Quality Characteristics

At the beginning, in the planning of the review 37 quality characteristics were proposed, but only 15 of these were found in the SLR. 11 other quality characteristics were obtained in the SLR, but these had not been proposed previously.

The final set of quality characteristics is the following: functionality, reliability, usability, efficiency, maintainability, portability, reusability, effectiveness, availability, configurability, integrability, scalability, modularity and applicability.

Regarding to the most important quality characteristics in the context of SPLs, we shows that maintainability and reusability are the most relevant ones, followed by reliability, functionality, portability and availability.

3.2 Object of Study

Various software artefacts were considered when we were setting out to define or evaluate quality characteristics in the context of SPLs. We looked at software artefacts, i.e. software architecture of the product line, software products obtained from SPLs and Others. As (Bass et al., 1998) states, "software architecture of the product line" is the structure or structures of the system, which are composed of software components, the externally visible properties of those components, and the relationships between them. A "software product obtained from SPLs" studies the quality of the products obtained using the SPL; "Others" includes the papers relating to core assets, core asset requirements or product line requirements.

3.3 Application Domain

The common domains are the embedded systems, which can be found in telecommunications, the automobile industry, electronic systems, medical machines and so on. In our study, the most typical is the telecommunications domain, with 11 papers. The telecommunications domain is a set of telecommunications functionalities, which in turn consists of other domains, such as switching, protocols, telephony and network. A telecommunications SPL is a specific set of software systems that provides some of these functionalities (Clements and Northrop, 2001).

The SPL domain that is in second place as regards prevalence is the medical one, with 5 papers. In addition, 3 papers have been classified as "general product line" (i.e. they are not specific to a specific domain, because the purpose was not really.

3.4 Type of Proposal

The type of proposals, that is, the type of techniques, has been classified as:

- Quality definition: when only the quality characteristics which are desirable for SPL are proposed, specified or defined.
- Quality improvement: when the proposal attempts to improve the quality characteristics.
- Quality assessment using scenarios: when the quality characteristics are evaluated through scenarios.
- Quality assessment using metrics: when the quality characteristics are evaluated by metrics.
- Quality assessment using scenarios and metrics: when scenarios and metrics are used to evaluate quality characteristics.

We can conclude that the majority of the papers considered only propose a list of quality characteristics which are relevant for evaluating SPL quality. The most widespread evaluation technique in the field of SPLs are scenarios and, to a lesser extent, quantitative metrics.

3.5 Research Method

We have considered five research methods, which reveal the type of evidence of the proposal; this shows how much evidence relating to SPL quality existed. The following research methods are ordered from their lowest to their highest levels:

- Speculation: the paper describes the quality characteristics, without presenting any study or example that would indicate its feasibility in software projects.
- Example: the paper describes approaches or proposals, showing their utility by means of an example.
- Survey: the paper sets out a questionnaire filled in by experts.
- Experience/industrial report: the paper describes a real team which is developing software in industry using the proposed SPL quality approach.
- Experimentation: the paper evaluates the SPL quality approach in some detail through an experimental.

Analyzing the papers, we can conclude that the level of empirical evidence in the different approaches proposed in the context of SPL quality is very low. The majority (44.19%) of the proposals are illustrated only with examples. Approximately 24% of papers are supported by experimentation. In this case, all of the 10 papers that were found validate the approaches presented through the use of case studies.

3.6 Type of Support

The proposal was considered to have a tool when the authors affirmed that a new tool had been created or when one or several existing tools was/were able to support their proposal. 20 (47%) of the 43 papers selected provided a support tool. The majority of the papers which did not propose a tool were those which were classified as "quality definition" in the "type of proposal" category, i.e. those papers which were limited to only defining quality characteristics did not propose any evaluation or improvement techniques.

3.7 Additional Results

Crossing the criteria application domain, research method, type of proposal and type of support, we can conclude that:

- The highest number of approaches validated through experiments exists in the Telecommunications domain, which is followed by the "Embedded systems" category.
- In the various Application domains, approximately the same number of proposals is supported by a tool as those which are not supported by a tool.
- The research method used to validate the proposals in each application domain is almost the same.
- Quality improvement proposals exist only in the Embedded systems and the General product line domains.
- In the Telecommunications and Medical domains, a high number of papers exist that only define quality characteristics.

Crossing "Quality characteristic" and other criteria we found that:

- For most of the quality characteristics, the "Object of study" was "Software architecture of the product line". However, for the Effectiveness characteristic, the main "Object of study" was "Software product obtained from SPLs" and for Applicability, it was "Others".
- For the majority of quality characteristics, the "Application domain" used to the greatest extent was "Embedded system industries".
- For the greater proportion of quality characteristics, the main "Type of proposal" was "Quality assessment using scenarios" and also "Quality definition". However, for the Usability and the Applicability characteristics, it was "Quality assessment using metrics".
- The "Research method" that enjoyed most widespread use for the greater part of the characteristics was "Example".

3.8 Recommendations

In this point, taking into account the results obtained, as well as our experience, some recommendations are presented in the context of SPL quality research. These are:

- A standard quality model for SPLs is needed, including characteristics and sub-characteristics, bearing in mind the quality characteristics researched in the context of SPL. In addition, techniques for assessing and improving such characteristics must be provided.
- SPL development must be spread more widely in the academic context, to make controlled experiments by students more possible. These are necessary if we are to find preliminary results before validating the proposal in industrial environments.
- A repository of easily accessible examples of SPLs that have already been developed is needed. They can be used as examples in the empirical validation of the approaches proposed for the evaluation and improvement of SPL quality. The development of SPLs consumes a great deal of resources, something which the majority of researchers lack in their universities. They consequently find it impossible to validate their proposals empirically.
- Further empirical validation by performing case studies or controlled experiments is essential if the level of evidence in this field is to be increased. If that were carried out, the approaches proposed for evaluating or improving SPL quality could become credible and would consequently be adopted by practitioners in industrial environments.

4 CONCLUSIONS AND FUTURE WORK

In this paper, we have presented a review of the main quality characteristics considered in the context of SPL development, by performing an SLR on the existing literature. We have found 43 primary studies in 5 digital libraries. The main findings organised by the selected data extraction criteria are shown in Table 2.

Table 2: Summary of the main findings.

Criteria analysed	Main findings
Quality characteristic	The quality characteristics in the majority of the works published are maintainability and reusability, followed by reliability, functionality, portability and availability.
Object of study	The quality focus of SPL development seems to centre principally upon SPL architecture.
Application domain	With regard to the SPL domain, the embedded systems are extensively published, and are mainly telecommunications infrastructures, medical machines and electronic systems. The software and the architecture of these domains are evaluated. The Telecommunications industry is the domain most frequently reported in our SLR.
Type of proposal	The papers contain several metrics concerning the quality of a software product line. Although a high percentage (35%) of the proposals limit themselves to proposing a list of characteristics, without showing how to evaluate or improve them, 65% of the papers propose the use of metrics and/or scenarios in the evaluation of quality, or a method to improve the quality.
Research methods	24% of the proposals present an experiment, which means that the majority of the proposals lack empirical validity.
Type of support	Different tools have been defined in the articles, in particular from the development of their own product lines.

From the SLR we can conclude that the area of SPLs is not yet mature and that our results are very useful for practitioners and researchers who need quality if they are using SPLs.

Future work is foreseen, which would take on the building of a quality model for SPLs, supported by a tool. There would be a validation of the quality model by means of empirical studies.

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