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A number of selected papers presented at ICSOFT 2008 will be published by Springer-Verlag in a CCIS Series book. This selection will be done by the Conference Co-chairs and Program Co-chairs, among the papers actually presented at the conference, based on a rigorous review by the ICSOFT 2008 program committee members.

FOREWORD

This volume contains the proceedings of the third *International Conference on Software and Data Technologies* (*ICSOFT 2008*), organized by the Institute for Systems and Technologies of Information, Communication and Control (*INSTICC*) in cooperation with the Interdisciplinary Institute for Collaboration and Research on Enterprise Systems and Technology (IICREST), and co-sponsored by the Workflow Management Coalition (WfMC).

The purpose of this conference is to bring together researchers, engineers and practitioners interested in information technology and software development. The conference tracks are "*Programming Languages*", "*Software Engineering*", "*Distributed and Parallel Systems*", "*Information Systems and Data Management*" and "*Knowledge Engineering*".

Software and data technologies are essential for developing any computer information system, encompassing a large number of research topics and applications: from programming issues to the more abstract theoretical aspects of software engineering; from databases and data-warehouses to management information systems and knowledge-base systems; Distributed systems, ubiquity, data quality and other related topics are included in the scope of ICSOFT.

ICSOFT 2008 received 296 paper submissions from more than 50 countries in all continents. To evaluate each submission, a double blind paper evaluation method was used: each paper was reviewed by at least two internationally known experts from ICSOFT Program Committee. Only 49 papers were selected to be published and presented as full papers, i.e. completed work (8 pages in proceedings / 30' oral presentations), 70 additional papers, describing work-in-progress, were accepted as short paper for 20' oral presentation, leading to a total of 119 oral paper presentations. There were also 40 papers selected for poster presentation. The full-paper acceptance ratio was thus 16%, and the total oral paper acceptance ratio was 40%.

In its program ICSOFT includes panels to discuss aspects of software development, with the participation of distinguished world-class researchers; furthermore, the program is enriched by several keynote lectures delivered by renowned experts in their areas of knowledge. These high points in the conference program definitely contribute to reinforce the overall quality of the ICSOFT conference, which aims at becoming one of the most prestigious yearly events in its area.

The program for this conference required the dedicated effort of many people. Firstly, we must thank the authors, whose research and development efforts are recorded here. Secondly, we thank the members of the program committee and the additional reviewers for their diligence and expert reviewing. I would like to personally thank the Program Chairs, namely Boris Shishkov and Markus Helfert, for their important collaboration. The local organizers and the secretariat have worked hard to provide smooth logistics and a friendly environment, so we must thank them all and especially Ms. Monica Saramago for their patience and diligence in answering many emails and solving all the problems. Last but not least, we thank the invited speakers for their invaluable contribution and for taking the time to synthesize and prepare their talks.

A successful conference involves more than paper presentations; it is also a meeting place, where ideas about new research projects and other ventures are discussed and debated. Therefore, a social event including a conference diner was organized for the evening of July 7 (Monday) in order to promote this kind of social networking.

We wish you all an exciting conference and an unforgettable stay in the cosmopolitan city of Porto. We hope to meet you again next year for the 4th ICSOFT, to be held in the charming city of Sofia (Bulgaria), details of which will be shortly made available at http://www.icsoft.org.

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SPECIAL SESSION ON GLOBAL SOFTWARE DEVELOPMENT: CHALLENGES AND ADVANCES

EVALUATING FACTORS THAT CHALLENGE GLOBAL SOFTWARE DEVELOPMENT

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Keywords: Global Software Development, Requirement Elicitation Process.

Abstract: Usually, some aspects of any Global Software Development (GSD) project strongly impact the requirements elicitation activities because of the importance of communication to reach a common understanding about the system under construction. For example, cultural diversity and the impossibility of running face-to-face meetings dominate the scenario where communication must be done. In this paper, we analyze aspects that might be a source of communication problems and suggest strategies to reduce misunderstandings among stakeholders, aiming to help achieve more committed requirements.

