ELECTRONIC REQUIREMENTS NEGOTIATION – A LITERATURE SURVEY ON THE STATE-OF-THE-ART (23)

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Electronic Requirements Negotiation – A Literature Survey on the State-of-the-Art

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Abstract

In the software development process, requirements negotiation is an essential part in which stakeholders jointly have to come to an agreement. Such a negotiation process is often conducted using information systems, which makes it an electronic requirements negotiation process. The aim of the current paper is to present the state-of-the-art in electronic requirements negotiations. We elicit the state-of-the-art by analysing relevant literature, extracting areas of current research, and describing the status quo of each area. The identified areas of research are foundations of electronic requirements negotiation, electronic requirements negotiation methodology, automation of electronic requirements negotiation, computer-mediated communication, and social communication.

Keywords: requirements negotiation; electronic requirements negotiation; literature survey; state-of-the-art; literature analysis.

1   Introduction

Information systems as socio-technical systems involve human aspects (Krcmar 2015). Users as the active agents play a pivotal role in information systems (Lamb, Kling 2003). The discipline of information systems (IS) involves software development in which the phase of requirements engineering (RE) is of prime importance to find out what is really required for the information system to be developed. RE involves various stakeholder groups as developers, analysts, business experts, and designers (Jarke et al. 2010; Sourour, Zarour 2011). They all have different ideas, wishes, or requirements about the information system, which have to be taken into account. When it comes to human beings, their rationality is often restricted by their cognitive limitations and the amount of information gathered (Raiffa 1982). They might be unaware of their needs or unable to utter them explicitly. Thus, changes of their opinions and preferences are likely once new information is obtained.

Regardless of the applied software development method – traditional/heavy-weighted methods, agile/light-weighted methods, or hybrid forms – changes of scope are likely.

For example, agile methods (which are established in practice (Jalali, Wohlin 2010)) involve requirements changes since the second principle of the Agile Manifesto is to "welcome changing requirements, even late in development (…)" (Beck et al. 2001, p. 1). Especially requirements and requirement related information change frequently as the focus of agile methods is to deliver software early and continuously even if the requirements are not sufficiently specified yet. Practice has to deal with these changes, reconcile conflicting stakeholders' views and needs, and decide on the desired outcome of the development process. As stakeholders continuously exchange their knowledge to reach their goals, it is a social and communicative process.

These are key aspects of the concept of negotiation. The relation of these two concepts lead to the emergence of requirements negotiation, which is defined as an "iterative process of communication and decision-making between customer and developer and maybe other parties who have the overall goal of agreeing on a software development process and outcome. Neither of the partners can reach this goal unilaterally as their tasks are interwoven in that the requirements are the basis for the development process which will have to be based on realistic target specifications. The negotiations involve multiple attributes and thus facilitate integrative negotiation outcomes." (Lenz et al. 2015, p. 304)

Since software development related tasks are increasingly performed in geographically distributed teams (Hansen et al. 2009), the process of requirements negotiations will often or even mostly be performed in an asynchronous and dislocated manner using electronic means. Therefore, electronic requirements negotiation is performed and supported by information systems in terms of communication support, decision support, and/or document management. (Lenz et al. 2015)

RE as well as negotiation research play a pivotal role in electronic requirements negotiation; these separated research areas have to be integrated to cope with the interdisciplinary character of electronic requirements negotiation. Due to its interdisciplinary character, research in electronic requirements negotiation is manifold viewing different perspectives and disciplines. Preliminary publications exist which integrate the disciplines of RE and negotiation (e.g. Grünbacher et al. 2006). To conduct research in electronic requirements negotiation, it is essential to analyse existing work. Few previous publications elicit the state-of-the-art regarding their particular focus. For example, Calefato et al. (2012) provide an elaborate state-of-the-art of computer-mediated communication within electronic requirements negotiation. However, to the

best of our knowledge a general dedicated literature review w.r.t. electronic requirements negotiation does not yet exist.

Hence, our research goal is to provide such review. In particular, we will answer the following two research questions:

RQ1: Which areas of research exist for electronic requirements negotiations?

RQ2: What is the state-of-the-art in research in these areas w.r.t. electronic requirements negotiations?

Analysing the existing work will pave the way for future research into dedicated support of electronic requirements negotiations.

To this end, the paper is structured as follows. In section 2, the process of extracting relevant literature, the identification of areas of research, and their assignment will be described. Then, we will present the status quo of each area of research grouped by the identified areas in section 3. In section 4, we will discuss our findings and conclude the paper in section 5.

2 Research Method

To analyse the state-of-the-art in electronic requirements negotiation, we planned and conducted an in-depth literature review (adapted from Kitchenham, Charters 2007; Vom Brocke et al. 2009), see Figure 1.

For the data collection, the first task that we will address in this paper is to define the scope of the review and thus to define the search strategy. Therefore, we will identify relevant disciplines and sources (adapted from Vom Brocke et al. 2009; Feldt 2013). We will further introduce inclusion and exclusion criteria to define the search term, search space, coverage, language, and relevance (see section 2.1).

