Retrospective and Trends in Requirement Engineering through WER

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Abstract. This work refers to the review of 258 papers published in the WER throughout 15 editions. This review´s goal was to identify the most active research groups within this workshop, the most debated topics and the trends in the Requirements Engineering area. The results showed that Brazil, Argentina and Spain hold the most active groups. Moreover, the results pointed out the requirements modeling as one of the most discussed topics in this event.

Keywords. Retrospective, Trends, Requirements Engineering, WER

1 Introduction

The Requirements identification is an extremely important activity, since it is the basis for the planning, development follow up and acceptance of the software project results [1]. In order to support these results, Requirements Engineering provides appropriate mechanisms to understand the client´s needs, analyzing necessities, checking feasibilities, negotiating a reasonable solution, specifying a solution without ambiguities, validating a specification and managing the needs as they are transformed into a system [2].

Some of the main activities related to Requirements Engineering are as follows: elicitation, analysis, specification, validation and requirements management [3]. These activities main goal is to support understanding and to formalize the client´s main needs in a way that it decreases the problems throughout the software development.

However, despite the advances in the Requirements Engineering area, as software become much more complex and bigger, new problems emerge and new solutions are proposed [4]. Thus, it is important to follow the evolution of the topics related to this area. Some mappings and systematic reviews have been performed in order to provide a better idea of what has been produced in this area. These works have offered a better vision for specific topics from the Requirements Engineering area, such as elicitation techniques [5] [6], specification techniques [7] and requirements writing standards [8].

However, it is also important to consider providing a broad vision of the main discussed topics among research groups, as well as identifying these groups. This infor-

mation may bring several benefits to the scientific area, such as the identification of new information sources, establishment of new partnerships and the orientation of researches toward more relevant topics at a given time. The scientific works are a quite important source to find this information. The Requirements Engineering area has several means of publishing these works, such as specialized journals and international events.

In this context, this work had the goal of identifying some of this information and as an initial source of research, the Workshop on Requirements Engineering (WER) was chosen. The WER is a workshop that has been taking place since 1998 with the goal of consolidating the Iberoamerican Requirements Engineering research community. The event has predominantly happened in Argentina and Brazil. However, in the last few years, other countries from South, North America and Europe have hosted this event as seen in Table 1. Throughout 15 editions of the WER, 258 papers have been published. The published topics discuss issues involving the main activities of Requirements Engineering. The WER is considered a mature and consolidated event in the Requirements Engineering area and for this reason was considered a feasible source to obtain relevant answers in this area.

Table 1. Host cities of WER

Year	Country/City
1998	Brazil/Maringá
1999	Argentina/Buenos Aires
2000	Brazil/Rio de Janeiro
2001	Argentina/Buenos Aires
2002	Spain/Valência
2003	Brazil/Piracicaba
2004	Argentina/Tandil
2005	Portugal/Porto
2006	Brazil/Rio de Janeiro
2007	Canada/Toronto
2008	Spain/Barcelona
2009	Chile/Valparaiso
2010	Ecuador/Cuenca
2011	Brazil/Rio de Janeiro
2012	Argentina/Buenos Aires
2013	Uruguay/Montevideo

Section 2 describes the method used in this research, followed by Section 3, which details and discusses the results. Finally Section 4 presents the final considerations of this work.

2 Method

This section describes the method used in this research, including the questions and the steps performed in order to make the extractions and classification of the analyzed papers.

2.1 Development of the research questions

With the goal of identifying the most active countries and institutions at the WER, as well as the most discussed topics and trends in Requirements Engineering, the following questions have been made:

1. What are the main countries that published in WER?
2. What are the main institutions that published in WER?
3. What are the main topics discussed in WER?
4. Which institutions have been discussed the main topics?
5. Which topics have been discussed for the main institutions?
6. What are the trends in Requirements Engineering?

2.2 Extraction of information

In order to answer the previous questions, each one of the 258 papers has been analyzed with the goal of extracting the following information: institutions involved in research, home country of the institution and main discussed topics. The access to the papers was made through the website http://wer.inf.puc-rio.br.

The institution identification and home country was manually made in each one of the papers. More than one institution could have been related to the article through their researchers, including the ones from different countries.

In order to define the topics to be classified, first was analyzed the classification used in the previous WER´s editions. However, it was noted that in back 1998, 2000, 2002, 2006, 2007 and 2012, no classification was proposed by the event. Moreover, it was also noted that the topics had a variation in their nomenclature throughout the years, as well as the unification of topics, as it can be seen in Table 2. Considering these limitations, it has been decided to propose a classification based on the classifications already made unifying or subdividing determined topics. The result of this new classification is presented in Table 3.

