A Further Analysis of the Importance of Systematic Reviews to Computer Science

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Abstract—**Systematic Review has become an essential scientific method to research in Computer Science, mainly because interdisciplinary studies and scientific research in the Internet are demanding it. This work provides a further analysis on the subject through a systematic review in the domain of Computer Science, which was performed using scientific papers databases relevant to Computer Science, from the years 2006 to 2012. Our research has shown that 75.5% of the total number of papers are concentrated in the top 10 journals. Only 54.9% of the papers declared in the keywords that it was a systematic review, and only 75.7% declared it in their title. Additionally, our research has verified that 59.8% of the papers are directly related to Software Engineering.**

Index Terms—**Computer science, technology and education, interdisciplinary research, software engineering, systematic review.**

I. Introduction

Previously, we have presented a quantitative analysis of systematic reviews in Computer Science [1] to show its growing importance. In order to do that, a systematic review had to be performed, that is, we have done a systematic review of systematic reviews in Computer Science from 2006 to 2012. Herein, we continue our analysis seeking further insights on the subject.

The importance of systematic reviews in Computer Science as a scientific method had to be assessed, because not only science itself is becoming more interdisciplinary [2], but Computer Science researches are becoming even more interdisciplinary. Especially, when the research is related to the Internet or to human beings.

A systematic review is a method to identify the studies related to a common subject that aims to obtain unbiased knowledge in a comprehensive, systematic and replicable review of the scientific literature. The use of this method in health care studies was already consolidated in the 80's [3] to assess the strength and quality of scientific evidence, especially with regards to clinical recommendations. Its benefits are not only applicable in health researches, but it has also been used in Social Sciences [4], [5].

The interdisciplinary approach in research is also a good enough motive for requiring systematic reviews. It implies in the investigation of two or more fields. That may imply in much more information to investigate than a traditional single field research. This would prevent unwanted bias in the scientific literature review and it could provide, as in the case of Evidence-Based Medicine [3], the assessment of strength and quality of scientific evidence.

Hence, this work is a qualitative analysis of Systematic Reviews in the domain of Computer Science based on a systematic review. For the organization of this paper, we chose IMRAD structure [6]: introduction, methodology, results and discussion. This structure is part of the uniform requirements for manuscripts submitted to biomedicine journals from the International Committee of Medical Journal Editors. The adoption of this framework should facilitate the information storage and retrieval in international databases by search engines for research purposes like systematic reviews and meta-analysis.

II. Methodology

A systematic review is a method that gathers a set of similar primary studies that goes through a selection process regarding some specified criteria. This work is based on a systematic review to identify studies which also use the systematic review in the field of Computer Science [1], that is, a quantitative synthesis of other reviews of the literature regarding the Information Technology area.

The Systematic Review performed to support this paper was published in [1], which was based on the study of two other Systematic Reviews in Computer Science, Breivold et al. in [7], and Ampatzoglou and Stamelos in [8], which followed the guidelines presented in [9].

By the way, the steps of a systematic review may be divided in:

- To determine the rules for the review implementation;
- To establish the criteria for inclusion and exclusion;
- To investigate relevant studies;
- To assess the quality, the information extraction, and the synthesis.

The systematic review presented in [1] showed the statistics of publications of systematic reviews in Computer Science between 2006 and 2012. A total of 3,645 articles were examined, out of which 102 were selected, as shown in Table I. Additionally, in Fig. 1, it is shown a direct comparison of the number of selected publications from scientific databases. Both Table I and Fig. 1 presented here are an *Errata* of our previous work presented in [1].

Therefore, the methodology applied to develop this work was a systematic review with deeper data analysis than

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presented before. Consequently, it may be considered the continuation of our previous work [1].

TABLE I: OUTCOMES FROM RESEARCH GROUNDED ON SCIENTIFIC DATABASES

Database	Total results	Papers published in Journals	Papers in English	Inclused papers
ACM	536	535	535	9
Compendex	131	41	40	5
Elsevier	584	584	584	56
IEEE	740	166	166	12
ISI Web of Science	12	4	4	1
Wiley	548	514	509	1
Springer	1094	333	325	18
TOTAL	3645	2178	2164	102

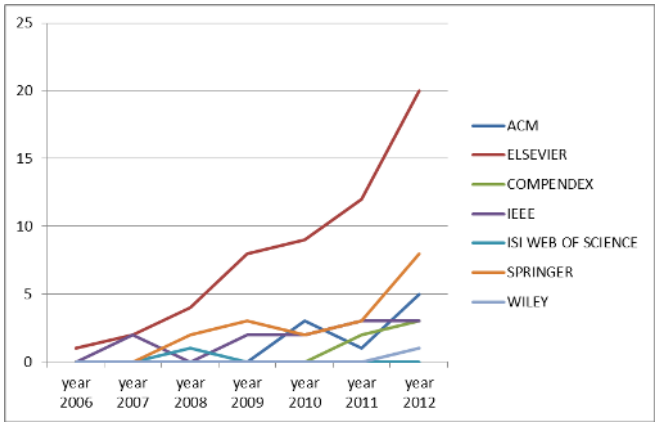

Fig. 1. Comparison among databases.