In section 2.2 we will retrieve and review relevant publications in collection and filtering processes according to the search strategy defined. To synthesise the reviewed publications, we will extract areas of current research within electronic requirements negotiation (adapted from Kelle, Kluge 2010) and assign relevant publications to the identified areas. Subsequently, we will present and analyse the state-of-the-art in electronic requirements negotiation by describing the status quo of each area.
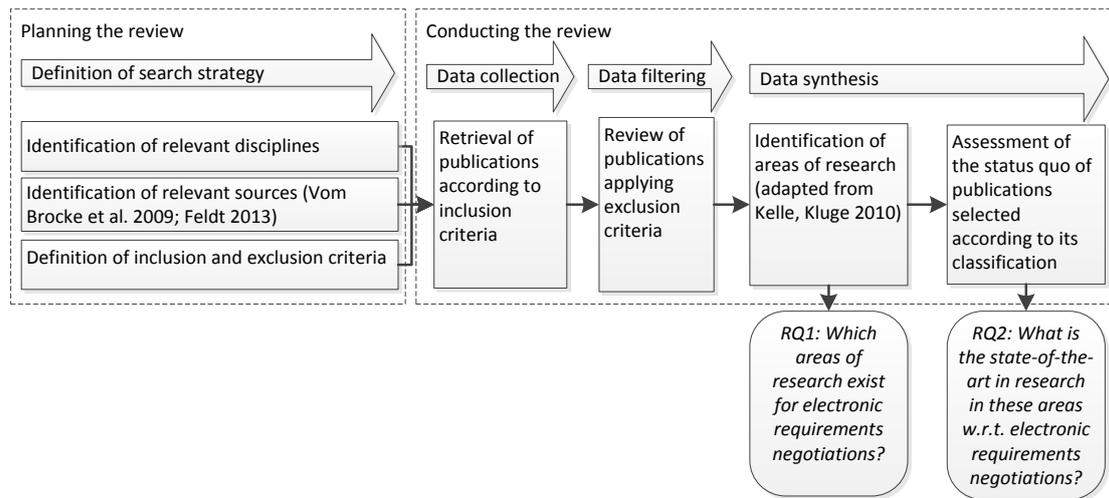
Figure 1. Research methodology of our literature review (adapted from Kitchenham, Charters 2007; Vom Brocke et al. 2009).

2.1 Planning the Review

The increased distribution of software development leads to stakeholders often being spatially dislocated, sometimes even being in different time zones. If travelling is too expensive, the stakeholders need to use information systems to perform their work tasks (Damian et al. 2008). Consequently, it becomes important to study the benefit of information systems in the context of electronic requirements negotiation.

Research in this field goes back to the 1990s when the first automated multi-agent requirements negotiations were analysed (Robinson 1990; Robinson 1994). 26 years later, we want to analyse the current state of research.

To answer our research questions (see section 1), we defined the following search strategy to collect data. Due to the multidisciplinary character of electronic requirements negotiation, we consequently included literature from the disciplines of IS, software engineering, and negotiation. In these disciplines, we included outstanding IS journals (Vom Brocke et al. 2009) and conference proceedings, software engineering journals (Feldt 2013), as well as negotiation journals and conference proceedings in digital or printed media. In case of digital journals, which are contained in a database, we searched the whole database for relevant publications. To ensure coverage of all relevant sources, we included the well-known general multidisciplinary databases SpringerLink (SL), SCOPUS, and CiteSeer (CS) as presented in Table 1.

Discipline	Source
Information Systems	Journals (adapted from Vom Brocke et al. 2009) • Artificial Intelligence (AI) • AI Magazine (AIMAG) • Communications of the ACM (CACM) • Data & Knowledge Engineering (DKE) • Decision Sciences (DSCI) • Decision Support Systems (DSS) • Electronic Markets (EM) • European Journal of Information Systems (EJIS) • Information Systems Research (ISR) • Journal of Management Information Systems (JMIS) • Management Information Systems Quarterly (MISQ) • Management Science (MS) • Business & Information Systems Engineering (BISE) Conference Proceedings • European Conference on Information Systems (ECIS) • International Conference on Information Systems (ICIS) • Wirtschaftsinformatik (WI)
Software Engineering	Journals (Feldt 2013) • ACM Transactions on Software Engineering and Methodology (TOSEM) • Automated Software Engineering (ASE) • CACM • Empirical Software Engineering (ESEJ) • IBM Journal of Research & Development (IBM JRD) • IEEE Computer (Comp) • IEEE Software (SW) • IEEE Transactions on Software Engineering (TSE) • IET Software (IET SW) • Information and Software Technology (IST) • Journal of Systems and Software (JSS) • Requirements Engineering Journal (REJ) • Software and Systems Modeling (SoSyM) • Software Engineering and Knowledge Engineering (IJSEKE) • Software Practice & Experience (SPE) • Software Quality Journal (SQJ) • Software Testing Verification & Reliability (STVR) • SW Maintenance & Evolution - Research & Practice (JSEP)
Negotiation	Journals • Group Decision and Negotiation Journal (GDNJ) • Journal of Conflict Resolution (JCR) • Negotiation Journal (NJ) Conference Proceedings • Group Decision and Negotiation (GDN) • International Association for Conflict Management (IACM)
Multidisciplinary	Databases • CS • SCOPUS • SL

Table 1. Sources of our literature review.

To retrieve and analyse all documents, we defined the following inclusion and exclusion criteria. We searched databases, which contain publications of the journals and conferences named above, namely ACM Digital Library (DL), AIS Electronic Library (EL), Business Source Premier via EBSCOhost (BSP), CS, IEEExplore (IEEE), ScienceDirect (SD), SCOPUS, and SL. They do not contain GDN Conference Proceedings, IACM, IJSEKE, ISR, JCR, and WI Conference, which we searched separately.

We combined the search terms of 'requirement' or 'requirements' and 'negotiation' or 'negotiations'. The exact search term varies for the used databases since they use different syntax. For detailed information on the mapping of journals and conferences to the databases as well as the search string used for each database, see Table 4 in the Appendix.

Since it was not possible to search in the title, abstract, and keywords of the literature in all of the databases (e.g. SpringerLink and AIS Electronic Library do not provide keywords and abstract search), we unified the search space for each source to the space, which was accessible in each source - the title of the publication - to ensure comparability. Regarding the date, we searched the time frame from 1990 when the earliest literature was published (e.g. Robinson 1990) to the date when the search was conducted, namely in September 2014. We excluded literature, which is not published in English or German language. A publication was defined to be relevant if its focus is on electronic requirements negotiation. To sum up, the inclusion criteria define publications to be included as follows.

- *The search terms used were combinations of 'requirement'/'requirements' and 'negotiation'/'negotiations'.*
- *The search term must appear in the title.*
- *The publication date is between 1990 and 09/2014.*

The exclusion criteria define publications to be excluded as follows.