After the topics classification definition, two students (one master and one doctor) read the papers with the goal of identifying the main discussed topics. It was defined that the paper must be related to at least one topic presented in Table 3 but new topics not listed in Table 3 could be included and related. The reading and identification of the topics was performed in an independent way between the students. For some of the papers, the reading of the abstracts was enough in order to identify their topics. In other cases, the papers had to be read thoroughly. After the individualized classification was performed, the students together made the consolidation of issues where there was divergence of classification.

Table 2. Topics of the WER

Year	Topics						
1999	Multidisc. approach and Education	Analysis	Modeling and Represent. Requirem.	Negotiation and Requirem. elicitation	Process e Management Requirem.		
2001	Requirements elicitation	Requirements modeling	Process and req. management	Quality Requirements	Non-functional requirements	Requirements reuse	
2003	Requirements elicitation	Specification and Requirements modeling	Requirements management and Experimental studies	Process, model, methods and tools	Quality requirements and Quality Assessment		
2004	Requirements elicitation	Experimental studies	Requirements management	Modeling and Specification	Process, Methods and Tools	Quality requirements	Requirements for agent-oriented paradigm
2005	Cognitive approaches and Reuse	Agents and objectives	Analysis and Modeling	Aspects and Composition	Requirements elicitation	Process	Quality and Metrics
2008	Analysis	Elicitation /Empirical Studies	Elicitation /Methodologies and Tools	Modeling	Process and Quality	Reuse and Traceability	
2009	Early requirements	Requirements elicitation and Management	Requirements specification and Management	Later Requirements and architecture	Traceability and Product Lines		
2010	Requirements elicitation	Req.specification and Modeling	Req. management and Traceability	Business process mod. and P. Families			
2011	Aligning req. with business objectives and process	Early requirements	Late requirements	Non-functional requirements	Reuse of requirements	Models transformation	

Table 3. Topics proposed for classification

Requirements Engineering topics
Cognitive approaches, educational and knowledge management
Requirements analysis and Requirements negotiating
Requirements elicitation
Requirements specification
Tools
Requirements management
Measurement/Metrics
Requirements modeling
Process/Method
Quality requirements
Requirements traceability
Non-functional requirements
Agent-oriented paradigm
Reuse
Requirements Validation

The obtained results after the papers' classification are presented and discussed below.

3 Results and Discussion

The results will be presented and organized according to the research questions presented in Section 3.

3.1 What are the main countries that published in WER?

In all, 20 countries had at least one publication at WER through 121 institutions. In Table 4 it is shown the amount of institutions involved, the number of published papers and the percentage of publications considering the total amount of papers published up to 2012.

As it has been pointed out in Table 4, the countries with the most publications at WER are Brazil, Argentina, Spain and Canada. Brazil has had an 80% participation ratio, as far as publication is concerned. Once the identification of the most active countries was done, this was also applied to the institutions (of education or not) with the most publications at WER.

Table 4. Numbers of papers per country

Country	Number of institutions	Number of papers	Percentage (of 258 papers)
Brazil	52	208	80.62%
Argentina	14	61	23.64%
Spain	13	60	23.26%
Canada	10	29	11.24%
Mexico	2	7	2.71%
Chile	6	6	2.33%
Portugal	3	5	1.94%
Italy	4	5	1.94%
United Kingdom	4	4	1.55%
Netherlands	1	4	1.55%
Switzerland	1	3	1,16%
Malaysia	1	2	0,78%
Venezuela	1	2	0,78%
Cuba	2	2	0,78%
China	2	2	0,78%
Costa Rica	1	1	0,39%
Ecuador	1	1	0,39%
Finland	1	1	0,39%
Sweden	1	1	0,39%
United States	1	1	0,39%

3.2 What are the main institutions that published in WER?

As it has already been mentioned, 121 institutions have had at least one publication at WER. However, due to space limitation, in Table 5 only the institutions that have had at least 10 publications since the beginning of the WER (15 years ago) are presented.

In this same table, the home country, amount of published papers and publishing ration for each institution are shown, considering the total of published papers up to 2012.

The institutions with the most number of publications, due to logical reasons, are located in the countries pointed out in Table 4. Among the 9 institutions with the most number of publications, 4 of them are located in Brazil, 2 in Argentina, 2 in Spain and 1 in Canada.

After the identification of the most active countries and institution, a verification of the most discussed topics and their relation with the research groups was performed.

