Interpersonal Trust in Virtual Software Development Teams: A Systematic Mapping Study

Sergio Zapata, José L. Barros-Justo, María Romagnano, Magdalena Arrón

***Abstract*—Context: The progress of Information and Communication Technologies has greatly promoted the relationships among people of different geographical regions. Under this novel context, new settings of software development arise, known as virtual teams, a team of geographically dispersed developers.**

Objective: to assess the impact of virtual team's interpersonal trust on software development process.

Method: We conducted a systematic mapping study of peer-reviewed literature up to August 2016.

Results: We reviewed 41 primary studies. Some highlights are that virtual team effectiveness is the most affected aspect by the lacking of interpersonal trust, while face-to-face meeting is the most mentioned work strategy to mitigate this problem.

Conclusions: This study corroborates the impact of interpersonal trust on virtual software development teams. We identified some work strategies but few advanced tools to mitigate the problems derived from the lack of interpersonal trust.

***Index Terms*—evidence-based software engineering, interpersonal trust, software development, systematic mapping study, virtual teams.**

I. INTRODUCTION

THE progress of Information and Communication Technologies (ICT) has greatly promoted the relationships (social, work, business, etc.) among people of different geographical regions, creating new technological, cultural and organizational challenges. This has led to the emergence of virtual work teams in the software development business, a group of developers who work geographically distributed.

Trust is a crucial aspect in virtual teams, where members are geographically dispersed and communicate primarily through ICT [1].

Existing relationships among members of virtual teams are very different from traditional collocated teams. To create and maintain trust in virtual teams is more difficult. Geographical distance, time difference and cultural diversity could reduce the possibilities for the growth of trust among the members of virtual teams.

Mayer et al. [2] define trust as "the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control that other party".

Trust allows people to participate in risky activities that they cannot control or monitor and even in which they may be disappointed by the actions of others [3], [4].

In interpersonal relationships, trust can be qualified as emotional (or based on affection and emotions) or cognitive (based on knowledge, responsibility, ability, etc.) [5], [6]. Trust affects performance of the work teams [7], [8], [9], even more when the tasks are highly interdependent [10], [11]. Trust is a critical aspect to improve intra and inter-institutional cooperation, coordination and control [12].

The purpose of this work is to identify and classify reported knowledge about the impact of virtual team's interpersonal trust on software development process. To achieve that purpose we applied a research technique known as Systematic Mapping Studies (SMS), also known as Scope Studies, to review the scientific, peer-reviewed literature, select relevant studies and extract data of interest from them. SMS provides a structure for research reports and results that have been published, by categorizing them and often giving a visual summary, the map, of the results [13]. The aim of a SMS, as a research method, is to identify all the evidence related to a specific topic, i.e., to answer broad questions related to trends in research or to provide a state-of-the-art of a discipline, it is also a good mechanism to detect research gaps [14].

The rest of this work is structured as follows: section 2 presents results from other related works; in section 3, we detail the SMS process; section 4 presents the results, while section 5 offers a discussion about these results and their impact. In section 6, we expose threats to validity in this SMS. Finally, section 7 presents the conclusions.

II. RELATED WORKS

After conducting pilot searches in several electronic data sources (online databases, publisher sites and general search engines), we have found three secondary studies about interpersonal trust in virtual software development teams.

The study of Niazi et al. [15], presents a systematic literature review aimed to identify important factors for establishing trust in offshore software outsourcing relationships. In that paper, trust is analyzed for the client-vendor's relationship and is defined as clients and vendors having positive expectations of each other's actions. The authors discovered that factors such as: face-to-face meeting, better communication, contract management between client and vendor, defining process tools, procedures and policies and reliable management, play an important role in establishing trust between clients and vendors, in the context of offshore software outsourcing relationships. Their paper only considers trust between clients and vendors.

The work from Chatfield et al. [16] addressed again re-

Sergio Zapata is with the Institute of Informatic, National University of San Juan, 5406 San Juan, Argentina. E-mail: szapata@iinfo.unsj.edu.ar

José L. Barros-Justo is with the School of Informatics (ESEI), University of Vigo, 32004 Ourense, Spain. E-mail: jbarros@uvigo.es.