- *The publication is in neither English nor German.*
- *The publication does not focus explicitly on electronic requirements negotiation.*

2.2 Conducting the Review

In the following data selection and review process, we collected and reviewed all publications retrieved to ensure their relevance to the state-of-the-art. In the data

extraction and synthesis process, we identified areas of research and assessed the state-of-the-art of each area.

In the data selection process, we identified 130 publications using the aforementioned search strategy. To consolidate the retrieved publications, we excluded publications in any other language than English or German. Consequently, two articles were excluded. In the review process, each publication was reviewed according to its relevance for the explicit focus on electronic requirements negotiation. To do so, we (i.e. three researchers with a background in negotiation research and in software engineering research) read the title of the paper. If the title was not sufficient to decide whether the publications covered requirements negotiation and its electronic conception, we read the abstract. Where reading the abstract did not suffice, we read the full paper to decide. This led to the exclusion of another 32 publications. In addition, in seven cases we identified duplicate publications. According to Kitchenham, Charters (2007), we only used the most complete one in each case not to bias any results. If one of the researchers asked for a second opinion, we conducted face-to-face meetings to reach consensus. The review process resulted in 89 publications relevant to electronic requirements negotiation. Table 2 gives a detailed insight in the contribution per database. Sources, which are not contained in the databases and resulted in 0 hits, are not listed.

In the subsequent data extraction process, we identified relevant information to answer our research questions. To answer what areas of research exist in electronic requirements negotiation (RQ1), we needed to analyse and synthesise the content. Based on the content, we built groups describing areas of research following appropriate guidelines (Kelle, Kluge 2010). The groups are not mutually exclusive because they describe the publications' content, which might be manifold.

To assess the status quo of each area of research in electronic requirements negotiation (RQ2), we firstly assigned each publication to the most appropriate area. When the focus of a publication was manifold, the assignment to more than one area was required. Subsequently, we read every publication in detail (if it had not been done in the first round) and elicited the status quo of each area of research. Therefore, we classified each publication indicating the relevance for the state-of-the-art from A (highly relevant) to C (irrelevant) resulting in 43 assignments to A, 13 assignments to B (moderately relevant, i.e. deals with some aspects of electronic requirements negotiations), and 33 assignments to C. We then extracted the state-of-the-art from publications according to their classification, their publication date, their quality and the quality of their source.

Database, respective sources, and coverage	Hits	Duplicate hits	Exclu-ded	Duplicate content	Reviewed
ACM DL	19	5 to CS 7 to IEEE 16 to SCOPUS	4	1	14
AIS EL	3	1 to SCOPUS	0	0	3
BSP	12	6 to CS 6 to IEEE 8 to SCOPUS 1 to SD	5	0	7
CS	62	5 to ACM DL 5 to BSP 5 to CS itself 17 to IEEE 31 to SCOPUS 1 to SD 3 to SL	11	3	48
IEEE	40	7 to ACM DL 6 to BSP 19 to CS 38 to SCOPUS	4	2	34
SCOPUS	92	16 to ACM DL 1 to AIS EL 8 to BSP 33 to CS 38 to IEEE 1 to SCOPUS itself 3 to SD 8 to SL	21	6	65
SD	4	1 to BSP 1 to CS 3 to SCOPUS	2	0	2
SL	9	3 to CS 8 to SCOPUS	0	0	9
Not in selected databases: GDN (printed media)	2	0	2	0	0
Total	130		34	7	89

Table 2. Hits and reviews per source.

3 Findings of our review

Applying the methods described above, we identified 89 relevant research contributions. In the following, we will present the identified areas of research as well as their status quo.

3.1 Areas of Research

Since the first publication in 1990, different emphases of research evolved in the field of electronic requirements negotiation. With respect to the areas of research, addressing RQ1, we detected five groups regarding their focus within the relevant publications as explained in section 2.2. The areas that emphasise different aspects of the research field are clustered as follows.

For *electronic requirements negotiation methodology*, we found out that the majority (two thirds) of research contributions whose focus is on electronic requirements negotiation in general covers the so-called *WinWin methodology* (Boehm, Ross 1989; Boehm et al. 1995). We consequently distinguished WinWin approach adopters from *approaches different to WinWin methodology* in this group. In the following group, we clustered automated approaches, which aim at a high level of *automation of electronic requirements negotiation*. Publications assigned to *computer-mediated communication* investigate the choice of the right communication strategy. Here, specific aspects of electronic requirements negotiation regarding *communication mode* and *communication medium* are investigated. The group *foundations of electronic requirements negotiation* covers definitions, typologies, or tool evaluation. The last group deals with *social communication*. These research contributions survey an early phase of the electronic requirements negotiation. They mainly investigate informal communication at the beginning of a software project, see Table 3. The areas are sorted in descending order according to the number of assigned.

Since multiple assignment is possible, the assignment process of the 89 publications identified resulted in 95 assignments to areas of research. To assess the chronological sequence of the publications, referring to the amount of assignments would not reflect the absolute amount of publications per year. Therefore, in case of multiple assignment, we assigned the respective publication to each area of research in equal shares, see Figure 2. This is of importance to ensure the correct overall sum of publications per year.

Area of research	Subarea of research	Count
Electronic Requirements Negotiation Methodology	WinWin Methodology	48
	Approaches Different to WinWin Methodology	
Automation of Electronic Requirements Negotiation	Agents, Web Services	17
	E-Commerce, E-Business, Ecosystems, Service Engineering	
Computer-Mediated Communication	Communication Medium: Speech, Text, Video	14
	Communication Mode: Synchronous, Asynchronous	
Foundations of Electronic Requirements Negotiation	Definitions, typologies, tool evaluation	10
Social Communication	Within the group of customers, customers and developers, partners in value added networks	6