1 INTRODUCTION

Global Software Development (GSD) takes place in scenarios where stakeholders are dispersed in many distanced sites across the limits of a country, and can be implemented by means of off-shoring (relocating the process in another country but as a part of the same organization) or offshore outsourcing (hiring an external organization to perform some activity in a different country than the one where software is actually developed) practices.

Industry has rapidly adopted these practices in order to save costs by locating software development in countries where salaries are lower; but even when it has many advantages (Lloyd, 2002), geographical dispersion over multiple sites negatively affect the team‘s performance (Damian, 2002; Prikladnicki, 2003). One of the most important challenges that GSD must face is the lack of face-to-face interaction; however there are other factors that affect virtual team performance, such as cultural diversity and time separation, and all of them are worth of consideration.

As communication is a well-known challenge during any requirements elicitation process (Al-Rawas, 1996), we consider that communication in GSD projects must be specially analyzed and a methodology for requirements elicitation in distributed scenarios must be defined.

In order to define such a methodology, we have analyzed the requirements elicitation methodologies for co-located projects and adapted the different phases to a distributed environment, proposing strategies to minimize the most common problems that affect communication. In this paper we analyze such factors and propose a way to evaluate them, as well as strategies to minimize the problems they can introduce in communication. Having this idea in mind, the rest of the paper is organized as follows: in Section 2 we discuss the main problems that challenge GSD projects, while in Section 3 we propose forms to collect related information and guidelines to evaluate it. Based on such evaluation, in Section 4, we present some strategies to minimize the problems introduced for such factors. Finally, conclusions and future work are addressed in the last section.

2 COMMON PROBLEMS IN GSD PROJECTS

Most of the works about GSD mention inadequate communications as a key problem for requirements engineering activities (Damian, 2002; Prikladnicki, 2003), which is mainly due to the loss of communication richness as a consequence of the lack of face-to-face interaction. In addition, there are other problems that challenge communication and are related to the fact that stakeholders are spread over different countries. The first one is the *time difference* which causes that timetables do not overlap or overlap just for a short period. Then, because of the lack of synchronous collaboration, some delays in the project can happen (Damian, 2002). Similarly, *time separation* also refers to timetables that do not overlap enough, but time separation considers not just the time difference but also the result of cultural issues like different working hours, lunch breaks, weekend or holidays times (Espinosa, 2003). *Cultural diversity* is another problem when team members are distributed on different countries, since they use to have diverse religions, languages, and customs (Damian, 2002) (MacGregor, 2005). Finally, *knowledge management* in GSD projects becomes more difficult in distributed settings since there is a huge amount of information from multiple sources that needs to be appropriately shared among all the stakeholders (Damian, 2002).

Having such problems in mind, we will try to identify some factors that are related to them. We aim to define strategies that minimize the problems they cause, as we will explain in the following two sections.

3 FACTORS THAT INTRODUCE PROBLEMS IN GSD

Based on the main problems detected in GSD projects, we looked for related factors that can be evaluated and used as a guide to suggest strategies to minimize such problems.

The factors we chose to evaluate are: working timetable overlap, language difference, cultural difference and stakeholders' cognitive characteristics. Their relationship with the main problems in GSD is shown in Table 1, and can be summarized as follows:

- Timetable overlap is related to time difference between sites but also to cultural issues like habits. It affects communication as it is related to the possibility or not of synchronous interaction.
- Language difference affects communication as well as knowledge management, because of the importance of a common vocabulary.
- Cultural difference is a natural consequence of cultural diversity. Having an indicator about cultural difference allows knowing about the need of implementing a strategy to minimize problems due to cultural diversity.
- Stakeholders' cognitive aspects refer to the way people behave according to innate characteristics. This behaviour has influence on the way people interact with the world and especially on their communication with other stakeholders.

