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

Evenynke Terpstra
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands
e.terpstra@student.utwente.nl

ABSTRACT

Requirements engineering is a fundamental part of the software engineering process. When the stakeholders of the software project disagree on the requirements, requirements negotiation methods can be used to reach that agreement. This avoids rework and extra costs. A number of new requirements negotiation methods are created by researchers over the last years. This paper provides a review on which negotiation method can be used under which circumstances. Such a review is relevant for both practitioners and researchers. Practitioners could use the results to make decisions on which method might be the best choice for their project contexts. To researchers, our study would help them see trends in the requirements negotiation field. Moreover, researchers are now informed about those requirements negotiation sub-areas which have been actively researched and the sub-areas where much evaluation and empirical work is needed for our knowledge to become complete. Riaz et al. did such a review on requirements negotiation methods till the year 2010. Therefore we compared the results of Riaz et al. with the new findings. This paper carried out a systematic literature review on requirements negotiation methods which are published between 2010 and 2015 and compared the results of Riaz et al. with the new findings.

In total, we found 12 new requirements negotiation methods. For each of those 12 methods, we identified the type of requirement conflicts that the methods resolves. We found that in the last five years there is more attention given to create new requirements negotiation methods than before and the methods also cover more types of requirement conflicts now than they did in the past. We also found that requirements contradiction conflicts and quality attribute conflicts are getting more attention now than they were getting before 2010, while resource conflicts and feasibility conflicts still are getting almost no attention at all. Furthermore, we found that almost all requirements negotiation methods are suitable for resolving viewpoint conflicts. Finally, we found that Theory W (WinWin approach) is still very popular for use in the design of requirements negotiation methods.

Keywords

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

1. INTRODUCTION

Requirements negotiation is the process of identifying and resolving requirements conflicts between project stakeholders [16]. During the requirements analysis phase of requirements engineering (RE), the requirements negotiation is a significant activity [16]. Actually, requirements negotiation saves money and time [1]. This is possible because there is preventive activity and agreement by the stakeholders, and therefore there is less rework, fixing of software difficulties that could have been discovered earlier or could have been avoided altogether, to be done [1]. Hence, it is important to use the best fitting negotiation method.

Academic researchers are creating new negotiation methods over time. Some of these methods have been evaluated empirically while others are at the stage of early proposals. A review about negotiation methods is needed so practitioners, such as requirements engineers, can wisely choose the best fitting negotiation method under their circumstances, such as requirements contradiction or viewpoint conflicts. Such a review is also needed for RE researchers to better understand the landscape of the proposed methods and the amount of evaluation work done to indicate the effectiveness and the fitness of each method in particular contexts. Therefore, this paper will give a contribution to both practitioners and researchers in RE.

In the RE literature, a systematic review has been published in 2010, which provides an analysis and comparison of negotiation approaches described in scientific papers in the period from 1995 till 2009 [16]. This paper draws on the systematic review of these authors and focuses on the published requirements negotiation methods from January 2010 till February 2015. Using the systematic literature review guidelines of Kitchenham et al. [11], we searched and analysed requirements negotiation method papers, and evaluated the empirical evidence presented in them. We compare and contrast the results of our work with respect to the findings of Riaz et al. [16]. Based on this, we identified trends and implications for practitioners and researchers. The requirements negotiation methods discussed by Riaz et al. are included in Appendix A.

This paper makes two contributions: to practitioners, we suggest a comparative analysis that could help them make an informed decision on the suitability of a method for a particular context. To researchers, we mapped out well-researched sub-areas of requirements negotiation, and sub-areas that need more evaluation work in real-life contexts.
1.1 Problem statement

Because the requirements negotiation is an active area of empirical RE research, over the last five years, many methods have been proposed. Little is known however about the extent to which the methods help achieve what they were supposed to achieve. It is not clear how effective the newly proposed methods are, particularly in software development. This is a problem because companies spend more money and time in software projects than needed, according to Jørgensen et al. [8] the average cost overrun of software projects is about 30%. This paper is a resolution for this problem because we give a review on which negotiation method can be used under which circumstances. Therefore money and time can be saved [1].