Table 3. Areas of research in electronic requirements negotiation (N=95).
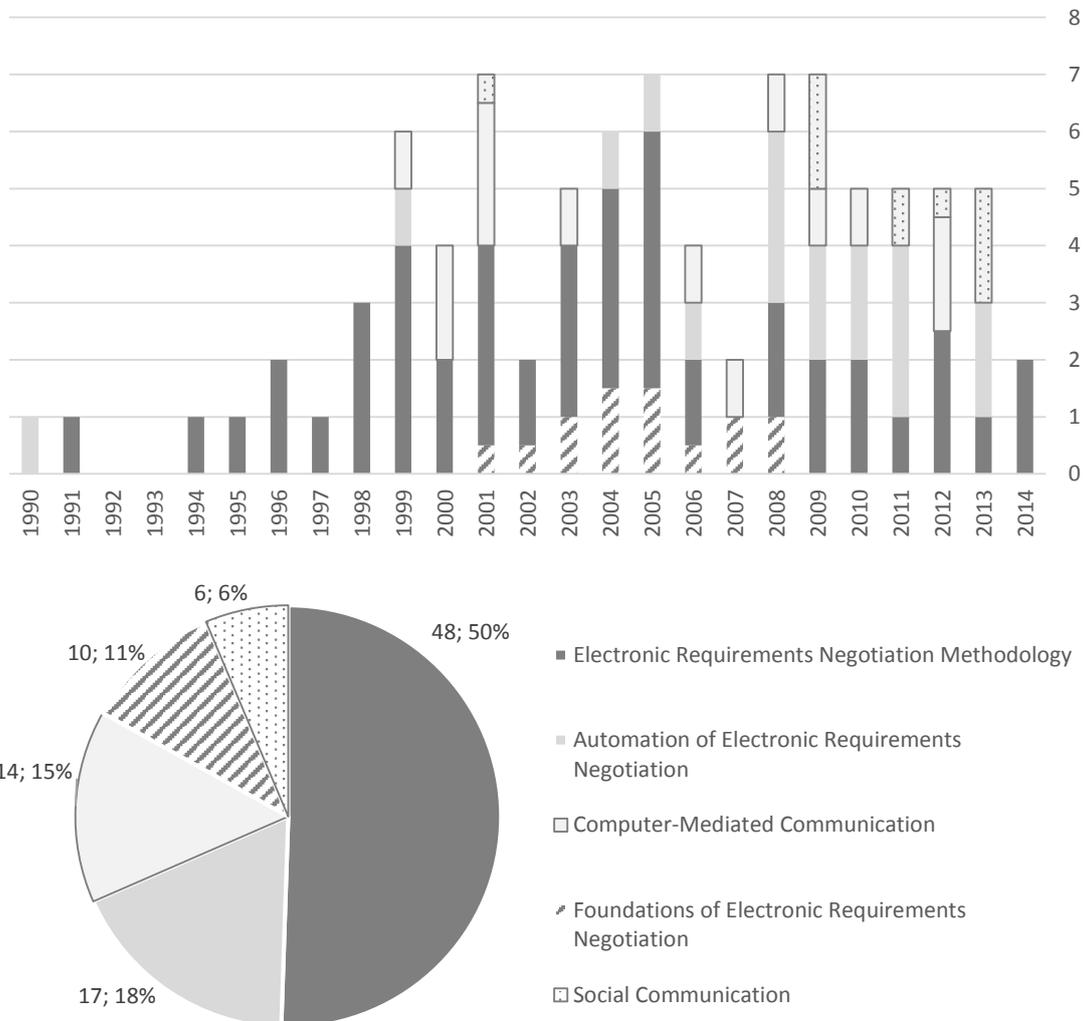

Figure 2. Share (N=95) and chronological sequence (N=89) of areas assigned to publications. Multiple assignment is possible.

Looking at the state-of-the-art in electronic requirements negotiation (RQ2), we will now analyse each group in detail.

3.2 Electronic Requirements Negotiation Methodology

We divided the area of *Electronic Requirements Negotiation Methodology* into two subareas because research referring to one methodology holds by far the largest share of 72% (N=50) within this area of research. Consequently, we grouped them to the subarea WinWin methodology.

The subarea *'WinWin Methodology'* research bases their work on the Theory W and corresponding WinWin negotiation model as well as the extended spiral approach (Boehm, Ross 1989; Boehm et al. 1995). The software project management theory Theory W is based on the Harvard Principled Negotiation (Fisher, Ury 1981; Boehm, Ross 1989). The aim is to come to a perceived fair agreement for every stakeholder by attempting to fulfil each stakeholder's win conditions (Boehm, Kitapci 2006). For this purpose, an iterative spiral model for developing a software system's definition (Boehm 1988) is extended. In each cycle, the WinWin extensions are performed, which are (1) relevant stakeholders are identified, (2) these stakeholders' win conditions, respectively requirements, are identified, (3) the win conditions are jointly agreed upon, objectives and constraints are defined, and alternatives are generated. The following phases of the original spiral model are then performed, which are (4) the evaluation of the product and process alternatives, the resolution of risks, (5) definition of product and process for the next cycle, (6) validation of product and process definitions, and (7) review and commitment, see Figure 3.
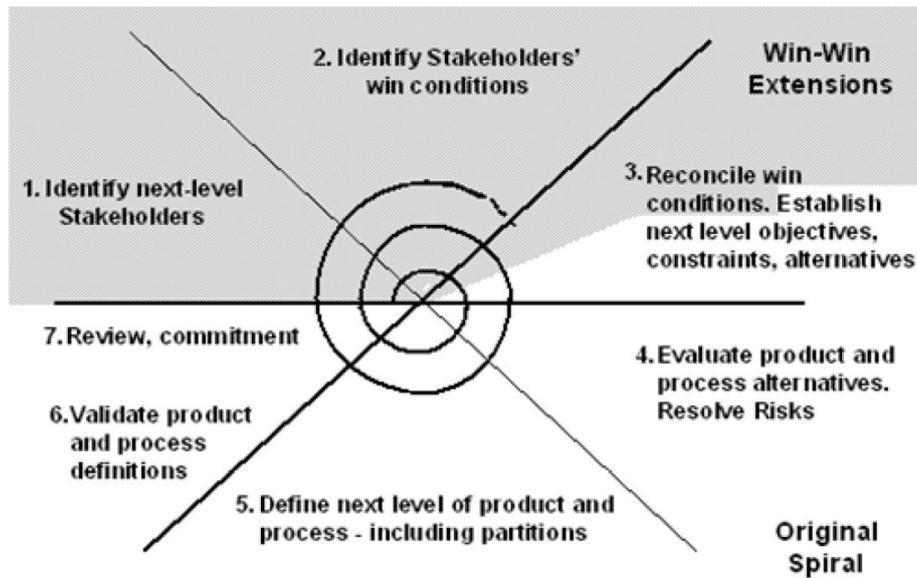
Figure 3. WinWin spiral model (Boehm, Kitapci 2006, p. 176).

