A Systematic Literature Review of Requirements Negotiation Methods from 2010 till 2015

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ABSTRACT

This paper carries out a systematic literature review of requirements negotiation methods (RNM) from 2010 till 2015. We provide advice to researchers and practitioners. To researchers we provide advice in which fields of study further research is needed. For practitioners we scored the methods for different requirement conflict (RC) types.

In total, we found 12 new RNM. For these methods, we identified the type of RCs that the methods resolve. In the last five years, more methods are created than before. Requirements contradiction conflicts and quality attribute conflicts are better covered in methods now than before 2010.

Keywords

Software Requirements Negotiation, Negotiation Techniques, Conflict Resolution, Systematic Literature Review

INTRODUCTION

Requirements negotiation is the process of identifying and resolving requirements conflicts (RCs) between project stakeholders [15]. During the requirements analysis phase of requirements engineering (RE), the requirements negotiation is a significant activity, which saves money and time [1, 15]. Hence, it is important to use the best fitting requirements negotiation method (RNM).

Researchers are creating new RNM over time. A review about RNM is needed so practitioners, such as requirements engineers, can wisely choose for the best fitting RNM under their circumstances. Such a review is also needed for RE researchers to better understand the landscape of the proposed methods. Therefore, this paper gives a contribution to both practitioners and researchers in RE.

Riaz et al. provide an analysis and comparison of negotiation approaches described in scientific papers in the period from 1995 till 2009 [15]. This paper draws on the systematic literature review (SLR) of these authors and focuses on the published RNM from January 2010 till February 2015. Using the SLR guidelines of Kitchenham et al. [10], we searched and analysed RNM papers. We

compare and contrast the results of our work to the findings of Riaz et al. [15]. Based on this, we identified trends and implications for practitioners and researchers.

Research questions

This research provides answers to the following research questions (RQs):

RQ 1: What RNM are created by researchers over the last five years?

RQ2: What is the best fitting RNM (created in the period of 2010-2015) under certain circumstances?

RQ 3: What changes occurred in the RNM in the last five years?

RELATED WORK

All the RNM discussed in this paper are earlier work of other researchers. In this paper we give an overview of all the methods discussed in these works (see the next page).

The WinWin approach, or Theory W, is named several times in this paper. The idea behind this approach created by Boehm and Ross [3] is that after the negotiation everyone wins. Thus, no stakeholder will be unhappy after the negotiation process.

METHOD OF RESEARCH

In this SLR, based on Kitchenham et al. [10], the search for literature sources is focused on the Scopus database. This automatically means that the results only contain papers which are published in peer-reviewed journals, conferences and workshops.

The search string (("requirements negotiation" OR "conflict resolution" OR "conflict handling" OR "requirements reconciliation") AND (technique OR model OR method OR approach OR tool) AND software) was used. Searches were carried out in Article, Title, Abstract and Keywords. The search was carried out on March 3rd, 2015.

To compose this string, we borrowed the search words that were used in the paper of Riaz et al. [15]. This choice is motivated by our intention to create a ground for comparison of the RNM that were proposed in 2010 till 2015, and those methods in the original review of Riaz et al. [15].

Table 1. Conflicts Resolved by Requirements Negotiation Practices

Requirements negotiation practice	Requirements contradiction	Terminology conflicts	Quality attribute conflicts	Viewpoint conflicts	Resource conflicts	Feasibility conflicts
Scrum with Win-Win [8]	◐	◐	●	●	◐	◐
GRNS [16]	◐	●	●	●	◐	◐
TOPSIS [13]	●	◐	●	●	◐	◐
s-CRM [7]	●	●	●	●	◐	◐
Winbook [11]	◐	●	●	●	◐	◐
IntelliReq [6]	●	◐	●	●	◐	◐
Framework Khatter and Kalia [9]	●	●	●	●	◐	◐
Quality-model-based approach [5]	◐	◐	◐	●	◐	◐
Conflict resolution strategy [4]	●	◐	●	●	◐	◐
Genetic algorithm [14]	●	◐	◐	◐	◐	◐
JSPWikiWinWin [17]	◐	◐	●	●	●	◐
View-based approach for service-oriented systems [12]	◐	◐	●	●	◐	◐

Scale:
Yes = ●
No = ○
Not reported = ◐

Table 2. Conflicts Resolved by Requirements Negotiation Practices by Riaz et al. [15]