This systematic review is established by first selecting and summarizing the requirements negotiation methods which are created in the last five years. In order to see whether a lot of changes happened and to see if the methods are improved over the last years, the results of this paper will be compared with the results of the paper of Riaz et al. [16], which surveys the requirements negotiation methods till 2010.

1.2 Research questions

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

RQ 1: What requirements negotiation methods are created by researchers over the last five years?

RQ 2: What is the best fitting requirements negotiation method (created in the period of 2010 - 2015) under certain circumstances?

RQ 3: What changes occurred in the requirements negotiation methods in the last five years?

1.3 Structure

This paper is structured as follows. Section 2 gives an overview of the related work to this paper. Section 3 describes the research method. Section 4 presents the overview of the related work to this paper. Section 5 presents the changes that happened in the last five years in the field of requirements negotiation. Section 6 deals with the limitations of this research and section 7 presents the conclusions, the implications for practitioners and the possible related future work that has to be done on the subject.

2. RELATED WORK

As already indicated in the introduction, this systematic literature review is built on the review from Riaz et al. [16]. The review from Riaz et al. [16] is only containing negotiation methods which are published in papers until 2010. This paper will therefore give a review on requirements negotiation methods which are published in papers between 2010 and 2015 and will make a comparison between the results of Riaz et al. [16] and our results.

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.

All the requirements negotiation methods discussed in section 4 are earlier work of other researchers. In those earlier works, new requirements negotiation methods are created or existing methods are discussed. In section 4 we give a detailed overview of all the methods discussed in these works.

3. METHOD OF RESEARCH

The research questions given in section 1.2 are answered by fulfilling a systematic literature study in the way described by Kitchenham [11]. We used a process that includes the following steps: planning a paper search strategy, formulating inclusion and exclusion criteria for paper selection, searching the Scopus library, evaluating the papers based on the inclusion criteria, and analysing the empirical evidence in those paper that we selected for inclusion. Below, we briefly discuss these steps.

3.1 Data retrieval

The search for literature sources is focussed on the Scopus database. This automatically means that the results only contain papers which are published in peer-reviewed journals, conferences and workshops. Because Scopus only contains peer-reviewed literature, no Master’s theses and PhD dissertations are included in our search results.

Filtering results in Scopus.

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. [16]. This choice is motivated by our intention to create a ground for comparison of the requirements negotiation methods that were proposed in 2010 till 2015, and those methods in the original review of Riaz et al. [16]. We however extended the set of search words, by adding the word ‘software’, because this way we excluded most results about medical or aeroplane subjects.

The limitation criteria which were used for filtering the results in Scopus, were limited by the date range between 2010 and February 2015. We only used results between 2010 and 2015 because the results published before have already been studied by other researchers [16]. The research of these authors is used in section 5 to compare the results of this study and our study and to identify the changes that occurred in the last five years.

With the search string and the limitation criteria described above, the Scopus database gave us 141 results.

Filtering the 141 results based on abstract review.

After this first stage of limiting papers in Scopus, we started with the second stage. This second stage was excluding prefaces and reading the titles and abstracts from the papers which were candidates for inclusion. We defined the following Inclusion and Exclusion criteria for this stage:

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

Exclusion: (E1) If a paper is about requirements negotiation, but compares two existing methods regarding their effectiveness, then we exclude it because it does not propose a new method or an improvement of an existing method. (E2) If a paper uses input from requirements negotiation activities in the formulation of another RE method (e.g. requirements change management), then we exclude the paper as it does not deal with a proposal of a
Table 1. Results after each iteration

<table>
<thead>
<tr>
<th>Iteration</th>
<th>Number of results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filtering results in Scopus</td>
<td>141</td>
</tr>
<tr>
<td>Filtering results based on abstract review</td>
<td>22</td>
</tr>
<tr>
<td>Filtering results based on full paper review</td>
<td>12</td>
</tr>
</tbody>
</table>

4. RESULTS

This section reports on the results regarding RQ1 and RQ2. Since 2010, we found 12 requirements negotiation methods that were proposed. Below, we first summarize these methods in section 4.1, and then we present them in a table (see Table 3) in section 4.2 for which we use the same format as the format in the table with requirements negotiation methods reported in [16]. We adopted this commonality in presenting the results, because we want to compare how the negotiation methods in the last five years are similar and different with respect to the proposed methods in the previous years reviewed in [16]. Section 4.2 also gives some tables (Table 4, Table 5) with extra information, such as the underlying theories and empirical evaluation, about the papers we used for this research.