In particular, by eliciting the success-critical stakeholders' win conditions and identifying conflicts (issues) among these conditions or between win conditions and existing resolutions, the negotiation agenda is set up in each cycle to then negotiate the win-win situation packages according to proposed alternatives (options), see Figure 4. Subsequently, it is monitored whether all win conditions are covered by agreements. The process results in a list of agreements and a list of unresolved issues in case of not reaching an agreement. In theory, the deliverables could be a domain taxonomy, project glossary, project plan, requirements specification, or a project contract (Boehm, Kitapci 2006).
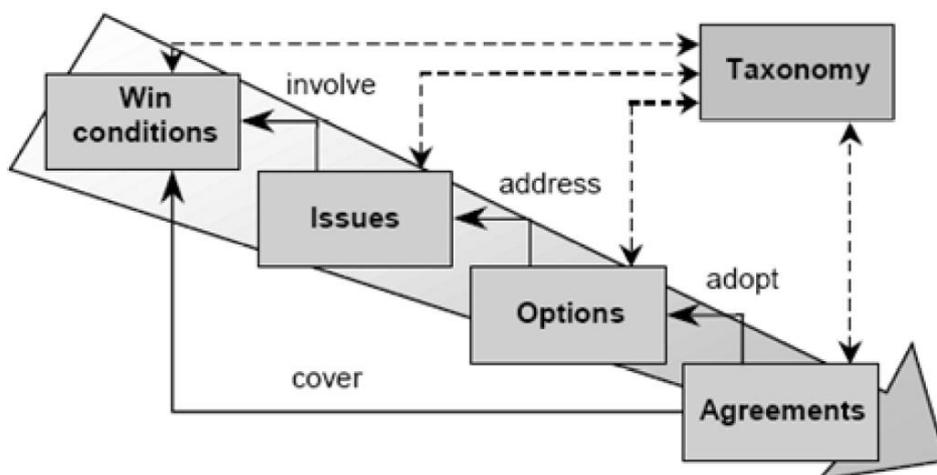

Figure 4. WinWin negotiation model (Boehm, Kitapci 2006, p. 181).

Since its advent, various enhancements of the WinWin methodology have been developed (e.g. Ruhe et al. 2002; In, Olson 2004; Wan et al. 2010; Khan et al. 2014; Sofian et al. 2014). Decision-making is improved by multi-criteria preference analysis as conflict resolution technique. For this, win condition conflicts are refined and classified in direct conflicts, quality conflicts, cost conflicts, and schedule conflicts (In, Olson 2004). Dai, Wang (2009) enable the distributed asynchronous and synchronous electronic requirements negotiation. They developed a composition with an expert system, which provides a repeatable and predictable process.

Compared to WinWin methodology, publications in the subarea '*Approaches Different to WinWin Methodology*' are very few, making up 28% (N=50) within this area of research. Among these publications the use of concepts such as BATNA (i.e. the *b*est *a*lternative *t*o the *n*egotiated *a*greement), aspiration levels, or reservation levels are discussed to complement the WinWin approach. In addition, to improve decision-making, decision alternatives are formulated as negotiation packages and assessed using utility values (Grünbacher et al. 2006).

Furthermore, the activity of electronic requirements negotiation demands a defined process to enable effective negotiation support (Grünbacher et al. 2006). One example is the integrated conflict resolution and architectural design process (ICRAD) (Herrmann et al. 2006). Based on requirements conflicts such as requirements inconsistency, requirements contradiction, or feasibility conflict, the transformation of requirements into software solutions is negotiated. During this process, architectural alternatives are identified which are then negotiated.

The electronic medium used to support requirements negotiation varies depending on the process (e.g. Ramires et al. 2005). The validation phase can be supported by software for filling in and consolidating Quality Function Deployment (QFD)-matrices (Ramires et al. 2005; Sourour, Zarour 2011). Stakeholders utter their requirements and suggested architectural solutions in the form of matrices to prioritise and validate them. There are various factors influencing consensus in the electronic requirements negotiation process (Price, Cybulski 2005). To reach consensus, besides the negotiation process, communication, conflict, intersubjectivity, power, knowledge, trust, corporate culture, collaboration, cooperation, and compromise must be considered (Price, Cybulski 2005; Yang, Liang 2013).

3.3 Automation of Electronic Requirements Negotiation

One area of research making up 18% (N=95) of the publications addresses the automated support of negotiating requirements. The assigned publications are characterised either by general approaches to automate electronic requirements negotiations or by publications which focus on domain specific applications. Consequently, we divided this area in automated approaches such as agents and web services and approaches concentrating on the application domain instead of technical implementation aspects.

Over the last 26 years, the automation of electronic requirements negotiation has continuously been improved. In the subarea '*Agents, Web Services*', software can detect conflicts among requirements, characterise the conflict, and can generate resolution alternatives (Robinson 1990; Robinson 1994). If the stakeholders' preferences are revealed, autonomous software agents can resolve conflicts consistent with those preferences. In case of requirements changes, logical representations of the requirement specification as well as its changes enable automated consolidation (Mu et al. 2011). Consistency is achieved by compromise-based algorithms without human involvement (Zhang et al. 2013).

As a precondition, these approaches need the requirements to be known and revealed in advance and to be specified completely. The automation of conflict resolution additionally requires revealing the individuals' preferences for the requirements.