Table 5. Number of papers per institution

Institution	Country	Number of papers	Percentage (of 258 papers)
Universidade Federal de Pernambuco	Brazil	44	17%
Pontificia Universidade Católica do Rio de Janeiro	Brazil	35	14%
Universidad Politécnica de Valencia	Spain	24	9%
Universidad Nacional del Centro de la Provincia de Buenos Aires	Argentina	16	6%
Universidad Nacional de La Plata	Argentina	14	5%
Universidade Metodista de Piracicaba	Brazil	12	5%
Universidade Estadual do Rio de Janeiro	Brazil	11	4%
York University	Canada	11	4%
Universitat Politécnica de Catalunya	Spain	10	4%

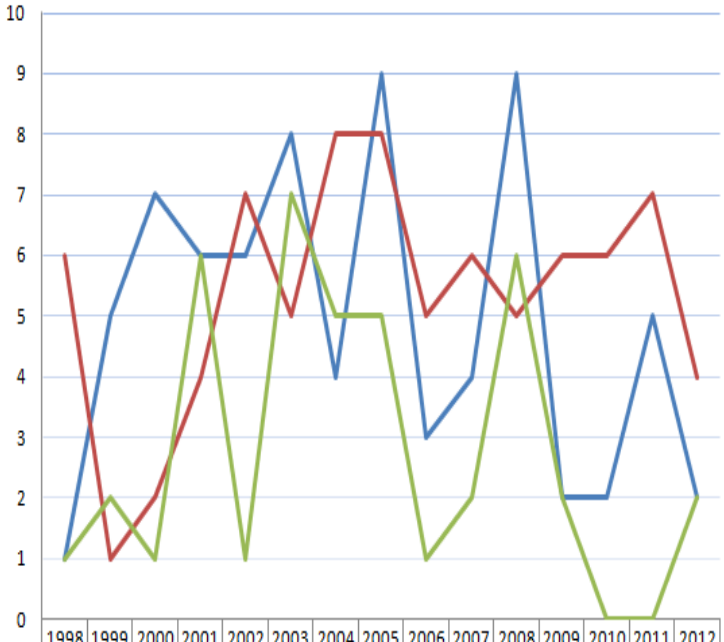
3.3 What are the main topics discussed in WER?

In Table 6 it is shown for each one of the topics defined in Table 3, the amount of papers that were related to the topic and the corresponding percentage in an array of 258 papers.

Table 6. The most discussed topics in WER

Topic	Number of papers	Percentage (of 258 papers)
Requirements modeling	80	31%
Requirements elicitation	73	28%
Process/Method	41	16%
Requirements management	35	14%
Requirements specification	32	12%
Tools	32	12%
Quality requirements	26	10%
Reuse	25	10%
Non-functional requirements	25	10%
Measurement/Metrics	16	6%
Agent-oriented paradigm	12	5%
Requirements traceability	11	4%
Cognitive approaches, educational and knowledge management	10	4%
Requirements analysis and Requirements negotiating	6	2%
Requirements validation	6	2%

As shown in Table 6, the 3 most related topics were: Requirements modeling, Requirements elicitation and Process/Method. In order to have a better idea of the intensity that these topics were discussed throughout the editions, the illustrative graphic in Fig. 1 was used.



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Requirements elicitation	1	5	7	6	6	8	4	9	3	4	9	2	2	5	2
Requirements modeling	6	1	2	4	7	5	8	8	5	6	5	6	6	7	4
Process/Method	1	2	1	6	1	7	5	5	1	2	6	2	0	0	2

Fig. 1. Number of papers related to the topic per year

Through this graphic it is possible to observe that the topic Requirements elicitation was highlighted up to 2008, with some peaks. As far as the topic Requirements modeling, since 2009, it started to be the more discussed than the topic Requirements elicitation. It´s important to observe that in general is difficult to separate the both terms, they are much related. Usually the elicitation activity is supported by the modeling activity and vice-versa. However the modeling activity in the last years may has been seen as the main activity in this relationship.

Process/Method is a topic that has had many peaks and starting on 2009, it presented a significant reduction in the number of published papers. This oscillation may be related to the period of the creation and dissemination of quality maturity models.

As it has been previously mentioned, the topic relation was based in Table 3, but the students who made the classification could also identify other topics that they judged relevant in the article. These other topics are presented in Table 7.