María Romagnano is with the Institute of Informatic, National University of San Juan, 5406 San Juan, Argentina. E-mail: maritaroma@iinfo.unsj.edu.ar

Magdalena Arrón is with the Department of Informatic, National University of San Juan, 5406 San Juan, Argentina. E-mail: marron@iinfo.unsj.edu.ar

search question: What are the organizational challenges in creating business value from leveraging virtual teams in the organization? In order to answer this question, the authors conducted a systematic review of the existing literature on virtual teams to identify the key organizational challenges. Their study analyzed papers about virtual teams that have been published from 2004 to 2012. Four key organizational issues: communication, people and skills, trust and knowledge, were identified and discussed. Their work concludes that trust and knowledge cannot be disregarded, as no organization can drive the performance without trusting the team. They analyzed interpersonal trust in virtual teams within organizations in general. We believe that virtual software development teams (VSDT) have particular organizational characteristics as less work stability, higher training to proper use of communication tools, more collaborative activities, etc. These characteristics could affect interpersonal trust and thus obtain different results with respect to organizations in general.

The goal of Da Silva et al.´s paper is "to build an evidence-based model of DSD project management from the research findings about challenges of DSD and the practices, models and tools proposed and used to overcome these challenges" [17]. The authors based the construction of their model on the evidence collected and synthesized by a comprehensive SMS, containing 70 research papers published between 1997 and 2009. Cultural differences, issues of trust, differences in knowledge levels, and language barriers are cited as causes of poor or ineffective communications, as well as the lack of synchronous communication. Temporal, geographical, and socio cultural distances exacerbate problems of trust, cohesion, and conflicts with negative impact on communication, cooperation, coordination, and general management issues. Specifically, about trust, this work identifies practices and traditional communication tools that would favor the interpersonal trust in DSD. The main practices identified to promote interpersonal trust are: provision of and training in collaboration and coordination tools, use and maintain common software process among work sites and divide the work into well-defined modules and carry out progressive integration. The most important communication tools identified are: phone (including teleconference and audio conference), emails and video conference. In all cases, these tools are supported in traditional (non-innovative) technology. The results obtained with this SMS are valuable to the scientific community; however, we consider it necessary to analyze other aspects of the trust in VSDT. For instance, work strategies and innovative communication tools to promote trust in VSDT, software development activities most impacted by interpersonal trust.

In our study, we expose a comprehensive analysis about interpersonal trust in VSDT involving those aspects and updating the results until August 2016.

III. RESEARCH METHOD

The aim of this SMS is to identify and classify reported knowledge about the impact of virtual team's interpersonal trust on software development activities. We are interested in the analysis of the effects of interpersonal trust, work strategies and advanced tools promoting interpersonal trust, affected software development activities by interpersonal trust and most involved countries in field studies about interpersonal trust.

In this section, we present the conducting phase of our SMS. Fig 1 shows the steps of our protocol, which is grounded on the guidelines proposed in [14]. We use seven search engines: ScienceDirect, SpringerLink, Wiley InterScience, SCOPUS, IEEEXplorer, ACM Digital Library and Google Scholar.