The subarea *'E-Commerce, E-Business, Ecosystems, Service Engineering'* covers domain application, e.g. Off-The-Shelf components selection (Carvallo, Franch 2011). In the domain of service design, the service receiver's requirements as well as the service provider's requirements for the design of cooperate services are agreed upon (Watanabe et al. 2010). The process applies, if service receiver and service provider have contradicting requirements. These are then prioritised by the AHP method according to the contradicting requirements' importance and are adjusted based thereon.

To support agent communication during electronic requirements negotiation, Speech Act Theory (Searle 1969) is utilised (Parsons-Hann et al. 2006). For this purpose, stakeholders provide descriptions and priority of the requirements as well as dependencies as input for the agents. Moreover, the importance of specific requirements

is derived from the stakeholder's rank resulting in a list of all stakeholders' prioritised requirements.

These are suitable approaches for their specific application domain, but generalisation to a broader application domain is hardly possible.

3.4 Computer-Mediated Communication

Most studies in this area research the influence of the richness of media on the communication and negotiation process (e.g. Mallardo et al. 2007; Damian et al. 2008; Arthi 2009; Erra, Scanniello 2009, 2010; Ahmad et al. 2012; Calefato et al. 2012). Damian et al. (2008) argue for a mix of media, utilising lean and rich media for appropriate tasks. Within the area of computer-mediated communication, which makes up 15% (N=95) of the publications, we discovered two subareas, which focus on the communication medium and on the communication mode.

The subarea *'Medium'* states that groups negotiating requirements face-to-face – the richest communication medium (Daft, Lengel 1986) – do not perform better than groups using leaner media (Herlea Damian et al. 2000). The communication medium influences the requirements negotiation process (Erra, Scanniello 2010). The time needed is shortest using face-to-face requirements negotiation, whereas the arisen number of issues during electronic requirements negotiation is larger using a distributed three-dimensional virtual environment. This suggests that the latter is more thought provoking.

Face-to-face requirements negotiation experiences the highest level of satisfaction, comfort, and perceived engagement, compared to rich media (video-chat) and text-based communication (instant messaging) (Ahmad et al. 2012). Nevertheless, synchronous distributed text-based chat is more effective than face-to-face negotiation in certain phases of the requirements negotiation process (Calefato et al. 2012).

According to research in the subarea *'Communication Mode'*, asynchronous discussion prior to synchronous electronic requirements negotiation influences the number of open issues after the electronic requirements negotiation process (Damian et al. 2006, 2008). Asynchronous discussion reduces the number of unresolved issues after synchronous negotiation. Requirements negotiation is more effective when an asynchronous medium is added to a face-to-face negotiation. The reasoning is that asynchronous communication reduces missing information in electronic requirements negotiation and

establishes common ground, so asynchronous discussions help to focus in the synchronous negotiation meeting on the issues that could not be resolved during the asynchronous phase.

Moreover, this assumption is confirmed considering uncertainty in the requirements engineering process (Mallardo et al. 2007). Accordingly, asynchronous communication is more suitable for handling process uncertainties.

3.5 Foundations of Electronic Requirements Negotiation

11% (N=95) of all relevant publications describe foundations of electronic requirements negotiation. These have mainly been developed between 2001 and 2008. Frameworks for requirements negotiation allow a classification and an understanding of negotiation approaches, collaboration situations, and tools (Grünbacher, Seyff 2005), which is facilitated by the following three dimensions: conflict resolution strategy, the stakeholders' spatial and temporal situation, and the level of negotiation support. As long as the stakeholders' collaboration situation is not synchronous and co-located, they need to utilise information systems to work together. Negotiation tool support is characterised in passive support tools, which provide an infrastructure to collaborate, active facilitative support tools, which support reaching an agreement by guiding the stakeholders, and pro-active intervention support tools which additionally coordinate the stakeholders' activities. Some tools are particularly designed to support electronic requirements negotiation while others target at negotiation support in general.

Using groupware for electronic requirements negotiation benefits from functions which groupware already provides for collaboration. Groupware has the capability to create thinking in a group, e.g. creating ideas, focusing on ideas, gain a better understanding of the relation of ideas, and better understand interests of the group members (Boehm et al. 2001). The functionality offered may also reduce complexity and related cognitive load (Briggs, Grünbacher 2002).

To support requirements negotiation by information systems, it is necessary to define a repeatable requirements negotiation process (Boehm et al. 2001; Campbell et al. 2004). Task structuring and providing explicit negotiation sequence influences the group performance (van de Walle et al. 2007). Structured electronic requirements negotiation facilitates more stakeholder participation than having no task structure, whereas lack of negotiation sequence has a positive impact on the stakeholders' satisfaction. In addition

to a sound process, repeatable quality assurance techniques must be established (Grünbacher et al. 2003).

All stakeholders' perceptions must be taken into account and their perspectives must be aligned or accepted by negotiating parties (Price, Cybulski 2006). Frameworks can be utilised to understand their negotiation constellations (Fricker, Grünbacher 2008). To understand their perceptions is essential for understanding the stakeholders' behaviour in software development projects. Based thereon, tactical and methodical negotiation advice can be enabled.

3.6   Social Communication

Publications assigned to the fifth area of research (6% overall, N=95) focus on social communication. Dealing with various stakeholders, group recommendation technologies enable group decision-making (Felfernig et al. 2012). In the event of conflict, the stakeholders' preferences are expatiated. Based on these, recommendation technologies are applied to reach a joint decision on which requirements to develop (first). The individual group members' preferences should not be disclosed at the beginning. Group recommendation technologies enhance the perceived usability and the quality of decision support.

In particular, non-technical stakeholder usage can be supported (Kukreja, Boehm 2012; Renzel et al. 2013). 'Winbook', which is based on the WinWin methodology addresses non-technical stakeholders by using a social networking approach. The intention is to provide easy-to-use-groupware to enable brainstorming and organising content.

To identify stakeholder groups and power relationships between stakeholders, an ontology-based approach is developed (Yang, Liang 2013). From such an ontology, decision-makers and supporter groups of conflicting requirements, even representative stakeholders of supporter groups, can be derived who then participate in requirements negotiation to resolve the conflict.