Requirements negotiation practice	Requirements contradiction	Terminology conflicts	Quality attribute conflicts	Viewpoint conflicts	Resource conflicts	Feasibility conflicts
Simplifiers and Complicators approach	○	○	○	●	○	●
Winwin spiral process model	○	●	◐	●	○	●
Wikiwinwin approach	○	○	○	○	●	○
Winwin system	○	○	●	●	○	○
QARCC	○	○	●	○	○	○
Easywinwin methodology	●	●	◐	●	○	◐
ARENA-M	◐	◐	◐	◐	◐	◐
The CBSP approach	○	●	○	●	○	○
ICRAD	◐	◐	○	○	○	●
Hybrid method approach	○	◐	○	●	○	○
FTR tool	○	◐	○	●	○	○
MEG tool	○	○	◐	●	○	○

Scale:
Yes = ●
No = ○
Not reported = ◐

The limitation criteria which were used for filtering the results in Scopus, were limited by the date range between 2010 and February 2015. With the search string and the limitation criteria described above, the Scopus database gave us 141 results.

After the search in Scopus, we defined the following Inclusion and Exclusion criteria:

Inclusion: (I1) The paper should discuss a RNM as its core topic. (I2) The paper proposes either a new RNM or an incremental improvement of an existing method.

Exclusion: (E1) If a paper compares two existing methods regarding their effectiveness, we exclude it, because it does not satisfy I1. (E2) If a paper uses input from requirements negotiation activities in the formulation of another RE method, we exclude it, because it does not satisfy I1. (E3) If a paper is an editorial, or a PhD proposal, we exclude it. (E4) Papers that are not in English are also excluded.

After reading the titles and the abstracts of the 141 results using these Inclusion and Exclusion criteria, only 22 papers were still in the scope of this research. These 22 papers have been read in detail and the inclusion and exclusion criteria were re-applied. This stage resulted in excluding ten papers, which left us with 12 papers that discussed RNM and were finally included in the data extraction and analysis.

RESULTS
Since 2010, we found 12 proposed RNM. These methods are reported in the first column of Table 1 (answer to RQ 1). The format of Table 1 has the same format as the table of Riaz et al. [15] (see Table 2). We adopted this commonality in presenting the results, because we compare the two tables later in this paper. The content of Table 1 shows us which RNM are suitable for which types of RC (answer to RQ 2). Table 1 is useful for practitioners, because they can see in the table which RNM can resolve their RCs. Table 1 is also useful for researchers, because they can see in the table which parts of RNM need some further research.

Changes in RNM over the last 5 years
This subsection compares and contrasts Table 1 and Table 2 (answer to RQ 3). Based on the information of the papers used for this research, it can be said that four [8, 11, 16, 17] of the 12 methods are based on Theory W, which is the theory behind the original WinWin approach [3]. RNM based on Theory W were also in the study of Riaz et al. [15]. This ongoing trend could be explained by the fact that when Theory W is implemented well, all stakeholders are winners [3]. Because of the negotiation part, the stakeholders understand each other's requirements better and have more sympathy for each other [2]. Furthermore, this theory is very easy to understand, to learn and to apply in different working areas [3]. Another aspect worth mentioning is that Boehm, one of the creators of Theory W in 1989 [3], was also one of the creators of the Winbook method [11].

Another observation that can be noticed is that in the years before 2010 there were 12 different RNMs developed and in the years from 2010 till 2015 there were also 12 different methods developed. This suggests that nowadays in the field of RE, there is much more attention to requirements negotiation and there is a stronger focus on designing new methods.

The third observation that can be noticed is that two [9, 13] of the 12 papers report that their methods were

suitable for non-functional requirements only. There were ten [4, 5, 6, 7, 8, 11, 12, 14, 16, 17] papers that did not mention if their methods were suitable for non-functional requirements, functional requirements, or both.

Comparing Table 1 with Table 2 shows us that requirements contradiction conflicts and quality attribute conflicts are given more attention in the methods created in the time from 2010 till 2015 then in the years before 2010. A possible explanation for this could be that researchers saw the need for RNM which would resolve those RCs.

In Table 2 are two methods with three times a 'yes'. There are no methods with more times 'yes'. In Table 1 there are two methods with four times a 'yes'. Thus in Table 1 there are methods which cover more RCs than there are in Table 2.