Having an indicator about each one of these factors will allow us to define when strategies to minimize the problems related to them are needed. Then, we determined a manner of obtaining a value for each factor from a set of easy-to-remember linguistic tags, giving us the chance of reusing our functions among different projects by adjusting different parameters. The tags we defined for each factor are shown in Table 2. In the following sections we will explain how the different linguistic tags are obtained for each factor.

Table 1: Relationship between factors and problems in GSD.

	Inadequate communication	Time separation	Cultural diversity	Knowledge management
Timetable overlap	√	√		
Language difference	√		√	√
Cultural difference	√		√	
Stakeholders' cognitive characteristics	√			

Table 2: Linguistic tags defined for each factor.

Factor	Linguistic tags
Time overlap	low, medium, high
Knowledge about a common language	low, low-intermediate, medium, high-intermediate, high
Cultural difference	low, medium, high
Stakeholders' cognitive characteristics	type 1, type 2, type 3

3.1 Timetable Overlap Evaluation

We consider a virtual team is the minimal group of people that must interact during the software requirements elicitation process, then, we propose evaluating how much time they share to interact synchronously. To do so, we propose using a form where timetable for each stakeholder is converted into Greenwich Time (GT), and calculating the overlap between all the stakeholders' timetables.

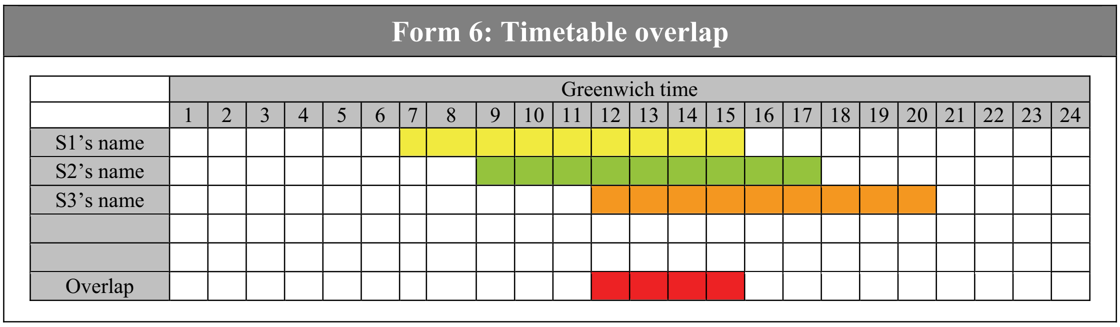

Figure 1: Timetable overlap evaluation.

As an example consider three stakeholders (S1, S2, S3) where S1 and S2 are in Spain and S3 in Argentina. Spanish time is +1 and Argentinean Time is -4, according to GT. Then, considering their normal timetable: S1's from 8 to 16 (that would be 7 to 15 for GT), S2's from 10 to 18 (9 to17 GT), and S3 from 8 to 16 (12 to 20 GT). Such information is filled in the form 6 (as it is shown in Figure 1) and the overlap is calculated. Then, for this example, the total overlap is 4 hours, which is the 50% of the total time.

In order to obtain the tags "low", "media", and "high" for the overlap factor, we propose the following formulas for a *n* hours working-day:

- *(n+1)/3* is the lowest limit for the "media" tag
- *n-(n+1)/3* is the highest limit for the "media" tag
- The highest limit for the "low" tag: *((n+1)/3)-1*
- The lowest limit for the "high" tag: *(n-(n+1)/3)+1*

For our previous example, the results are shown in Figure 2.

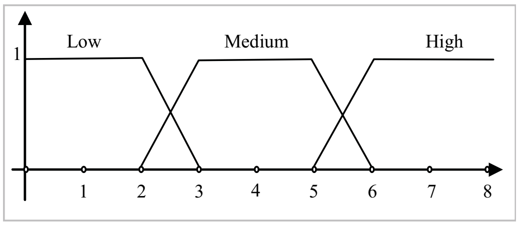

Figure 2: Fuzzy function for the overlap timetable variable.