III. RESULTS

The results presented in this section are a deeper analysis of our systematic review presented in [1]. It is based on the data contained in Tables II, III and IV, which comprehend the period between 2006 and 2012.

From Table III – quantity of selected papers published per journal, it is facile to notice that the top 10 journals regarding the quantity of papers represent 75.5% (77/102). If we consider a quartile analysis, we have that each quartile has 9 journals and they have the following percentage of papers:

- Q1 – 73.5 (75/102);
- Q2 – 9.8 (10/102);
- Q3 – 8.8 (9/102);
- Q4 – 8.8 (9/102).

Additionally, it is quite evident the importance of the journal "Information and Software Technology" of Elsevier, because it responds for 39.2 % (40/102) of the selected papers.

From inspection of Table IV, we can observe that the following papers have the words "systematic" and "review" in their titles: [S1], [S2], [S3], [S5], [S6], [S7], [S11], [S12], [S13], [S14], [S15], [S16], [S17], [S18], [S19], [S20], [S21], [S22], [S23], [S24], [S25], [S26], [S27], [S28], [S29], [S30], [S31], [S32], [S33], [S34], [S35], [S36], [S37], [S38], [S39], [S40], [S41], [S42], [S43], [S44], [S45], [S46], [S47], [S49], [S50], [S51], [S52], [S53], [S55], [S56], [S58], [S63], [S64], [S68], [S70], [S71], [S72], [S73], [S75], [S76], [S77], [S79], [S80], [S82], [S85], [S86], [S87], [S88], [S89], [S91], [S92], [S95], [S97], [S98], [S99], [S100], [S102]. That is, 77 papers out of 102 (75.7%) express in their title that the paper is a systematic review.

From the keyword list – Table V, we observe that the expression "systematic review" appears only 56 times, that is, it appears 54.9% (56/102) of the selected papers.

From Tables III and IV an analysis of terms related to Software Engineering was performed. These lists show that:

- the papers [S3], [S13], [S20], [S30], [S32], [S33], [S34], [S39], [S43], [S44], [S54], [S57], [S58], [S62], [S64], [S71], [S75], [S82], [S90], [S91], [S92], [S96] contain in the keywords "software engineering", that is, 22 of 102 papers (21.6%) express in their keywords explicitly that their content is related to Software Engineering;
- and only the papers [S32], [S33], [S34], [S38], [S91], [S96], [S39], [S43], [S44], [S54], [S57], [S58], [S64], [S72], [S82] explicit in their titles that their content is related to Software Engineering, or 14.7%.

However, a thorough examination of the titles and keywords demonstrate that the list of papers related to Software Engineering" is: [S2], [S3], [S6], [S12], [S13], [S14], [S19], [S20], [S22], [S23], [S24], [S28], [S29], [S30], [S32], [S33], [S34], [S36], [S37], [S38], [S39], [S41], [S43], [S44], [S45], [S46], [S47], [S51], [S54], [S56], [S57], [S58], [S59], [S60], [S62], [S64], [S66], [S68], [S71], [S73], [S75], [S77], [S78], [S81], [S82], [S86], [S88], [S90], [S91], [S92], [S96], [S97], [S98], [S99], [S100]. In other words, 55 papers out of 102 (53.9%) are directly related to Software Engineering in their keywords.

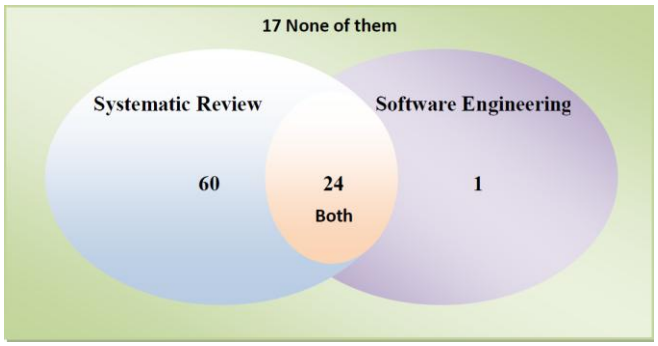

Fig. 2. Relation among papers that declare if they are a systematic review and of software engineering content.

TABLE II: PAPERS RELATED TO SOFTWARE ENGINEERING

Papers that	Contain Software Engineering in the title	Do not contain Software Engineering in the title
Contain Software Engineering in the key word	13	9
Do not contain Software Engineering in the key word	3	36

It is important to notice that it was difficult to determine if the papers [S16], [S21], [S25], [S53], [S70], [S80], [S93],

[S94], [S101] were related to Software Engineering only through their title and keywords. Then reading their abstract and introduction, we have determined that only the papers [S21], [S25], [S70], [S80], [S93], [S101] were related to Software Engineering. Hence, the total number of papers related to Software Engineering are 61 or 59.8%, which are analyzed in Fig. 2 and Table II.