4.1 Requirements negotiation methods and their functionalities

The 12 proposed methods in the period of 2010 till 2015 include the following:

Integrated Scrum in the Win-Win requirements model [9]. This approach leverages the fact that Scrum uses daily meetings and that it divides projects and huge tasks into subtasks – called in [9] ‘negotiable sprints’, which are typically two till four weeks in duration. Due to the daily meetings and the negotiable sprints, re-negotiation and late changes are possible. The perceived benefits of using scrum in the Win-Win model are the perceived increase of collaboration among stakeholders, the improvement in software productivity and the reduction of project failure risk. The authors of the approach consider it applicable to both small and large systems.

3.2 What to do with the publications?

All requirements negotiation methods created in the filtered publications are extracted (RQ 1) and the functionalities of each of the methods are summarized (see section 4.1). After that, we made an overview on when to use which method (RQ 2) in section 4.2. Finally, we compared the results of the paper written by Riaz et al. [16] with the results from our paper (RQ 3) in section 5. For this purpose, we compared the table of Riaz (see Table 2) with the table created in this paper and discussed the points that are worth mentioning.

Integrated Scrum in the Win-Win requirements model [9]. This approach leverages the fact that Scrum uses daily meetings and that it divides projects and huge tasks into subtasks – called in [9] ‘negotiable sprints’, which are typically two till four weeks in duration. Due to the daily meetings and the negotiable sprints, re-negotiation and late changes are possible. The perceived benefits of using scrum in the Win-Win model are the perceived increase of collaboration among stakeholders, the improvement in software productivity and the reduction of project failure risk. The authors of the approach consider it applicable to both small and large systems.

The Groupware Requirements Negotiation System (GRNS) [17]. This is an all-in-one requirements negotiation process model. It solves requirements negotiation problems by integrating EasyWinWin, quality assurance methods, multi-criteria preference methods and Bayes theorem all into one model. Due to this combination
of methods, the authors of the method expect to achieve the following benefits: clear requirements will be elicited, structured communication among stakeholders will be provided, defects will be reduced, agreements will be achieved and the severity level of the requirements will be decreased. In experiments it is proved that the GRNS reduces defects by 78.5%.

**Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS)** [14]. This is a goal-based multi-criteria decision analysis technique for determining the best solution. “Best” is identified by means of a weighted normalized decision matrix that has to be made while applying the technique. The best solution has the shortest distance to the ideal solution and the farthest distance to the so-called ‘negative-ideal’ solution (this is the solution that is the exact opposite of the ideal solution). TOPSIS has been designed to work for non-functional requirements.

**The Stakeholder Conflict Resolution Model (s-CRM)** [7]. It is designed to help identifying the key stakeholders of the project and giving a resolution for conflicts between the requirements of those stakeholders. s-CRM does this by first measuring the entropy between the requirements and the identified stakeholders. After that the conflict resolution takes place.

Winbook [12]. This is a method represented as an avatar of the Win-Win framework. It is based on the way people collaborate with each other on Facebook and the way people organize their email with Gmail. Because of this, Winbook is very easy to use, even for non-technical stakeholders. The Winbook environment allows win conditions to be captured on a virtual wall (similar to a user’s wall on Facebook) that all members in a project team can review and update. The posts (win conditions, issues, options, comments) are displayed with the corresponding user’s avatar (as selected during the sign-up process) to maintain the social networking look and feel. The wall serves as a virtual whiteboard for documenting user needs as win conditions. With the use of Winbook all the stakeholders can agree on the requirements faster. Another advantage is that stakeholders are more involved in the definition and prioritization of requirements.

IntelliReq [6]. This is a group decision support environment that supports the group decision process in requirements negotiation. It is used by computer science students of the Graz University of Technology. IntelliReq helps the students deciding which requirements should be implemented within the scope of their project. The functionalities implemented in IntelliReq are: add/change personal preferences, show and comment on preferences of group members, show group recommendations, edit a current group decision, and evaluate IntelliReq. It is found that the perceived usability and the quality of decision support can be improved by using IntelliReq.