3.2 Language Difference Evaluation

Language difference is a common factor in global environments as a consequence of the interaction among people from different countries. Analyzing the probable scenarios, we have identified three cases:

- *Same language*: For example, in a project involving organizations from Spain and Argentina the language is the same (Spanish) but differences in pronunciation, intonation, use of different words for the same concept or, on the contrary, the same word for different concepts, may introduce misunderstandings and confusing situations.
- *Different language (native language for one of the sites)*: For example, in a project involving people from Spain and USA, the languages will be completely different. Since English is widely spread all over the world as a second language, it will probably be chosen as the common language.
- *Different language (non native language for none of the sites)*: For example, in a project involving people from Spain and The Philippines, their languages will be completely different. Again, as English is widely spread all over the world as a second language, it will be probably chosen as the common language. The difference with the previous case is that, as English is a second language for people in both sites, stakeholders share a similar difficulty when dealing with the foreign language, which is supposed to generate more empathy.

In this case, instead of using a scale to evaluate the language difference, we preferred a scale that evaluates the degree of knowledge of a common language. In this scale the tag "High" is the best choice (which means that there is no language difference), and then High-Intermediate, Intermediate, Low-Intermediate and Low. Then, we propose a form (shown in Figure 3) to gather the information related to knowledge about a given language and propose a scale to classify such difference. We propose filling a form for each language that can be considered as a possible common language and analyze which one obtains the highest mark according to the tags we have previously defined.

<table>
<tr><th colspan="3">Form 7: Degree of knowledge of a common language</th></tr>
<tr><td>Possible common language</td><td colspan="2">Language: ………………………………………………………………………………………...</td></tr>
<tr><td rowspan="5">Choose the options closer to your virtual team</td><td>❍ All the stakeholders are from the same country
❍ Stakeholders don't share the mother language but they have a high level of knowledge about the chosen common language.</td><td>High</td></tr>
<tr><td>❍ Stakeholders share the mother language but they are from different countries.
❍ Stakeholders don't share the mother language but they a high-intermediate level of knowledge about the chosen common language.</td><td>High-Intermediate</td></tr>
<tr><td>❍ Stakeholders don't share the mother language but they have at least an intermediate level of knowledge about the chosen common language.</td><td>Intermediate</td></tr>
<tr><td>❍ Stakeholders don't share the mother language but they have at least a low-intermediate level of knowledge about the chosen common language.</td><td>Low-Intermediate</td></tr>
<tr><td>❍ Stakeholders don't share the mother language and all of them have a low level of knowledge about the chosen common language.</td><td>Low</td></tr>
</table>

Figure 3: Language difference evaluation form.

3.3 Cultural Diference Evaluation

Culture is defined as a set of key values, norms and beliefs that are shared between members of a society, and can be described in terms of a series of dimensions (Nataatmadja, 2007). The Hofstede's model is the most widely used to analyze cultural differences in GSD projects (Egan, 2006; MacGregor, 2005), and applies to many situations, such as analysing behaviour between bosses and employees, the way in which people privilege individualism or collectivism, etc (Hofstede, 1996). The five dimensions for the Hofstede's model are:

- *Power Distance Index* (PDI): the degree of equality, or inequality, between people in the country's society.
- *Individualism* (IDV): the degree the society reinforces individual or collective, achievement and interpersonal relationships.
- *Uncertainty Avoidance Index* (UAI): the level of tolerance for uncertainty and ambiguity within the society - i.e. unstructured situations.
- *Masculinity* (MAS): the degree the society reinforces, or does not reinforce, the traditional masculine work role model of male achievement, control, and power
- *Long-Term Orientation* (LTO): the degree the society embraces, or not, long-term devotion to traditional, forward thinking values

Values for the first four dimensions were defined by means of surveys in 53 different countries, while the fifth dimension was defined by means of a survey in 23 countries. In Table 3, values for some of those countries are shown (Hofstede, 1996).

Table 3: Hofstede's model values for some countries.