IV. Discussion

The number of published papers of systematic review is growing in Computer Science in recent years, Fig. 1 [1]. Our research started with 3,645 papers from which 102 were selected, that is a survival rate of 2.8%. That means that the Systematic Review process is laborious and it requires much attention.

TABLE III: Quantity of Selected Papers Published Per Journal.

Journal	Publisher	qty
Information and Software Technology.	Elsevier	40
Journal of Systems and Software	Elsevier	9
Empirical Software Engineering	Springer	6
IEEE Transactions on Software Engineering	IEEE	6
Software Quality Journal	Springer	5
Requirements Engineering	Springer	3
Artificial Intelligence Review	Springer	2
Computer Standards & Interfaces	Elsevier	2
IEEE Transactions on Engineering Management	IEEE	2
Journal of Applied Sciences	IGI Global	2
ACM Computing Surveys	ACM	1
ACM Transactions on Computing Education	ACM	1
Advanced Engineering Informatics	Elsevier	1
COMPUTERS INFORMATICS NURSING	Kluwer	1
Computer Supported Cooperative Work	Springer	1
IEEE Transactions on Education	IEEE	1
Foundations and Trends in Information Retrieval	Elsevier	1
Future Generation Computer Systems	Elsevier	1
Health Research Policy and Systems	Springer	1
Higher-Order and Symbolic Computation	Springer	1
IEEE Software	IEEE	1
IEEE Transactions on Software Engineering	IEEE	1
IET software	IEEE	1
Intelligent Neuroscience	Hindawi.	1
International Journal of Enterprise Information Systems	IGI Global	1
International Journal of Information and Computer Security	Inderscience	1
International Journal of Metadata, Semantics and Ontologies	Inderscience	1
Journal of Database Management	IGI Global	1
Journal of Network and Computer Applications	Elsevier	1
Journal of Network and Computer Applications	Elsevier	1
Journal of the American Society for Information Science and Technology	Wiley	1
Multimedia Systems	Springer	1
Procedia Technology	Elsevier	1
Journal of Systems and Control Engineering	Domain analysis	1
Service Oriented Computing and Applications	Springer	1

Our research has shown that the top 10 journals that had published more systematic reviews papers in Computer Science represents 75.5% of the total number of papers. The number one journal regarding that – "Information and Software Technology", is responsible for 39.2% of the total number of papers. Only 54.9% of the papers declared in the keywords that it was a systematic review, and only 75.7% declared it in their title. Additionally, our research has verified that 59.8% are directly related to Software Engineering.

Consequently, as in [6], we recommend that every "Systematic Review" paper in Computer Science should declare it in their title and keywords. Another recommendation is to declare that the paper is related to "Software Engineering" should be explicit in the keywords. Both statements would facilitate and improve the results of systematic reviews in software engineering.

Finally, it is important to report that in the Department of Computer Science of the Federal University of Tocantins (UFT – *Universidade Federal do Tocantins*), Systematic Review has been taught in the discipline of Scientific Methodology for the last two years resulting in the publication of papers such as in [1], [10] and this paper itself, i.e., we have been teaching systematic review for both graduate and undergraduate students in an effective way, which suggests further studies of efficiency in the learning process.

TABLE IV: List of Selected Papers.