Table 7. Other relevant topics discussed in WER

Topic	Number of papers	Percentage (of 258 papers)
i*	26	10%
Models transformation	22	9%
Oriented goals (GORE)	18	7%
Scenarios	15	6%
Business modeling	15	6%
LEL/LAL	12	5%
Meta model, ontology and taxonomy	11	4%
Natural language	10	4%
Tropos	9	3%
Distributed development	8	3%
Model driven development	8	3%
Patterns	8	3%
Organizational modeling	8	3%
Inspection	7	3%
Product lines	6	2%
Variability	6	2%
Verification	6	2%
NFR Framework	5	2%
Aspects	5	2%
Software transparency	4	2%

These topics can also be understood as subtopics, since each one of them is related to at least one topic from Table 3. Out of these subtopics, the most related ones were: i*, Models transformation and Oriented goals, also known as GORE (Goal Oriented Requirement Engineering). The i* is an objective oriented approach used to describe not only social and intentional needs in the organizational environment, but also functional and non functional Requirements [9]. These three topics appear in conjunction in many situations, since there are strongly related.

With the mapping of the main topics and institutions, the relation of these topics with the institutions and vice versa has been also performed.

3.4 Which institutions have been discussed the main topics?

According to the 3 highlighted topics in Table 6 and the most related subtopic in Table 7, it was possible to identify which institutions had the most publications related to these topics. In Table 8 it is shown the 3 institutions with the most papers related to the 4 topics selected for evaluation.

Table 8. The main topics and related institutions

Topic	Institution	Number of papers
Requirements elicitation	Pontifícia Universidade Católica do Rio de Janeiro	13
	Universidade Federal de Pernambuco	11
	Universidad Nacional de La Plata	8
Requirements modeling	Universidade Federal de Pernambuco	14
	Universidad Politécnica de Valencia	11
	Pontifícia Universidade Católica do Rio de Janeiro	11
Process/Method	Universidade Federal de Pernambuco	10
	Pontifícia Universidade Católica do Rio de Janeiro	6
	York University	4
	Universidade Estadual do Rio de Janeiro	4
i*	Universidade Federal de Pernambuco	12
	Universidade Estadual do Rio de Janeiro	4
	Universitat Politécnica de Catalunya	4

The Requirements elicitation topic was the most discussed one by the Pontifícia Universidade Católica do Rio de Janeiro, whereas the Requirements modeling, Process/Method and i* was the most discussed by Universidade Federal de Pernambuco (UFPE). The UFPE appears as one of the 3 most active institutions as far as the 4 topics analyzed are concerned.

The topics that main institutions have been discussing have also been identified. The results are presented as follows.

3.5 Which topics have been discussed for the main institutions?

Based on the 5 most active institutions highlighted in Table 5, the most discussed topics by them have been analyzed. In Table 9, the institutions, the 3 most discussed topics and the amount of papers related to this topic are presented.

Both the Universidade Federal de Pernambuco and the Universidad Politécnica de Valencia have been discussing with more emphasis the Requirements modeling topic, whereas the Pontificia Universidade Católica do Rio de Janeiro and the Universidad Nacional de La Plata have been discussing the Requirements elicitation topic. The Universidad Nacional del Centro de la Provincia de Buenos Aires has been emphasizing the Scenario subtopic discussion.

With the mapping of the most discussed topics at WER, it is observed that some topics were more discussed in the past, whereas other topics gained more importance in the last few years.

Based on this observation, some topics were extracted where these variations are more meaningful. These variations may indicate trends in Requirements Engineering and the results are shown below.

Table 9. The main institutions and the related topics

Institution	Topic	Number of papers
Universidade Federal de Pernambuco	Requirements modeling	14
	i*	12
	Requirements elicitation	11
Pontifícia Universidade Católica do Rio de Janeiro	Requirements elicitation	13
	Requirements modeling	11
	Process/Method	6
Universidad Politécnica de Valencia	Requirements modeling	11
	Models transformation	9
	Business modeling	6
	Requirements specification	6
Universidad Nacional del Centro de la Provincia de Buenos Aires	Scenarios	6
	Requirements elicitation	5
	Requirements modeling	5
Universidad Nacional de La Plata	Requirements elicitation	8
	LEL/LAL	7
	Measurement/Metrics	5

3.6 Which are the trends in Requirements Engineering?

According to the variation on the amount of published papers related to the analyzed topics, a trend analysis in the Engineering Requirements area was performed. In order to facilitate the visualization of this analysis, the publications were gathered into triennium groups, coming to a total of 5 groups, according to what is shown in Table 8. Between the second and fourth triennium there has been an increase in the amount of publications, when compared to the first and fifth triennium. It is important to observe this detail so that a correct analysis in the variation of publications can be performed.

Table 10. Numbers of paper published per triennium

Year	Number of papers
1998-2000	37
2001-2003	63
2004-2006	63
2007-2009	55
2010-2012	40

Among the evaluated topics, it has been noted some significant variations. These topics are represented in Table 11. The amount of publications for each triennium and its corresponding percentage of the total amount of published papers are shown on it. This percentage was used to balance the difference in the number of publications that has happed among the trienniums.