Country	PDI	IDV	UAI	MAS	LTO
Argentina	49	46	56	86	
Australia	36	90	61	51	31
Austria	11	55	79	70	
Belgium	65	75	54	94	
Brazil	69	38	49	76	65
Canada	39	80	52	48	23
Chile	63	23	28	86	
China					118
Spain	57	51	42	86	

In order to obtain a value for cultural difference between two countries in a scale (low, medium, high), we propose the following formula, where:

- i is a dimensions (1: PDI, 2: IDV, 3:UAI, 4:MAS, 5:LTO)
- v_i is a value for the i-th dimension for a given country
- $d_i(A,B)$ is the distance for the i-th dimension, calculated as $|v_i\,(A) - v_i\,(B)|$
- $D_{A,B}$ is the cultural distance between countries A and B, calculated as:

$$D_{A,B} \;=\; \sum_{i=1}^{5} \; d_{i(A,B)}$$

For example, based on the values for Argentina and Spain obtained from Table 3, we have calculated:

Argentina	49	46	86	56
Spain	57	51	86	42
Cultural difference	8	5	0	14

$D_{Argentina,Spain} = (8+5+0+14) = \mathbf{27}$

Applying this formula to each pair of countries, we have obtained an indicator for cultural difference between them. In Table 4 we show the values calculated for the countries we have presented in Table 3. We used the symbol “-” to mark the cells that correspond to the same country. The table is symmetric since $D_{A,B} = D_{B,A}$, since the formula uses the absolute value to calculate the difference for each dimension, and addition is commutative. Finally, we marked with a “*” the cells that are not possible to calculate because the values known for both countries do not match (for example, for Argentina we know the first four dimensions and for China only the fifth one, then calculation is not possible).

Table 4: Cultural differences for countries in Table 3.

	Argentina	Australia	Austria	Belgium	Brazil	Canada	Chile	China	Spain
Argentina	-	97	86	55	45	86	65	*	27
Australia	97	-	97	94	156	33	162	87	114
Austria	86	97	-	123	111	102	151	*	103
Belgium	55	94	123	-	64	79	88	*	52
Brazil	45	156	111	64	-	145	52	53	42
Canada	86	33	102	79	145	-	143	95	95
Chile	65	162	151	88	52	143	-	*	48
China	*	87	*	*	53	95	*	-	*
Spain	27	114	103	52	42	95	48	*	-

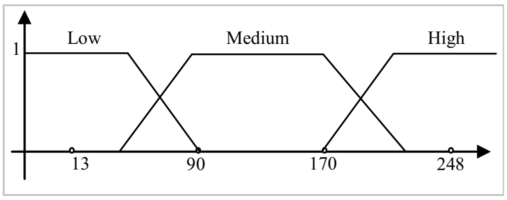

Figure 4: Fuzzy function for cultural difference variable.

Finally, based on the indicators for cultural difference for all the pairs of countries, we define the values for the linguistic tags for cultural difference considering the lowest difference between to countries (D_{min} = 13; which correspond to West Africa and Indonesia), and the highest difference between to countries (D_{max} = 248; which correspond to Sweden and Japan). Doing so, we divided the distance between D_{min} and D_{max} in similar parts and defined the values for tags “low”, “medium”, and “high”, and the corresponding fuzzy function, as it is shown in Figure 4. In our example between Argentina and Spain, since the cultural difference indicator is 27, we can talk about a “low” cultural difference.

3.4 Stakeholders Cognitive Characteristics Evaluation

In order to know more about stakeholders, we have analyzed some instruments from the field of cognitive psychology designed to measure human characteristics and explain differences between people (Miller, 2004). Specifically, we chose a learning style model, called Felder-Silverman (F-S) (Felder, 1988 (and author preface written in 2002)), which analyses the way people receive and process information, with the aim of making the environment closer to their cognitive profile. Stakeholders’ F-S learning styles are obtained by means of a test that catalogues their preferences about four categories (perception, input, processing, and understanding) as slight, moderate and strong between two opposite subcategories. For instance, for the category “input”, people are catalogued as verbal or visual on the scale (slight, moderate, strong). Then, if people are verbal they would prefer perceiving information by means of spoken words, while visual people would prefer graphics. The form used to gather the test results is similar to the one that is shown in Figure 5.