[S1]	Philip Woodall and Pearl Brereton. 2010. A systematic literature review of inference strategies.*Int. J. Inf. Comput. Secur.* 4, 2 (August 2010), 99-117. DOI=10.1504/IJICS.2010.034813 http://dx.doi.org/10.1504/IJICS.2010.034813
[S2]	Sonia Montagud, Silvia Abrahão, and Emilio Insfran. 2012. A systematic review of quality attributes and measures for software product lines. Software Quality Control 20, 3-4 (September 2012), 425-486. DOI=10.1007/s11219-011-9146-7 http://dx.doi.org/10.1007/s11219-011-9146-7
[S3]	Maria\&\#45;Cruz Valiente. 2010. A systematic review of research on integration of ontologies with the model\&\#45;driven approach. Int. J. Metadata Semant. Ontologies 5, 2 (May 2010), 134-150. DOI=10.1504/IJMSO.2010.033283 http://dx.doi.org/10.1504/IJMSO.2010.033283
[S4]	E. W. Lang, A. M. Tomé, I. R. Keck, J. M. Górriz-Sáez, and C. G. Puntonet. 2012. Brain connectivity analysis: a short survey. Intell. Neuroscience 2012, Article 8 (January 2012), 1 pages. DOI=10.1155/2012/412512 http://dx.doi.org/10.1155/2012/412512
[S5]	Barbara A. Kitchenham, Pearl Brereton, Mark Turner, Mahmood K. Niazi, Stephen Linkman, Rialette Pretorius, and David Budgen. 2010. Refining the systematic literature review process--two participant-observer case studies. Empirical Softw. Engg. 15, 6 (December 2010), 618-653. DOI=10.1007/s10664-010-9134-8 http://dx.doi.org/10.1007/s10664-010-9134-8
[S6]	Mario Piattini, Geert Poels, Marcela Genero, Ana M. Fernández-Saez, and H. James Nelson. 2011. Research Review: A Systematic Literature Review on the Quality of UML Models. J. Database Manage. 22, 3 (July 2011), 46-70. DOI=10.4018/jdm.2011070103 http://dx.doi.org/10.4018/jdm.2011070103
[S7]	Sudhanshu Tyagi and Neeraj Kumar. 2012. Review: A systematic review on clustering and routing techniques based upon LEACH protocol for wireless sensor networks. J. Netw. Comput. Appl. 36, 2 (March 2012), 623-645. DOI=10.1016/j.jnca.2012.12.001 http://dx.doi.org/10.1016/j.jnca.2012.12.001
[S8]	Boris Danev, Davide Zanetti, and Srdjan Capkun. 2012. On physical-layer identification of wireless devices. ACM Comput. Surv. 45, 1, Article 6 (December 2012), 29 pages. DOI=10.1145/2379776.2379782 http://doi.acm.org/10.1145/2379776.2379782
[S9]	Michael J. O'Grady. 2012. Practical Problem-Based Learning in Computing Education. Trans. Comput. Educ. 12, 3, Article 10 (July 2012), 16 pages. DOI=10.1145/2275597.2275599