4   Discussion of the Results and Study Limitations

Comprehensively, we found 89 relevant publications and identified five areas of research and six subareas among them (see section 3.1), which address foundations of electronic requirements negotiation, the methodology, the media used, automation of electronic requirements negotiation, and communication. Six publications were assigned to more than one area, because their main concern is manifold.

Publications addressing automation of electronic requirements negotiation can be found during the whole period of publications our study analysed (Robinson 1990; Robinson 1994; Dubois et al. 2011). Likewise, the WinWin methodology has had early publications and is still a subject of research now (Boehm et al. 1995; Kukreja, Boehm 2013). We were surprised that the WinWin methodology is represented to this extent making up the largest identified area. However, our first impression that the WinWin methodology is the sole methodology discussed in electronic requirements negotiation was revised by the amount of not less than 14 publications describing different approaches. Nonetheless, the WinWin methodology is widely used and forms this field of research. Since 2009, the new area of social communication in electronic requirements negotiation research has been established (e.g. Tang, Jin 2009). Whether this trend can be maintained remains to be seen.

Overall, various areas of research are addressed, which is not surprising in such a multidisciplinary research field. The very fact that different perspectives on negotiation can be taken and emphasised (Grünbacher, Seyff 2005) confirms the detected variety of research. In contrast, we supposed that negotiation research would also address electronic requirements negotiation as an application domain but we did not identify any such publications in our sources.

We identified the following limitations of our literature review. Since electronic requirements negotiation is an interdisciplinary field of research, it is of prime importance to include an appropriate variety of research disciplines. Consequently, we divided the field of electronic requirements negotiation into its disciplines to identify relevant publications. We considered IS, software engineering, and negotiation research as relevant disciplines to answer our research questions. Thus, predictions about these disciplines are reliable. To ensure completeness, we included broader databases (see section 2.1). However, further disciplines might have been left out. Additionally, we searched pertinent sources within these disciplines, but this does not ensure completeness, so relevant publications might have been left out.

Non-English and non-German publications of importance and relevance are not considered; also, synonyms of our search string were not searched.

We used a two-staged process in which the publications were examined by three different researchers in order to reduce subjectivity in the selection of the relevant publications (see section 2.2). However, the complete prevention of subjectivity by personal preferences cannot be guaranteed.

5 Conclusion

The aim of our research is to examine the state-of-the-art of electronic requirements negotiation. We utilised a structured literature review for this and proposed the following research questions in order to reach this goal. RQ1: Which areas of research exist for electronic requirements negotiations? RQ2: What is the state-of-the-art in research in these areas w.r.t. electronic requirements negotiations?

It was discovered that publications in the field of electronic requirements negotiation focus on five areas of research: (1) electronic requirements negotiation methodology, (2) automation of electronic requirements negotiation, (3) computer-mediated communication, (4) foundations of electronic requirements negotiation, and (5) social communication.

Opinions differ w.r.t. the occasion of electronic requirements negotiation. Whereas some state that requirements negotiation is entered as soon as the stakeholders utter their needs (Robinson, Volkov 1998; Reiser et al. 2012), others presume various kinds of conflicts to precede (e.g. Boehm, Kitapci 2006; Herrmann et al. 2006; Felfernig et al. 2012; Sourour, Zarour 2011).

The WinWin methodology as a subarea of *electronic requirements negotiation methodology* is approved as an appropriate approach for electronic requirements negotiation. However, it is optimised for synchronous electronic requirements negotiation and therefore lacks supporting asynchronous electronic requirements negotiation (Grünbacher et al. 2006). Findings indicate that asynchronous discussions prior to synchronous requirements negotiation is more effective. Asynchronous communication is useful to resolve uncertainty issues and more appropriate to handle uncertainties (Mallardo et al. 2007; Damian et al. 2008).

Research in electronic requirements negotiation utilises collaborative environments (van de Walle et al. 2007), group support systems (Boehm et al. 2001), or group recommender systems (Felfernig et al. 2012), which support collaboration but lack process support (cf. Lenz et al. 2015). A process needs to be defined, which improves the stakeholders' cognitive and information processing capabilities, to support negotiation (Grünbacher et al. 2006). Furthermore, the agenda is set up before the start of the electronic requirements negotiation and the preferences are elicited via direct preferences elicitation methods at the beginning of a negotiation (Boehm, Kitapci

2006). If the agenda is changed, the preferences will not be adjusted. There are no consistency checks to analyse whether preferences have changed, whether new requirements exist, or whether requirements in the negotiation agenda are no longer relevant. Current WinWin methodology research includes prioritisation of requirements according to weighted business goals or project goals (Kukreja, Boehm 2013), but the method itself has drawbacks, e.g. the original prioritisation order of requirements may change if the agenda is updated and not relevant requirements are added to the prioritisation (Kukreja, Boehm 2013; Kukreja et al. 2013).

The deliverables of current approaches of the electronic negotiation process are (prioritised) lists of requirements and lists of conflicts if they could not be resolved throughout the process (Boehm, Kitapci 2006). In the WinWin methodology, traceability is only enabled from agreements and open issues back to win conditions by a tree structure (Boehm, Kitapci 2006). A complete, consistent, and traceable requirements specification as process outcome is, however, desirable (Boehm, Kitapci 2006).

In the area of research regarding *automation of the electronic requirements negotiation* process, knowledge about requirements is a prerequisite (Parsons-Hann et al. 2006). The approaches assume the requirements are known in advance. Additionally, the stakeholders' preferences must be known and the stakeholders must be willing to disclose their preferences. This is an unrealistic precondition as requirements are not yet available in the beginning of a requirements negotiation process (Fernandes et al. 2014) and the finding that the stakeholders' preferences should not be disclosed at the beginning (Felfernig et al. 2012). Possibly, semi-automated approaches, which enable human stakeholders to communicate their knowledge, might be promising. In addition, some approaches are domain-specific and thus hardly generalizable (e.g. Carvallo, Franch 2011; Watanabe et al. 2010).