Strong Moderated Slight Moderated **Strong**

	-11	-9	-7	-5	-3	-1	1	3	5	7	9	11	
Active		√											Reflexive
Sensitive											√		Intuitive
Visual							√						Verbal
Sequential				√									Global

Figure 5: Analyzing cognitive styles with F-S test.

In order to define the types of virtual teams regarding the stakeholders’ learning style, we focus on the strongest preferences (values -11, -9, 9, and 11). For example, in the case shown in Figure 5, the stakeholder is strongly active and strongly intuitive.

In Form 8 (Figure 6) information gathered about the virtual team members’ cognitive profile is summarized. Since when preferences are stronger people may have difficulty when learning in an environment that does not support their preference (Felder, 2005), we decided to classify teams according to the occurrence of strong preferences, as follows:

- **Type 1:** There are no strong preferences in the team.
- **Type 2:** There are strong preferences but not at the opposite sides of the same category. For instance: if there are strongly visual people in the team, and there are no strongly verbal people, communication should be based on diagrams and

Form: Defining the Virtual Team type

		Nº	Nº	
Calculate the number of stakeholders with **strong preferences** for each subcategory and fill the middle columns	Strongly ACTIVE (-11,-9)			Strongly REFLEXIVE (11,9)
	Strongly SENSITIVE (-11,-9)			Strongly INTUITIVE (11,9)
	Strongly VISUAL (-11,-9)			Strongly VERBAL (11,9)
	Strongly SEQUENTIAL (-11,-9)			Strongly GLOBAL (11,9)

Verify each row and choose the question whose answer is "YES". The team type is on the right column	¿All cells have been filled with zeros?	❍ **Type 1** (non-strong preferences group)
	¿Is there one or more non-zero cells and their adjacent (in the same row) are always zero?	❍ **Type 2** (strong preferences without conflict group)
	¿Is there one or more non-zero cells and one of their adjacent (in the same row) is non-zero, too?	❍ **Type 3** (strong preferences with conflict group)

Figure 6: Virtual team evaluation regarding stakeholders' cognitive characteristics.

written words, since that would increase the involvement of visual people, and people with slight and moderate preferences can be easily accustom to them.

- **Type 3:** If there are strong preferences at the opposite sides of the same category, then there is a conflict of preferences. For example, if there are one or more strongly visual people, and also some strongly verbal people, communication should give support to both kinds of styles, as we will discuss later.

Rationale behind our decisions is supported by research results in the field. In the following sections we will analyze the possible strategies to be used by a given virtual team, once all these factors have been evaluated.

4 DEFINING STRATEGIES TO MINIMIZE GSD PROBLEMS

Once values for time overlap, cultural difference, language difference and team type regarding cognitive aspects have been obtained (as we explained before), we recommend three main strategies to minimize the problems introduced by such factors.

For example, regarding cultural difference, the main problems are related to people's behaviour. For instance, USA ranks high about individualism while collectivism is a common characteristic of Latin culture (Hofstede, 1996), then interaction between such countries can be problematic, giving Latin people the idea that Americans are not compromised with the group (Audy, 2004) or Americans thinking that Latin people spent too much time building an unnecessary social relationship. Since such kind of misunderstanding about behaviour can be source of frustration for team members, we propose a first strategy, called A, which focuses on learning about the other cultures:

Strategy A: Learning about Cultural Diversity. Cultural differences cannot be avoided, but stakeholders can learn about the differences of the other culture. Being trained about cultural diversity is crucial for stakeholders to be aware of normal behaviour in other cultures as well as being conscious of their own behaviour, especially for things that can be offensive or misunderstood. To minimize such kind of problems, we have classified used strategies as follows:

- Literature review, seminars, courses, etc.
- Cultural mediation: taking advantage of people who have visited the other site before – and therefore they know about customs and normal behaviour related to the foreign culture – that become referents for communication with people at the other site. Those people are called mediators, bridgeheads (Carmel, 1993) or liaisons (Herbsleb, 1999).
- Virtual mentoring: based on simulation and virtual actors and it can become an interesting way for motivating stakeholders in foreign language training and cultural familiarization (Sims, 2007).