Table 11. Number of publications per topic/year

Topic/year	1998/2000	2001/2003	2004/2006	2007/2009	2011/2012
Requirements management	5 (14%)	6 (10%)	12 (19%)	8 (15%)	4 (10%)
i*	2 (5%)	4 (6%)	5 (8%)	7 (13%)	8 (20%)
Measurement/Metrics		4 (6%)	9 (14%)	2 (4%)	1 (3%)
Business modeling		4 (6%)	2 (3%)	4 (7%)	5 (13%)
Oriented-agent paradigm		1 (2%)	8 (13%)	2 (4%)	1 (3%)
Process/Method	4 (11%)	14 (22%)	11 (17%)	10 (18%)	2 (5%)
Quality requirements	1 (3%)	6 (10%)	9 (14%)	5 (9%)	5 (13%)
Software transparency				1 (2%)	3 (8%)

Based on these percentages the graph was created (Fig.2) where it is possible to observe these variations in a clearer manner.

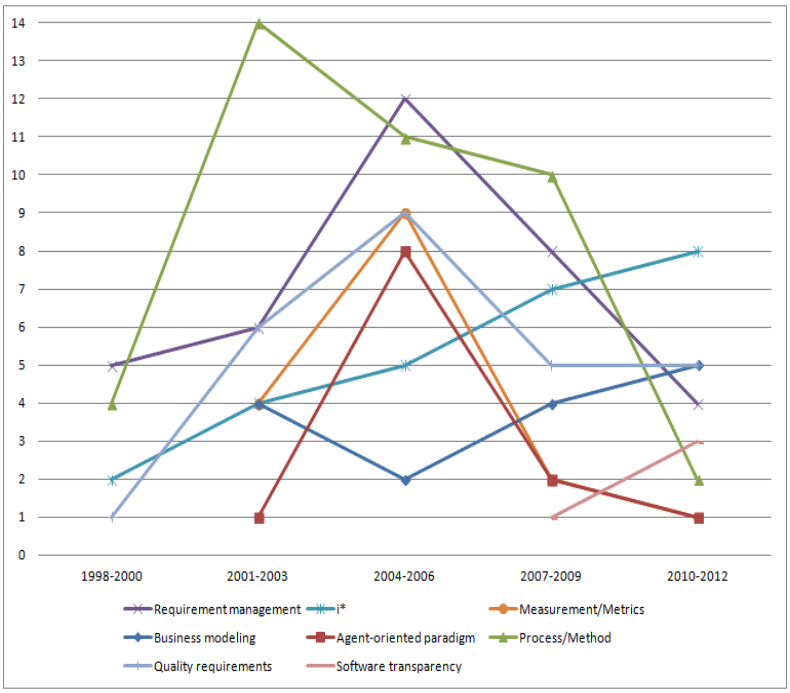


Fig. 2. Publications' variation of some topics

Through Fig. 2 it is possible to observe an increase in the past few years of the following topics: i*, Business modeling and Software transparency. On the other hand, it has been observed a decrease in the number of publication of the following topics: Process/Method, Requirements Management, Measurement/Metrics and Agent-

oriented paradigm. The Quality software topic had its pinnacle in the 2004-2006 trienniums, but it still bears certain stability.

4 Conclusion

When studying a research area, it is important to identify the answers to some questions, such as: the most active groups, the most discussed topics, the identified trends and so forth. This information may bring some benefits as the identification of new information sources, establishment of new partnerships and the orientation of researches toward more relevant topics at a given time

The revision of 258 papers published at WER had the goal of answering these questions as far as this event is concerned. Some of the main obtained results were the identification of Brazil, Spain and Argentina as the home countries of the main institutions that have published at WER so far. The Universidade Federal de Pernambuco located in Brazil, is a reference as the most active in this event. The Requirements elicitation and Requirements modeling topics are the most referenced in the published papers and the Requirements modeling is the most cited in the past few years. It has been observed an increase in the reference to the following topics: i*, Business modeling and Software transparency.

This is a preliminary study, since the issues exposed here may be broaden and explored in a deeper fashion in future works. All the data collected by this paper have been uploaded into an access database and is available for free use[1].

Other analysis may be performed in the database mentioned above, allowing distinct points of view, other than the one presented in this work. A new paper classification may be performed in order to refine the obtained results and it may also amplify the events to be analyzed. A similar but more refined review may be performed, including the main events or journals in the Requirements Engineering area.

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