	http://doi.acm.org/10.1145/2275597.2275599
[S10]	Lerina Aversano, Carmine Grasso, Maria Tortorella, A Literature Review of Business/IT Alignment Strategies, Procedia Technology, Volume 5, 2012, Pages 462-474, ISSN 2212-0173, http://dx.doi.org/10.1016/j.protcy.2012.09.051.
[S11]	Sarah Heckman and Laurie Williams. 2011. A systematic literature review of actionable alert identification techniques for automated static code analysis. Inf. Softw. Technol. 53, 4 (April 2011), 363-387. DOI=10.1016/j.infsof.2010.12.007 http://dx.doi.org/10.1016/j.infsof.2010.12.007
[S12]	Lars M. Karg, Michael Grottke, and Arne Beckhaus. 2011. A systematic literature review of software quality cost research. J. Syst. Softw. 84, 3 (March 2011), 415-427. DOI=10.1016/j.jss.2010.11.904 http://dx.doi.org/10.1016/j.jss.2010.11.904
[S13]	Carla Pacheco and Ivan Garcia. 2012. A systematic literature review of stakeholder identification methods in requirements elicitation. J. Syst. Softw. 85, 9 (September 2012), 2171-2181. DOI=10.1016/j.jss.2012.04.075 http://dx.doi.org/10.1016/j.jss.2012.04.075
[S14]	Gursimran Singh Walia and Jeffrey C. Carver. 2009. A systematic literature review to identify and classify software requirement errors. Inf. Softw. Technol. 51, 7 (July 2009), 1087-1109. DOI=10.1016/j.infsof.2009.01.004 http://dx.doi.org/10.1016/j.infsof.2009.01.004
[S15]	Gerald Holl, Paul Grünbacher, and Rick Rabiser. 2012. A systematic review and an expert survey on capabilities supporting multi product lines. Inf. Softw. Technol. 54, 8 (August 2012), 828-852. DOI=10.1016/j.infsof.2012.02.002 http://dx.doi.org/10.1016/j.infsof.2012.02.002
[S16]	Eladio DomıNguez, Beatriz PéRez, ÁNgel L. Rubio, and MarıA A. Zapata. 2012. A systematic review of code generation proposals from state machine specifications. Inf. Softw. Technol. 54, 10 (October 2012), 1045-1066. DOI=10.1016/j.infsof.2012.04.008 http://dx.doi.org/10.1016/j.infsof.2012.04.008
[S17]	Martin Ivarsson and Tony Gorschek. 2011. A method for evaluating rigor and industrial relevance of technology evaluations. Empirical Softw. Engg. 16, 3 (June 2011), 365-395. DOI=10.1007/s10664-010-9146-4 http://dx.doi.org/10.1007/s10664-010-9146-4
[S18]	Liana Barachisio Lisboa, Vinicius Cardoso Garcia, Daniel Lucrédio, Eduardo Santana de Almeida, Silvio Romero de Lemos Meira, and Renata Pontin de Mattos Fortes. 2010. A systematic review of domain analysis tools. Inf. Softw. Technol. 52, 1 (January 2010), 1-13. DOI=10.1016/j.infsof.2009.05.001 http://dx.doi.org/10.1016/j.infsof.2009.05.001
[S19]	Lianping Chen, Muhammad Ali Babar, and Nour Ali. 2009. Variability management in software product lines: a systematic review. In Proceedings of the 13th International Software Product Line Conference (SPLC '09). Carnegie Mellon University, Pittsburgh, PA, USA, 81-90.
[S20]	HÖST, Martin; ORUČEVIĆ-ALAGIĆ, Alma. A systematic review of research on open source software in commercial software product development.Information and Software Technology, v. 53, n. 6, p. 616-624, 2011.
[S21]	Wasif Afzal, Richard Torkar, and Robert Feldt. 2009. A systematic review of search-based testing for non-functional system properties. Inf. Softw. Technol. 51, 6 (June 2009), 957-976. DOI=10.1016/j.infsof.2008.12.005 http://dx.doi.org/10.1016/j.infsof.2008.12.005
[S22]	Daniel Mellado, Carlos Blanco, Luis E. Sánchez, and Eduardo Fernández-Medina. 2010. A systematic review of security requirements engineering. Comput. Stand. Interfaces 32, 4 (June 2010), 153-165. DOI=10.1016/j.csi.2010.01.006 http://dx.doi.org/10.1016/j.csi.2010.01.006
[S23]	Hongyu Pei Breivold, Ivica Crnkovic, and Magnus Larsson. 2012. A systematic review of software architecture evolution research. Inf. Softw. Technol. 54, 1 (January 2012), 16-40. DOI=10.1016/j.infsof.2011.06.002 http://dx.doi.org/10.1016/j.infsof.2011.06.002
[S24]	Ali Shahrokni, Robert Feldt, A systematic review of software robustness, Information and Software Technology, Volume 55, Issue 1, January 2012, Pages 1-17, ISSN 0950-5849, http://dx.doi.org/10.1016/j.infsof.2012.06.002. (http://www.sciencedirect.com/science/article/pii/S0950584912001048)
[S25]	Emelie Engström, Per Runeson, and Mats Skoglund. 2010. A systematic review on regression test selection techniques. Inf. Softw. Technol. 52, 1 (January 2010), 14-30. DOI=10.1016/j.infsof.2009.07.001 http://dx.doi.org/10.1016/j.infsof.2009.07.001
[S26]	Amir Hossein Ghapanchi and Aybuke Aurum. 2011. Antecedents to IT personnel's intentions to leave: A systematic literature review. J. Syst. Softw. 84, 2 (February 2011), 238-249. DOI=10.1016/j.jss.2010.09.022 http://dx.doi.org/10.1016/j.jss.2010.09.022
[S27]	Carlos Blanco, Joaqu\&\#237;n Lasheras, Eduardo Fern\&\#225;ndez-Medina, Rafael Valencia-Garc\&\#237;a, and Ambrosio Toval. 2011. Basis for an integrated security ontology according to a systematic review of existing proposals. Comput. Stand. Interfaces 33, 4 (June 2011), 372-388. DOI=10.1016/j.csi.2010.12.002 http://dx.doi.org/10.1016/j.csi.2010.12.002
[S28]	Byron J. Williams and Jeffrey C. Carver. 2010. Characterizing software architecture changes: A systematic review. Inf. Softw. Technol. 52, 1 (January 2010), 31-51. DOI=10.1016/j.infsof.2009.07.002 http://dx.doi.org/10.1016/j.infsof.2009.07.002
[S29]	Parastoo Mohagheghi, Vegard Dehlen, and Tor Neple. 2009. Definitions and approaches to model quality in model-based software development - A review of literature. Inf. Softw. Technol. 51, 12 (December 2009), 1646-1669. DOI=10.1016/j.infsof.2009.04.004 http://dx.doi.org/10.1016/j.infsof.2009.04.004
[S30]	Tore Dybå and Torgeir Dingsøyr. 2008. Empirical studies of agile software development: A systematic review. Inf. Softw. Technol. 50, 9-10 (August 2008), 833-859. DOI=10.1016/j.infsof.2008.01.006 http://dx.doi.org/10.1016/j.infsof.2008.01.006
[S31]	Antoni Lluís Mesquida, Antonia Mas, Esperança Amengual, and Jose A. Calvo-Manzano. 2012. IT Service Management Process Improvement based on ISO/IEC 15504: A systematic review. Inf. Softw. Technol. 54, 3 (March 2012), 239-247. DOI=10.1016/j.infsof.2011.11.002 http://dx.doi.org/10.1016/j.infsof.2011.11.002
[S32]	Finn Olav Bj\&\#248;rnson and Torgeir Dings\&\#248;yr. 2008. Knowledge management in software engineering: A systematic review of studied concepts, findings and research methods used. Inf. Softw. Technol. 50, 11 (October 2008), 1055-1068. DOI=10.1016/j.infsof.2008.03.006 http://dx.doi.org/10.1016/j.infsof.2008.03.006
[S33]	Pearl Brereton, Barbara A. Kitchenham, David Budgen, Mark Turner, and Mohamed Khalil. 2007. Lessons from applying the systematic literature review process within the software engineering domain. J. Syst. Softw. 80, 4 (April 2007), 571-583. DOI=10.1016/j.jss.2006.07.009 http://dx.doi.org/10.1016/j.jss.2006.07.009
[S34]	Sarah Beecham, Nathan Baddoo, Tracy Hall, Hugh Robinson, and Helen Sharp. 2008. Motivation in Software Engineering: A systematic literature review. Inf. Softw. Technol. 50, 9-10 (August 2008), 860-878. DOI=10.1016/j.infsof.2007.09.004 http://dx.doi.org/10.1016/j.infsof.2007.09.004
[S35]	Rafael Prikladnicki and Jorge Luis Nicolas Audy. 2010. Process models in the practice of distributed software development: A systematic review of the literature. Inf. Softw. Technol.52, 8 (August 2010), 779-791. DOI=10.1016/j.infsof.2010.03.009 http://dx.doi.org/10.1016/j.infsof.2010.03.009
[S36]	Andréa Magalhães Magdaleno, Cláudia Maria Lima Werner, and Renata Mendes de Araujo. 2012. Reconciling software development models: A quasi-systematic review. J. Syst. Softw. 85, 2 (February 2012), 351-369. DOI=10.1016/j.jss.2011.08.028 http://dx.doi.org/10.1016/j.jss.2011.08.028