The framework Khatter and Kalia for identification and analysis of conflicts in non-functional requirements [10]. It uses a matrix with the strategies versus the requirements to detect conflicts between non-functional requirements based on the relationship between the requirements and the system’s architecture. When there is a conflict in high-level non-functional requirements, these requirements are then transformed into lower-level non-functional requirements. This decomposition process would continue until there are no high-level conflicts anymore. The authors use a conflict tree to understand the semantics of the conflicts.

The quality-model-based approach of Carvallo and Franch [5]. It supports the negotiation of initial and emergent requirements and helps stakeholder reconcile their concerns. The approach is based on the Quality Model ISO/IEC 9126-1, a popular standard in the fields of software engineering, and in particular in RE. The proposed requirements negotiation process starts an identification of the underlying software architecture behind a solution that will be developed in a project, and proceeds with the construction of quality models that are derived from the ISO/IEC standard. These models are then used in the evaluation of alternative components that fit the underlying architecture.

**The Conflict Resolution Strategy framework of Butt et al.** [4]. It structures elicited requirements into three categories: mandatory requirements, essential requirements and optional requirements. Once this is done, the method checks if requirements are conflicting with each other. The conflicts are then solved by using a number of techniques, such as conflict prevention, conflict detection and removal or conflict containment. The Conflict Resolution Strategy works for both non-functional and functional requirements.

**Requirements negotiation using the Genetic Algorithm approach** [15]. It borrows ideas of computational intelligence and uses a fitness function from the field of genetic algorithms, to resolve stakeholders’ requirements conflicts. It starts with giving a weight to all of the requirements by all of the clients. Crossover and mutation process then takes place, which resolves conflicts. A new weight is then given by the clients to the resolved conflicts. Next, the average weight of the conflicting requirements is compared against the total of the sum of the resolved conflicts. If this total is greater than the average weight of the conflicting requirements, then this means that the conflict is resolved. Otherwise, the process should be repeated for a suitable requirement.

JSPWikiWinWin [18]. It is grounded on the WinWin theory and is built on the JSPWiki framework. JSPWikiWinWin is the successor of TWikiWinWin, which is built on the TWiki framework. Compared to the TWiki framework, the JSPWiki framework provides higher security. JSPWikiWinWin has some other advantages compared to TWikiWinWin. One of them is the improved speed of stakeholders’ responding to requirements changes. JSPWikiWinWin sends emails with notifications and due to this, stakeholders check JSPWikiWinWin more often than they did using TWikiWinWin. This makes JSPWikiWinWin time-saving: when there are changes in the requirements, this is instantly known by the stakeholders, who can stop doing their task. With TWikiWinWin they saw these changes after they finished their tasks. The interface of JSPWikiWinWin is also easier to use than the old interface of TWikiWinWin.

The view-based approach to quality requirements negotiation for service-oriented systems [13]. It is grounded in the 1st philosophy for defining requirements as goals and acknowledges that in service-oriented systems there are static and dynamic requirements (dynamic are those that are determined at runtime). The proposal in [13] includes a model for resolving conflicts in quality requirements (such as service interoperability, recoverability, and fault tolerance) from the viewpoints of consumers of services and designers of services, as stakeholders. The resolution mechanism used by the authors is based on concepts of fuzzy set theory. These concepts of fuzzy set theory are explained in [20].
4.2 Theoretical basis and empirical evaluation

Table 3 shows us which requirement negotiation methods are suitable for which types of requirement conflicts. Table 3 is useful for practitioners, because they can see in the table for which type of requirement conflict, which requirements negotiation methods can resolve the requirement conflict. As an example: if there are resource conflicts, the JSPWikiWinWin method could be useful. The other requirements negotiation methods did not report if the method can resolve this type of requirement conflict.

In Table 4 the underlying theories and the type of empirical evaluation per requirements negotiation method can be found.