One ongoing trend observable in both Table 1 and Table 2 is that there is only one RNM which is suitable for resource conflicts and there are no RNM methods which are suitable for feasibility conflicts. Therefore, this seems a good topic for research in the future.

Another ongoing trend that can be observed in both Table 1 and Table 2 is that most RNMs are suitable for viewpoint conflicts. One explanation is that it is relatively easier to create RNMs for viewpoint conflicts comparing with other types of RC. Another explanation is that when researchers create a new RNM, they unconsciously think about viewpoint conflicts and forget other types of RCs.

LIMITATIONS
This systematic review has some limitations. First, we used Scopus as the only source of searching papers. While research methodologists suggest that Scopus is a comprehensive library proving the best possible coverage of published work, it might be possible that we would have found other related publications if we have searched other libraries, e.g. Web of Science.

Second, a well-known thread to validity in systematic reviews is the researcher's bias in selecting the papers. We however think that this threat is minimal, because the researcher and her supervisor have no published work on requirements negotiation and had no work relationships with the authors of the included papers.

Third, the evaluations included in Table 1 could possibly be subjective. Some papers provide no information about how their proposed methods address the aspects that were included in the study of Riaz et al. [15]. To minimize this threat, Table 1 was produced with the participation of two researchers, who collectively discussed their findings.

The last limitation that can be noticed is that there are no 'No'- bullets in Table 1 while there are 'No'-bullets in Table 2. This is probably because Table 2 is designed for the paper of Riaz et al. [15] and we used the same table format to compare Table 1 and Table 2 in a better way. It could be that the papers Riaz et al. [15] used, were more explicit about what the methods were not suitable for.

CONCLUSIONS AND FUTURE WORK
This section gives the conclusions to our RQs and indicates some subjects for future research. We finish with implications for practitioners.

Answers to the RQs
We answered three RQs based on a SLR. The answers to these RQs can be summarized as following:

RQ 1: What RNM are created by researchers over the last five years?
Over the last five years 12 new RNM are created by researchers. These 12 methods are in the first column of Table 1.

RQ 2: What is the best fitting RNM (created in the period of 2010-2015) under certain circumstances?
Table 1 indicates on what the best fitting RNM is under certain circumstances. This table helps practitioners to choose which RNM is useful under a certain RC type. This table also shows researchers where gaps exist between RNMs and RCs and therefore shows them for what types of RCs they can create new RNM.

RQ 3: What changes occurred in the RNM in the last five years?
Some changes occurred in the last five years in RNM. We list the changes below:

- There is more attention given to the creation of new RNMs: in the years before 2010 12 RNMs were created, in the years between 2010 and 2015 the same account, 12, new RNMs were created.

- Some papers nowadays explicitly said whether their method was suitable for non-functional requirements, functional requirements, or both.

- Requirement contradiction conflicts and quality attribute conflicts are getting more attention now than they were getting before 2010.

- The RNM created between 2010 and 2015 cover more types of RC than they did before 2010.

- In the papers used for this research it was never mentioned whether the RNM is not suitable for the RC types as defined in Table 1 and Table 2.

There are also some points which Table 1 and Table 2 have in common:

- Theory W (WinWin approach) is still very popular.

- Resource conflicts and feasibility conflicts still are getting almost no attention at all.

- Almost all RNM are suitable for viewpoint conflicts.

Future work
By doing this research we detected some gaps in literature which can be filled by doing more research:

- There are almost no RNM to resolve resource conflicts and feasibility conflicts. This gap could be closed by creating RNM which resolves those types of RCs.

- The following RQ still needs to be answered: Which RNMs have been used in practice?

- This research includes RNMs till February 2015. All RNMs created after this month are therefore not included in our paper and could be subject to future research.

Implications for practitioners

For practitioners, this paper has the following implications:

- It offers a way to be able to choose a RNM based on types of RC. Table 1 can be used to see which methods are effective for the type of RC.

- From it, practitioners know what to expect from a range of methods.

ROLE OF THE STUDENT

Evenynke Terpstra was an undergraduate student working under the supervision of Dr. M. Daneva. The student proposed the field of study, namely requirements engineering, and the supervisor proposed the topic. The processing of the results as well as formulation of the conclusions and the writing were done by the student. The selection of the literature as well as filling in Table 1, were done by the student and the supervisor individually, after which they discussed the differences.

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