[S37]	Vander Alves, Nan Niu, Carina Alves, and George Valen\&\#231;a. 2010. Requirements engineering for software product lines: A systematic literature review. Inf. Softw. Technol. 52, 8 (August 2010), 806-820. DOI=10.1016/j.infsof.2010.03.014 http://dx.doi.org/10.1016/j.infsof.2010.03.014
[S38]	Wasif Afzal and Richard Torkar. 2011. Review: On the application of genetic programming for software engineering predictive modeling: A systematic review. Expert Syst. Appl. 38, 9 (September 2011), 11984-11997. DOI=10.1016/j.eswa.2011.03.041 http://dx.doi.org/10.1016/j.eswa.2011.03.041
[S39]	Fabio Q. B. da Silva, André L. M. Santos, Sérgio Soares, A. César C. França, Cleviton V. F. Monteiro, and Felipe Farias Maciel. 2011. Six years of systematic literature reviews in software engineering: An updated tertiary study. Inf. Softw. Technol. 53, 9 (September 2011), 899-913. DOI=10.1016/j.infsof.2011.04.004 http://dx.doi.org/10.1016/j.infsof.2011.04.004
[S40]	Dhavleesh Rattan, Rajesh Kumar Bhatia, Maninder Singh: Software clone detection: A systematic review. Information & Software Technology 55(7): 1165-1199 (2012)
[S41]	Danijel Radjenović, Marjan Heričko, Richard Torkar, Aleš Živkovič, Software fault prediction metrics: A systematic literature review, Information and Software Technology, Volume 55, Issue 8, August 2012, Pages 1397-1418, ISSN 0950-5849, http://dx.doi.org/10.1016/j.infsof.2012.02.009.(http://www.sciencedirect.com/science/article/pii/S0950584913000426)
[S42]	Jianfeng Wen, Shixian Li, Zhiyong Lin, Yong Hu, and Changqin Huang. 2012. Systematic literature review of machine learning based software development effort estimation models. Inf. Softw. Technol. 54, 1 (January 2012), 41-59. DOI=10.1016/j.infsof.2011.09.002 http://dx.doi.org/10.1016/j.infsof.2011.09.002
[S43]	Barbara Kitchenham, O. Pearl Brereton, David Budgen, Mark Turner, John Bailey, and Stephen Linkman. 2009. Systematic literature reviews in software engineering - A systematic literature review. Inf. Softw. Technol. 51, 1 (January 2009), 7-15. DOI=10.1016/j.infsof.2008.09.009 http://dx.doi.org/10.1016/j.infsof.2008.09.009
[S44]	Barbara Kitchenham, Rialette Pretorius, David Budgen, O. Pearl Brereton, Mark Turner, Mahmood Niazi, and Stephen Linkman. 2010. Systematic literature reviews in software engineering - A tertiary study. Inf. Softw. Technol. 52, 8 (August 2010), 792-805. DOI=10.1016/j.infsof.2010.03.006 http://dx.doi.org/10.1016/j.infsof.2010.03.006
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TABLE V: LIST OF SELECTED PAPERS' KEYWORDS.