Table 4 shows us that ten [4, 5, 6, 7, 9, 10, 12, 15, 17, 18] out of the 12 requirements negotiation methods are empirically evaluated by a case study. Table 5 contains whether the case study of the requirements negotiation methods are done by practitioners, students or researchers, in which organisation the case study took place and in which country the case study took place.

From Table 5 can be noticed that six [4, 5, 7, 9, 10, 17] out of the ten requirements negotiation methods tested by practitioners, three [6, 12, 18] out of the ten requirements negotiation methods are tested by students and one [15] requirements negotiation method is tested by researchers. Conclusions from the tests are more realistic if the method is tested by its target audience [19]. This is the case in seven out of the ten requirements negotiation methods: six of them are tested by practitioners [4, 5, 7, 9, 10, 17] and one is tested by students, but in this case students are the target audience [6]. Another thing that can be noticed from Table 5 is that five [4, 6, 12, 15, 18] out of the ten requirements negotiation methods are tested in a university, while one [9] requirement negotiation method it is not specified in which organisation they tested the method. The other four [5, 7, 10, 17] requirements negotiation methods are tested in very different companies from each other. The last thing worth mentioning is that five [4, 7, 15, 17, 18] out of the ten requirements negotiation methods are tested in Asia. For two [9, 10] requirements negotiation methods it is not specified in which country they are tested and the other three methods are tested in North-America [12], South-America [5] and Europe [6]. For all papers in Table 5 except the paper with the GRNS method [17] the country was explicitly given. For paper [17] the names of the companies were provided only. Therefore we googled the names for finding the country.

5. THE CHANGES IN REQUIREMENTS NEGOTIATION METHODS OVER THE LAST 5 YEARS

This section compares and contrasts Table 3 and Table 2, which comes from Riaz et al. [16].

Based on Table 4, it can be said that four [9, 12, 17, 18] of the 12 methods are based on Theory W, which is the theory behind the original WinWin approach [3]. In 2010, there were methods based on the WinWin approach and now, in 2017, there are still new methods based on the same WinWin approach. The preferred choice for using the WinWin approach as the foundation for new design variants of methods for requirements engineering could be explained by the fact that when the WinWin approach is implemented well, all stakeholders are winners [3]. Because of the negotiation part, the stakeholders understand each others 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]. One thing 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 [12].

Another thing that can be noticed is that in the years until 2010 there were 12 different methods in requirements negotiation developed and in the years from 2010 till 2015 there were also 12 different methods developed. So in the years until 2010 the same number of methods were developed as in the five years thereafter. This result suggests that nowadays in the field of requirements engineering, there is much more attention to requirements negotiation and there is a stronger focus on designing new methods.

The third thing that can be noticed is that two [10, 14] of the 12 papers said that their method was suitable for non-functional requirements only. There were ten [4, 5, 6, 7, 9, 12, 13, 15, 17, 18] papers that did not mention if their methods were suitable for non-functional requirements, functional requirements, or both.

From Table 4 can be noticed that ten [4, 5, 6, 7, 9, 10, 12, 15, 17, 18] of the 12 methods were evaluated by a case study. This means that they are used in practice and therefore are more carefully tested than evaluations based on a illustration of the application in a realistic case or evaluations based on mathematical proof.

Comparing Table 2 with Table 3 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 requirements negotiation methods would resolve those type of conflicts.

In Table 2 are two methods with three times a ‘yes’. There are no methods with more times ‘yes’. In Table 3 there are three methods with four times a ‘yes’. Thus, in Table 3 there are methods which cover more of the conflict types then there are in Table 2.

One ongoing trend which can be observed in both Table 2 and Table 3 is that there is only one requirements negotiation method which is suitable for resource conflicts and there are no requirements negotiation methods which are suitable for feasibility conflicts. Therefore, this seems a good topic for research in the future.

Another ongoing trend is that it can be observed in both Table 2 and Table 3 that most requirements negotiation methods are suitable for viewpoint conflicts. One explanation is that viewpoint conflicts are relatively easy to create requirements negotiation methods for comparing with other types of requirement conflicts. Another explanation is that when researchers create a new requirements negotiation method, they unconsciously think about viewpoint conflicts and forget the other types of requirement conflicts.