In the *computer-mediated communication in electronic requirements negotiation*, previous studies base their research besides on media richness theory (Daft, Lengel 1986) also on media synchronicity theory (Dennis, Valacich 1999) and task/technology fit (e.g. Damian et al. 2006), or on media switching theory (Robert, Dennis 2005) (e.g. Mallardo et al. 2007; Damian et al. 2008). However, more recent studies only focus on the influence of the richness of media (e.g. Erra, Scanniello 2009, 2010; Ahmad et al.

2012; except for Calefato et al. 2012). This is surprising and contradicts the finding of recent negotiation research, which suggests that the application of media richness theory to negotiation is limited because it does not consider that the interaction of the user with the medium moderates the richness (Parlamis, Geiger 2015; Carlson, Zmud 1999). Secondly, Parlamis, Geiger (2015) argue that media synchronicity theory (Dennis et al. 2008) suggests that different communication media enable different tasks rather than a mode being superior or inferior for communication. Media synchronicity theory postulates that appropriate conveyance processes (transmission and distribution of information) and convergence processes (aggregation of information) are required to collaborate. Hence, complex tasks, which require both processes, are accomplished best using multiple media. Additionally, the stakeholders' familiarity with the medium influences the appropriateness (Parlamis, Geiger 2015).

This confirms that literature in computer-mediated communication is not based on the state-of-the-art in negotiation research sufficiently. Further research would benefit from eliciting the state-of-the-art in computer-mediated communication in negotiation research and adjust the state-of-the-art in computer-mediated communication in electronic requirements negotiation to it.

Moreover, semantic precision in electronic requirements negotiation can be improved, e.g. by semantic modelling (Grünbacher et al. 2006). Additionally, precise definition of key terms or glossary are prerequisites for knowledge management (Grünbacher et al. 2006; Boehm, Kitapci 2006). Alharthi et al. (2014) developed an ontological model for electronic requirements negotiation.

Studies in this area of research aim at quantitative empirical research. However, to study electronic requirements negotiation, subjects are grouped into teams to facilitate validation. This leads to a very small number of teams examined, in particular six to twelve teams (e.g. Damian et al. 2006; Mallardo et al. 2007; Damian et al. 2008; Erra, Scanniello 2009; Calefato et al. 2012; Ahmad et al. 2012). Additionally, students are used as subjects for availability reasons. Therefore, further empirical studies with large samples are needed to validate these assumptions.

In *foundations of electronic requirements negotiation*, even though fundamental for understanding electronic requirements negotiation, negotiation itself has not been studied as thoroughly as other facets of this engineering discipline (Fricker, Grünbacher 2008). Most approaches are developed in the requirements engineering discipline and

do not integrate present negotiation research (Fricker, Grünbacher 2008; Grünbacher, Seyff 2005). As mentioned above, the subarea of computer-mediated communication would also benefit from state-of-the-art negotiation research. Hence, an integration of the disciplines involved, in particular including negotiation research, must happen to advance this interdisciplinary research field.

Diverse aspects of electronic requirements negotiations need to be supported. Research and software utilised aim at supporting group collaboration (e.g. van de Walle et al. 2007), supporting communication (e.g. Calefato et al. 2012), supporting decision-making (e.g. Felfernig et al. 2012), or should aim at supporting document management. Research referring to the WinWin methodology tries to integrate supporting more than one aspect of electronic requirements negotiation (e.g. group collaboration (Briggs, Grünbacher 2002) and decision-making (In, Olson 2004; Ruhe et al. 2002)). However, truly integrated electronic support for requirements negotiation does not yet exist.

The last area of research concerning *social communication in electronic requirements negotiation* has been established for the last six years. We could identify only six publications within this area. Consequently, there are still plenty of open issues to simplify technical usage by providing familiar software.

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Appendix

Database and Containing Journals and Conference Proceedings	Search String
ACM DL • CACM	acmdlTitle:(+requirement +requirements +negotiation +negotiations) Published since: 1990 Published before: 2015
AIS EL • ECIS • ICIS	title:(requirement* negotiation*)
BSP • AIMAG • JMIS	TI requirement* AND TI negotiation* Published Date: 19920101-20141231
CS	title:(requirements negotiation) title:(requirements negotiations) title:(requirement negotiation) title:(requirement negotiations)
IEEE • Comp • SW • TSE	"Document Title":requirement* negotiation* Year: 1990-2014
SD • AI • DKE • DSS	pub-date > 1989 and TITLE(requirement*) and TITLE(negotiation*)

Table 4. Mapping of journals and conference proceedings to databases, coverage, and search string used (1 of 2).

SCOPUS • ASE from 1994-2015 • DSCI from 1996 to 2015 • EJIS from 1995 to 2015 • ESEJ from 1996-2015 • IBM JRD • IET SW from 2007 to 2015, IEE Proceedings – Software from 1997 to 2006 • IST • JSEP from 2012 to 2015, Journal of Software Maintenance and Evolution from 1996 to 2011, Software Process Improvement and Practice from 2003 to 2009 • JSS • MISQ • MS • SoSyM from 2005-2015 • STVR 1991 to 2015 • TOSEM from 1992-2015 • SPE • SQJ from 1992 to 1999 and from 2001 to 2015	TITLE (requirement* negotiation*) AND PUBYEAR > 1989 AND PUBYEAR < 2015
SL • BISE • EM from 2009 to 2016 (also searched in online archive from 1990 – 0 hits) • GDNJ • NJ from 1985 to 2003 (also searched online at Wiley Online Library – 0 hits) • REJ from 1996 to 2015	'requirement* AND negotiation*' within 1990 - 2014
Not in selected databases • GDN from 2005 to 2014 • IACM from 2002 to 2014 • IJSEKE (searched online at World Scientific) • ISR (searched online at Informs) • JCR (searched in online archive) • WI Conference Proceedings (searched online at dblp and printed media)	requirement negotiation, requirements negotiation, requirement negotiations, requirements negotiations

Table 4. Mapping of journals and conference proceedings to databases, coverage, and search string used (2 of 2).