[KW1]	Systematic review	56	[KW142]	inference strategies	1
[KW2]	Software engineering	11	[KW143]	inferring information	1
[KW3]	Ontology	7	[KW144]	Informatics	1
[KW4]	Empirical studies	6	[KW145]	information security	1
[KW5]	Evidence-based software engineering	6	[KW146]	Information services	1
[KW6]	Mapping study	6	[KW147]	information systems	1
[KW7]	Requirements engineering	6	[KW148]	Innovation	1
[KW8]	Empirical software engineering	5	[KW149]	Instructional strategy	1
[KW9]	Quality attributes	4	[KW150]	Intention to leave	1
[KW10]	Security	4	[KW151]	Internet	1
[KW11]	Software process	4	[KW152]	Intrusion detection	1
[KW12]	Software Process Improvement	4	[KW153]	ISO/IEC 15504 (SPICE)	1
[KW13]	Software product line	4	[KW154]	IT personnel	1
[KW14]	agile	2	[KW155]	IT Service Management (ITSM)	1
[KW15]	Case study	3	[KW156]	Java	1
[KW16]	model-driven engineering	3	[KW157]	Large-scale systems	1
[KW17]	Modelling	3	[KW158]	Learning software organization	1
[KW18]	Software architecture	3	[KW159]	Life cycle	1
[KW19]	Software development	3	[KW160]	Machine learning	1
[KW20]	Tertiary study	3	[KW161]	management	1
[KW21]	Traceability	3	[KW162]	Management science	1
[KW22]	UML	3	[KW163]	Manual search	1
[KW23]	aggregation	2	[KW164]	MDE	1
[KW24]	Automated search	2	[KW165]	Measurement framework	1
[KW25]	Broad search	2	[KW166]	metrics/measurement	1
[KW26]	Clinical research	2	[KW167]	Model based clone	1
[KW27]	Communication	2	[KW168]	Model quality	1
[KW28]	Cooperation	2	[KW169]	Model-driven development	1
[KW29]	Cost estimation	2	[KW170]	model-driven software development	1
[KW30]	Domain analysis	2	[KW171]	Models	1
[KW31]	Empirical evidence	2	[KW172]	Motivation	1
[KW32]	Information technology	2	[KW173]	Motivation	1
[KW33]	Knowledge management	2	[KW174]	Multi product lines	1
[KW34]	Learningsystems	2	[KW175]	Natural language	1
[KW35]	Mapping study	2	[KW176]	Natural language processing systems	1
[KW36]	Measurement	2	[KW177]	neglected diseases	1
[KW37]	Measures	2	[KW178]	Non-functional system properties	1
[KW38]	Mixed-methods	2	[KW179]	Nursing skills	1
[KW39]	Open source software	2	[KW180]	Offshore software development outsourcing (OSDO)	1
[KW40]	People management	2	[KW181]	Ontology Application	1
[KW41]	Quality	2	[KW182]	Ontology-Based Knowledge Management	1
[KW42]	Quality evaluation process	2	[KW183]	open source	1
[KW43]	Regression testing	2	[KW184]	Organizations	1
[KW44]	Routing	2	[KW185]	pair programming	1
[KW45]	Search strategy	2	[KW186]	performance measures	1
[KW46]	Software	2	[KW187]	Personality	1
[KW47]	Software fault prediction	2	[KW188]	pharmaceutical innovation	1
[KW48]	Software quality	2	[KW189]	physical layer	1
[KW49]	Strategic release planning models	2	[KW190]	PL	1
[KW50]	Test selection	2	[KW191]	Plan-driven	1
[KW51]	Trade-off approaches	2	[KW192]	Practical problems	1
[KW52]	Variability	2	[KW193]	Prevention appraisal failure cost scheme	1
[KW53]	Abstracting	1	[KW194]	privacy	1
[KW54]	access control	1	[KW195]	Problem based learning	1
[KW55]	Actionable alert identification	1	[KW196]	Process implementation and change	1
[KW56]	Actionable alert prediction	1	[KW197]	Process lines	1
[KW57]	Agile software development	1	[KW198]	process measurement	1
[KW58]	alignment	1	[KW199]	Process tailoring	1
[KW59]	Analysis model	1	[KW200]	Product development	1
[KW60]	AOM	1	[KW201]	Product line engineering	1
[KW61]	Application layer	1	[KW202]	program comprehension	1
[KW62]	Architecture analysis	1	[KW203]	Program transformations	1