6. 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 providing 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.
Table 3. Conflicts resolved by requirements negotiation practices

<table>
<thead>
<tr>
<th>Requirements negotiation practice</th>
<th>Terminology conflicts</th>
<th>Requirements contradiction</th>
<th>Quality attribute conflicts</th>
<th>Viewpoint conflicts</th>
<th>Resource conflicts</th>
<th>Feasibility conflicts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrum with Win-Win [9]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>GRNS [17]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>TOPSIS [14]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>s-CRM [7]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Winbook [12]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>IntelliReq [6]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Framework Khatter and Kalia [10]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Quality-model-based approach [5]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Conflict resolution strategy [4]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Genetic algorithm [15]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>JSPWikiWinWin [18]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>View-based approach for service-oriented systems [13]</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>

Scale:

Yes = ●
No = ○
Not reported = ○

Table 4. Underlying theories and empirical evaluation

<table>
<thead>
<tr>
<th>Requirements negotiation practice</th>
<th>Underlying theory</th>
<th>Empirical evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrum with Win-Win [9]</td>
<td>Theory W</td>
<td>Case study</td>
</tr>
<tr>
<td>GRNS [17]</td>
<td>Theory W</td>
<td>Case study</td>
</tr>
<tr>
<td>TOPSIS [14]</td>
<td>Two-dimensional conflict-relationship graphics</td>
<td>Illustration of the application in a realistic case</td>
</tr>
<tr>
<td>s-CRM [7]</td>
<td>Entropy</td>
<td>Case study</td>
</tr>
<tr>
<td>Winbook [12]</td>
<td>Theory W + social networking</td>
<td>Case study</td>
</tr>
<tr>
<td>IntelliReq [6]</td>
<td>Group decision support</td>
<td>Case study</td>
</tr>
<tr>
<td>Framework Khatter and Kalia [10]</td>
<td>Strategy vs. requirements matrix</td>
<td>Case study</td>
</tr>
<tr>
<td>Conflict resolution strategy [4]</td>
<td>Conflict resolution strategy, filtering into sets based on the importance</td>
<td>Case study</td>
</tr>
<tr>
<td>Genetic algorithm [15]</td>
<td>Genetic algorithm</td>
<td>Case study</td>
</tr>
<tr>
<td>JSPWikiWinWin [18]</td>
<td>Theory W</td>
<td>Case study</td>
</tr>
</tbody>
</table>
Table 5. Case study information

<table>
<thead>
<tr>
<th>Requirement negotiation method</th>
<th>Tested by practitioners, students or researchers</th>
<th>Organisation</th>
<th>Country of organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scrum with Win-Win [9]</td>
<td>Practitioners</td>
<td>Not specified</td>
<td>Not specified</td>
</tr>
<tr>
<td>GRNS [17]</td>
<td>Practitioners</td>
<td>Two software development companies: Century Software Bhd &amp; iMocha Sdn Bhd</td>
<td>Malaysia</td>
</tr>
<tr>
<td>s-CRM [7]</td>
<td>Practitioners</td>
<td>A company who launches products in China’s third-generation of mobile terminals</td>
<td>China</td>
</tr>
<tr>
<td>Winbook [12]</td>
<td>Students</td>
<td>University of Southern California</td>
<td>United States of America</td>
</tr>
<tr>
<td>IntelliReq [6]</td>
<td>Students</td>
<td>Graz University of Technology</td>
<td>Austria</td>
</tr>
<tr>
<td>Framework Khatter and Kalia [10]</td>
<td>Practitioners</td>
<td>A manufacturing firm</td>
<td>Not specified</td>
</tr>
<tr>
<td>Conflict resolution strategy [4]</td>
<td>Practitioners</td>
<td>The university management system of the National University of Sciences &amp; Technology</td>
<td>Pakistan</td>
</tr>
<tr>
<td>Genetic algorithm [15]</td>
<td>Researchers</td>
<td>University of Arid Agriculture &amp; FAST-National University of Computer and Emerging Sciences &amp; Institute of Management Sciences</td>
<td>Pakistan</td>
</tr>
<tr>
<td>JSPWikiWinWin [18]</td>
<td>Students</td>
<td>Chinese Academy of Sciences</td>
<td>China</td>
</tr>
</tbody>
</table>

Second, a well known threat to validity in systematic reviews is the researcher’s bias in selecting the papers. In this case, we think however 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 3 could possibly be subjective. This is because some papers provide no information about how their proposed methods address the aspects that were included in the study of Riaz et al. [16]. To minimize this threat, Table 3 was produced with the participation of two researchers, who collectively defined the evaluations.