In addition to cultural diversity, GSD projects also must deal with language differences. Language difference can happen in a wide variety of levels, considering if stakeholders share or not the same mother language. When people do not share the native language, English is usually the language chosen for interaction and it is crucial having a clear understanding of domain concepts and relationships. But also when people share the native language, if they come from different countries, idiomatic differences are a challenge for communication. For instance, people from Argentina and Spain share Spanish as their native language, but pronunciation and the use many words can have different meanings in both sites. Since during the requirements elicitation process it is crucial having a common understanding about the system domain, our strategy to minimize the idiomatic differences is using ontologies to help communication, as follows:

Strategy B: Using Ontologies as Communication Facilitators. When stakeholders are not from the same country of origin, even if they share the mother language, misunderstanding can arise because some words have more than one meaning, or different words refer to the same concept, etc. Sharing a common vocabulary, especially referring to the domain components is crucial, and to help to build it, we propose a domain ontology. In addition, ontologies play a natural role in supporting knowledge management, which is very important during requirements elicitation where a lot of data is collected from many distant sources. Then, ontologies make possible clarifying the structure of knowledge and allow a clear specification of the concepts and the terms used to represent them (Chandrasekaran, 1998).

Finally, but not less important, we have considered the fact that people in GSD projects apply requirements elicitation techniques by means of groupware tools. Then, in order to improve people communication, we have focused on analyzing how technology selection can influence people performance. Based on such analysis we propose a third strategy:

Strategy C: Selection of Suitable Technology. There are two types of technology that are used during requirements elicitation: groupware and requirements elicitation techniques. By analysing the factors we measured, we aim at choosing the most suitable technology according to the characteristics of the virtual team.

There are different points of views to select technology. The first one is time overlap. In this case, it is obvious that when time overlap is low synchronous interaction will be difficult, so we recommend using asynchronous groupware tools and avoiding requirements elicitation techniques based on synchronous interaction (like brainstorming). Also when the stakeholders' mother language is not the same, and the degree of knowledge of a common language is intermediate or less, we propose restricting communication to asynchronous tools, in order to give people the chance to read and write with greater care.

Finally we propose using knowledge about the stakeholders' cognitive characteristics for technology selection. As we explained before, one of the factors that it is possible to know in a virtual team is the cognitive characteristics that are innate to people and are related to the way people perceive the information and understand it. Since communication in GSD projects is done by means of groupware tools and requirements elicitation techniques, we have proposed a model to obtain preference rules at the individual level (Aranda, 2005) as well as strategies to combine the technology according to the type of virtual team (type 1, 2, or 3), which depends on the occurrences of people with strong preferences in the given virtual team (Aranda, 2006). Such strategies can be summarized as follows:

- Strategy for Type 1 (non-strong preferences) groups, called C_1, is expressed:

$$C_1 (\{g\}, GS_1, GS_2, ..., GS_n) \rightarrow g_i \in \{g\}$$

where GS_i represents the groupware tool that fit the *i-th* stakeholder's preferences (which have been defined by mechanisms based on fuzzy logic and fuzzy sets), and $g_i \in \{g\}$ is the tool that appears more times.

- Strategy for Type 2 (strong preferences without conflict) groups, called C2, is:

$$C_2 (\{g\}, (\{GS_1\}, ws_1), (\{GS_2\},ws_2), ..., (\{GS_n\},ws_n)) \rightarrow g_i \in \{g\} \wedge g_i \in \{GS_j\} \wedge ws_j = \max(ws_1, ws_2, \ldots , ws_n)$$

where GS_i represents the groupware tool that fit the *i-th* stakeholder's preferences and ws_i is the weight – meaning how strong the preferences are—, and the resulting g_i is a tool that is appropriate for the stakeholder whose personal preferences are the strongest.