[KW63]	Architecture evolution	1
[KW64]	Artificial intelligence	1
[KW65]	aspect modelling	1
[KW66]	aspect represetations	1
[KW67]	aspects	1
[KW68]	aspectual UML	1
[KW69]	Automated static analysis	1
[KW70]	Awareness	1
[KW71]	BPM	1
[KW72]	Business models	1
[KW73]	Business process management	1
[KW74]	Bytecode engineering	1
[KW75]	Capability Maturity Model	1
[KW76]	Case study, computing education	1
[KW77]	Change characterization	1
[KW78]	Characteristics	1
[KW79]	Cloud computing	1
[KW80]	Clustering	1
[KW81]	CMM	1
[KW82]	CMMI	1
[KW83]	Code generation	1
[KW84]	Commercial	1
[KW85]	Communication and collaboration	1
[KW86]	Competency ass essment	1
[KW87]	Component based software engineering	1
[KW88]	Computer crime	1
[KW89]	Computer game	1
[KW90]	Computer science	1
[KW91]	Computer software	1
[KW92]	Computing education	1
[KW93]	Conceptual Model Quality	1
[KW94]	Conceptual Models	1
[KW95]	Control syste	1
[KW96]	Control system synthesis	1
[KW97]	Controlled experiment	1
[KW98]	Cost benefit	1
[KW204]	Project management	1
[KW205]	Proprietary	1
[KW206]	Quality costs	1
[KW207]	Quasi-gold standard	1
[KW208]	Reactive systems	1
[KW209]	Reconciliation among development models	1
[KW210]	Replications	1
[KW211]	Requirements	1
[KW212]	Requirements elicitation	1
[KW213]	Requirements selection factors	1
[KW214]	Research	1
[KW215]	research methods	1
[KW216]	Research synthesis	1
[KW217]	Resource management	1
[KW218]	risk management	1
[KW219]	Road-mapping	1
[KW220]	Robustness	1
[KW221]	Scrum	1
[KW222]	Search engines	1
[KW223]	Search-based software testing	1
[KW224]	Secure development	1
[KW225]	Security engineering	1
[KW226]	Security requirements	1
[KW227]	Security requirements engineering	1
[KW228]	Semantic clones	1
[KW229]	Service-based application	1
[KW230]	Service-based systems	1
[KW231]	Service-oriented system engineering	1
[KW232]	Small and medium software enterprises	1
[KW233]	SMEs	1
[KW234]	SOA	1
[KW235]	Software changes	1
[KW236]	Software clone	1
[KW237]	software complexity	1
[KW238]	software cost estimation	1
[KW239]	Software design	1
	analysis	
[KW99]	cost prediction	1
[KW100]	cross curting	1
[KW101]	CS education	1
[KW102]	Design	1
[KW103]	Development lifecycle	1
[KW104]	diagrams	1
[KW105]	Distributed software development	1
[KW106]	Distributed software engineering	1
[KW107]	distributed software projects	1
[KW108]	Domain modeling	1
[KW109]	Domain scoping	1
[KW110]	drug discovery	1
[KW111]	dynamic analysis	1
[KW112]	Dynamic binding	1
[KW113]	Education	1
[KW114]	Electric power distribution	1
[KW115]	Electronic mail	1
[KW116]	Elicitation methods	1
[KW117]	Employee retention	
[KW118]	Employee turnover	1
[KW119]	Energy management	1
[KW120]	Planning	1
[KW121]	Enterprise evolution	1
[KW122]	Enterprise Systems	1
[KW123]	Evaluation and analysis	1
[KW124]	Evidence-based practice	1
[KW125]	Evolvability analysis	1
[KW126]	Experimental software engineering	1
[KW127]	Experimental study	1
[KW128]	experimentation	1
[KW129]	Experiments	1
[KW130]	Extreme programming	1
[KW131]	fingerprinting	1
[KW132]	Finite state machines	1
[KW133]	Free/open source software	1
[KW134]	Genetic programming	1
[KW135]	Global software	1
[KW240]	software effort	1
[KW241]	Software effort estimation	1
[KW242]	software estimation	1
[KW243]	Software evolution	1
[KW244]	Software evolvability	1
[KW245]	Software maintenance	1
[KW246]	Software metric	1
[KW247]	Software product lines	1
[KW248]	Software robustness	1
[KW249]	Software testing	1
[KW250]	SOSE challenge	1
[KW251]	SOVRM	1
[KW252]	SPI	1
[KW253]	Stakeholder identification	1
[KW254]	Statecharts	1
[KW255]	Survey	1
[KW256]	Symbolic regression	1
[KW257]	Systematic mapping	1
[KW258]	Systematic mapping study	1
[KW259]	Systematic review software effort	1
[KW260]	Targeted search	1
[KW261]	Taxonomies	1
[KW262]	Technology evaluation	1
[KW263]	Technology transfer	1
[KW264]	Teleo-Reactive formalism	1
[KW265]	Test case prioritization	1
[KW266]	Testing	1
[KW267]	Tools	1
[KW268]	Transformation	1
[KW269]	UML state machines	1
[KW270]	Unactionable alert mitigation	1
[KW271]	Unified Modeling Language UML	1
[KW272]	Usability	1
[KW273]	Usefulness	1
[KW274]	Variability management	1
[KW275]	Variant-rich processes	1
[KW276]	Warning	1

	engineering	
[KW136]	group projects	1
[KW137]	GWG (game world graph)	1
[KW138]	Human errors	1
[KW139]	Identification	1
[KW140]	Industry	1
[KW141]	inference protection	1

	prioritization	
[KW277]	Wave filters	1
[KW278]	Web engineering	1
[KW279]	wireless device	1
[KW280]	World Wide Web	1
[KW281]	WSN	1

APPENDIX

In this appendix, we present three tables. The first shows the number of selected papers per journal from 2006 to 2012; the second lists the selected papers from 2006 to 2012; and the third is a list of all keywords of the selected papers from 2006 to 2012.

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