The last limitation that can be noticed is that there are no ‘No’-bullets in Table 3 while there are ‘No’-bullets in Table 2. This is probably because Table 2 is designed for the paper of Riaz et al. [16] and we used the same table-format, because in this way we can compare Table 2 and Table 3 in a better way with each other. It could be that in the papers Riaz et al. [16] the researchers were more explicit about what their methods were not suitable for.

7. CONCLUSIONS AND FUTURE WORK

In this section we give the conclusions to our research questions and indicate some subjects for future research. We finish with implications for practitioners.

7.1 Answers to the research questions

In this paper we gave an answer on three research questions based on a systematic literature review. The answers to these research questions can be summarized as following:

RQ 1: What requirements negotiation methods are created by researchers over the last five years?

Over the last five years 12 new requirements negotiation methods are created by researchers. Four of the 12 methods were based on Theory W (WinWin approach) and ten of the 12 methods were evaluated by a case study. This 12 methods are:

- Scrum with WinWin
- GRNS
- TOPSIS
- s-CRM
- Winbook
- IntelliReq
- A framework from Khatter and Kalia
- Quality-model-based approach
- Conflict Resolve Strategy
- Genetic algorithm approach
- JSPWikiWinWin
- View-based approach for service-oriented systems

RQ 2: What is the best fitting requirements negotiation method (created in the period of 2010 - 2015) under certain circumstances?

Table 3 gives an indication on what the best fitting requirements negotiation method is under certain circumstances. This table helps practitioners to choose which requirements negotiation method is useful under a certain requirement conflict type and this table also shows researchers where gaps exist between requirements negotiation methods and requirement conflicts and therefore shows them for what type of requirement conflicts they can create new requirements negotiation methods.

RQ 3: What changes occurred in the requirements negotiation methods in the last five years?

Some changes occurred in the last five years in requirements negotiation methods. We list the changes below:
In the last five years there is more attention given to the creation of new requirements negotiation methods: in the years before 2010 12 requirements negotiation methods were created, in the years between 2010 and 2015 the same account, 12, new requirements negotiation techniques were created.

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

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

The requirements negotiation methods created between 2010 and 2015 cover more types of requirement conflicts than they did before 2010.

In the papers used for this research it was never mentioned whether the requirements negotiation method is not suitable for the requirement conflict types as defined in Table 2 and Table 3.

There are also some points which Table 2 and Table 3 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 requirements negotiation methods are suitable for viewpoint conflicts.

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

- There are almost no requirements negotiation methods to resolve resource conflicts and feasibility conflicts. This gap could be closed by creating requirements negotiation methods which resolve those types of requirements conflicts.
- Because this research is about which requirement negotiation methods are created and what the best fitting requirements negotiation method is in which circumstances and how this differs from 2010. Some further research can be done by answering the following research question: Which requirements negotiation methods have been used in practice?
- This research includes requirements negotiation methods till February 2015. All requirements negotiation methods created after this month are therefore not included in our paper and could be subject to future work.

7.3 Implications for practitioners
For practitioners, this paper has the following implications:

- It offers a way to be able to choose a requirements negotiation method based on types of conflicts. Table 3 can be used to see which methods are effective for the type of conflict.
- From it, practitioners know what to expect from a range of methods.
- It shows the most recent developments in the Win-Win family of methods.

8. ACKNOWLEDGEMENTS
I would like to thank Dr. M. Daneva for being my supervisor, her structured way of working and her input through the whole process of writing this paper. I would also like to thank my student colleagues M.J.P. Oude Weernink and R. van der Veen for their reviews.

9. REFERENCES


**APPENDIX**

**A. REQUIREMENTS NEGOTIATION METHODS FOUND IN THE REVIEW OF RIAZ ET AL.**

This section provides a brief description in the methods included in the review of Riaz et al. [16]. These methods were referred to in Table 2 of this paper.