- Strategy for Type 3 (strong preferences with conflict) groups, called C3, improves the process by using a different machine-learning algorithm. To do so, we aim to develop an algorithm that for each rule returns a ranking of output
- variables, instead of only one. Then, when a conflict is detected, as we have a ranking for each person, we can browse the ranking for those people with the strongest preferences, and the tool that is located higher for all of them will be the best choice for the team, even though it would not be the first choice for some, or even none of them.

In Table 5 we show the strategies suggested for a combination of factors. Because of space limitations we show the table only for the "low" cultural difference, but rows for the "medium" and "high" values, can be added just filling the strategy A column with a "◎"character.

In order to abbreviate the technology selection strategies names in Table 5, we have used the names C1, C2, and C3 for strategies according to the group type, and similarly, we called C4 the technology

Table 5: Possible scenarios according to the values obtained for each factor.

Same Country		Cultural difference			Timetable Overlap			Degree of knowledge of a common language					Virtual team type			Strategies					
Y	N	L	M	H	L	M	H	H	HI	I	LI	L	1	2	3	A	B	C1	C2	C3	C4
·	✦	✦	·	·	✦	·	·	✦	·	·	·	·	✦	·	·	·	◎	◎	·	·	◎
·	✦	✦	·	·	✦	·	·	✦	·	·	·	·	·	✦	·	·	◎	·	◎	·	◎
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·	✦	✦	·	·	·	·	✦	·	·	·	·	✦	✦	·	·	·	◎	◎	·	·	◎
·	✦	✦	·	·	·	·	✦	·	·	·	·	✦	·	✦	·	·	◎	·	◎	·	◎
·	✦	✦	·	·	·	·	✦	·	·	·	·	✦	·	·	✦	·	◎	·	·	◎	◎

Abbreviations: Y=YES, N=No, L=Low, M=Medium, H=High, I=Intermediate

selection strategy based on asynchronous interaction, which is related to wide time separation or low knowledge about the common language.

To illustrate the use of this table with an example, let us consider the case we have analyzed in a controlled experiment we have recently carried out. In this experiment we counted on 24 computer sciences students and teachers from Spanish and Argentinean universities. Then the value for "Same Country" was "NO", and the cultural difference (as we explained the formula before in Section 3.3) was 27, then the value for this factor was "Low". Virtual teams were conformed by 2 Spanish students and 1 Argentinean teacher and their time overlap has been used as an example in section 3.1, then, the value for this factor was "Medium". Finally, as we had enough people with strong preferences for visual subcategory, we formed similar Type 2 groups (one or more people with strong preference without conflict). As it can be seen in Table 5 (with a different colour) the strategies suggested to minimize communication problems in our experiment where: (1) using a domain ontology to minimize misunderstandings and (2) choosing the groupware technology by means of the selection strategy for Type 2 groups previously explained. Preliminary results of such experiment indicate that stakeholder perception about communication is better in groups that applied the strategy (2), which is expected to be related to improvement in requirements quality. In order to corroborate such a relationship, we asked a group of software engineering teachers to analyze the requirements specifications written during our experiment, and we are currently analyzing such data.

5 CONCLUSIONS

Many organizations have adopted GSD because of the advantages it represents to minimize costs, but the cultural diversity and the time difference present in such kind of projects, challenge the team performance, especially during requirements elicitation when communication is crucial for a common understanding of de problem.

To help minimize such problems, in this paper we propose a method to evaluate the factors that are related to them and we propose a set of strategies that can be used in each case. Our current work is focused on analyzing the results of a controlled experiment that we carried out to test performance when using domain ontologies and groupware technology selection in groups with strong preferences without conflict (type 2). Preliminary results indicate that groups that used the most suitable groupware tools, according to our selection strategy for type 2 groups, felt more comfortable about communication than groups that did not use them. Nevertheless more experiments should be performed in order to be more conclusive.

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