**The WinWin spiral model.** It was developed based on the Theory W and Boehm’s spiral model of the software development life cycle. In the WinWin model, negotiation activities derived from Theory W were embedded for conflict resolution which lacked in the earlier approaches. Riaz et al. indicated that this model at tempted to resolve viewpoint conflicts, feasibility conflicts and terminology conflicts.

**QARCC- Quality Attribute Risk And Conflict Consultant.** This is a knowledge-based tool for identifying and resolving particularly quality requirements conflicts. QARCC was developed on the basis of the WinWin system, a tool supporting the WinWin spiral model. Riaz et al. indicated that QARCC worked well for identifying and resolving high and low level quality attribute conflicts.

**Simplifiers and Complicators (S&C’s) approach.** It resolved two-culture problem between users and developers. Riaz et al. indicated that it helped resolving viewpoint conflicts and feasibility conflicts. Although the approach is claimed not to be based on WinWin theory, it was found that it used win-win behaviour to reduce requirements conflicts among simplifiers and complicators.

**EasyWinWin.** This is a system that was developed in response to a finding that the earliest WinWin system supported suboptimally the WinWin negotiation model. EasyWinWin was designed to increase facilitation and face-to-face communication. Riaz et al. indicated that the tool resolves viewpoint conflicts, terminology conflicts and requirements contradiction.

**ARENA.** It was developed to address the limitation of EasyWinWin and for supporting negotiation in the distributed environment. It was further enhanced to support mobile negotiation (ARENA-M: Anytime, anywhere Requirements Negotiation Aids-Mobile). Riaz et al. indicated that the main emphasis of ARENA was usability issues. It only enhanced the distributed communication support i.e. asynchronous mode. It was not clearly mentioned in the empirical and literature about the types of conflicts that were handled by using the ARENA.

**WikiWinWin.** EasyWinWin evolved into WikiWinWin, which used the so-called ‘WikiWinWin’ requirements negotiation process model. As EasyWinWin did not support adequately the evolving nature of agreements and win conditions, WikiWinWin was designed to help improve the gradual creation of a shared vision among stakeholders and information management. Riaz et al. indicated that WikiWinWin only enhanced the facilitation and it partially resolved the resource conflicts.

**The CBSP- Component-Bus-System-Property approach.** It originated from WinWin approach and the Architecture Tradeoff Analysis Method (ATAM). The overall idea of CBSP is to respond to the fact that earlier approaches did not consider architectural knowledge for conflict handling. The CBSP approach attempted to resolve viewpoint conflicts and terminology conflicts.

**ICRAD- Integrated Conflict Resolution and Architectural Design.** This approach rests on the complementary use of ATAM, CBAM, CBSP and the WinWin negotiation model. It is developed in response to the fact that state of the art architecture analysis methods do not include any conflict resolution aspects. Riaz et al. indicated that ICRAD enhanced the degree of formality during requirements transformation. The approach resolves feasibility conflicts adequately. Plus, Riaz et al. claim that it can also resolve requirements contradiction and terminology conflicts which might appear during requirements transformation.

**Hybrid method framework.** It rests on concepts from Model-Based Architecture in Software Engineering (MBASE) and six other approaches (the mixed initiated template, Natural Language Processing, Keyword analysis, inspection, walkthrough and WinWin negotiation approach). Riaz et al. indicated that the method attempted to resolve viewpoint conflicts.

**MEG.** This approach was based on IBIS- Issue Based Information Systems, WinWin approach and the Software Quality Function Deployment (SQFD) approach. MEG just provided a tool support for SQFD process. Riaz et al. indicated that MEG attempted to resolve mainly viewpoint conflicts and claimed that the tool could resolve quality attribute conflicts as well.

**The Formal Technical Review (FTR) approach.** It includes a FTR process and negotiation-collaboration process. The basic aim of FTR was to increase the support for negotiation collaboration activities. The approach ensures negotiation-collaboration equilibrium is discussed as part of the FTR process. Riaz et al. indicated that FTR mainly emphasized to resolve viewpoint conflicts.