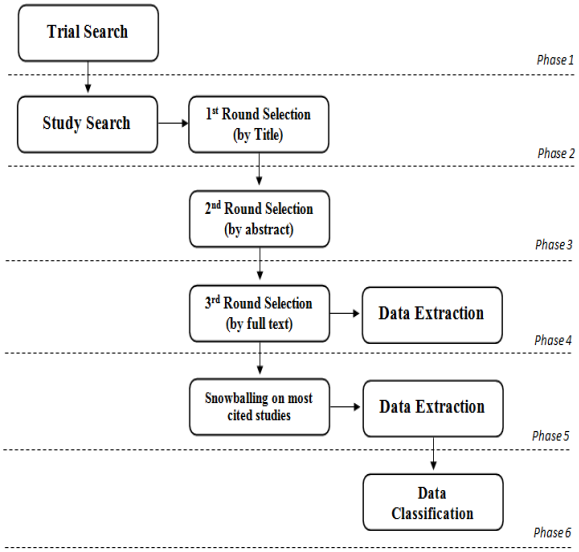

Fig. 1. SMS execution process

Study search, is the final search in the selected search engines. From them, we obtain a set of candidate papers. Then we conduct three rounds of paper selection, including selection by title (1st round), selection by abstract (2nd round), and selection by full text (3rd round). In phase 4, we extract data relevant to our research.

In phase 5, we apply snowballing technique [18] to the most cited paper of selected studies.

A. Research and Publication Questions

We defined a set of four research questions (RQ) which makes a full coverage of the goal. Two publication questions (PQ) were also included to cover the demographic information. These questions are listed in Table 1.

TABLE 1. RESEARCH AND PUBLICATION QUESTIONS

	Question
RQ1	Which aspects of the software development process are affected by the interpersonal trust within virtual teams?
RQ2	Which work strategies have been used to support interpersonal trust within virtual software development teams?
RQ3	Which kinds of tools have been used to support interpersonal trust within virtual software development teams?
RQ4	What are the most reported software development activities related to interpersonal trust within virtual teams?
PQ1	What are the most active countries researching interpersonal trust within virtual software development teams?
PQ2	Where the selected studies have been published?(Journal or Conference)

B. Search strategy

In this section, we describe the search scope and strategy. About scope, the aim is to analyze all the scientific literature existing with regard to interpersonal trust within virtual teams. The search was limited to the computer science field and papers published in peer-reviewed conferences or journals.

To construct the set of search terms we used the PICOC technique (Population, Intervention, Comparison, Outcome and Context) [19]. This technique supports the selection and classification of the search terms. We structured the search string as follows:

Population: {software, system} development.

Intervention: trust, confidence.

Outcomes: impact on software development.

Context: {virtual, global, distributed, remote, offshore} team.

The final search string was built connecting all the facets of PIOC (we do not use Comparison) by Boolean AND connectors:

("software development" OR "system development") AND (trust OR confidence) AND (impact) AND ("virtual" OR "global" OR "distributed" OR "remote" OR "offshore") AND (team)

The search string was run on the titles, keywords, and abstracts in IEEEXplore, Science Direct and SCOPUS. In the other electronic databases (i.e., ACM Digital Library, SpringerLink and Wiley InterScience), the search string was run only on the titles and abstracts due to the limitations of the search engines. In Google Scholar the search was run on studies' titles only.

We found 180 non-duplicated studies. This set of candidate studies was the main input to the next phase, selection of works.

C. Selection phase

The purpose of the selection process is to build up a set of relevant papers, by applying inclusion/exclusion criteria to the studies retrieved by the searches. The main researcher (first author) defined the inclusion/exclusion criteria, which was reviewed and agreed by the other three authors. These criteria are shown in Table 2.

TABLE 2. INCLUSION/EXCLUSION CRITERIA

#	Inclusion/Exclusion Criteria
IC1	Papers written in English.
IC2	Papers published in Journals indexed by the JCR or in International Conferences with a peer-reviewed acceptance system.
IC3	Papers focused in interpersonal trust, virtual teams and software development.
EC1	Grey literature (slides presentations, tutorials, forewords, keynote speeches, letters, etc.)
EC2	Short papers (less than 4 pages)

Selection phase involved three iterations: 1st round selection (considering only the paper's title), 2nd round selection (including the abstract) and 3rd round selection (reading the full text). The four authors, splitted into two teams and working independently, conducted these iterations. From that, we selected 34 primary studies.

In order to validate/extend this automated search strategy, we applied the snowballing technique, following the guidelines in [18].We use the most cited study (S38, with 50 citations) as a seed, obtaining7 additional studies. Finally, 41 works were included in the selected studies set (see Appendix).

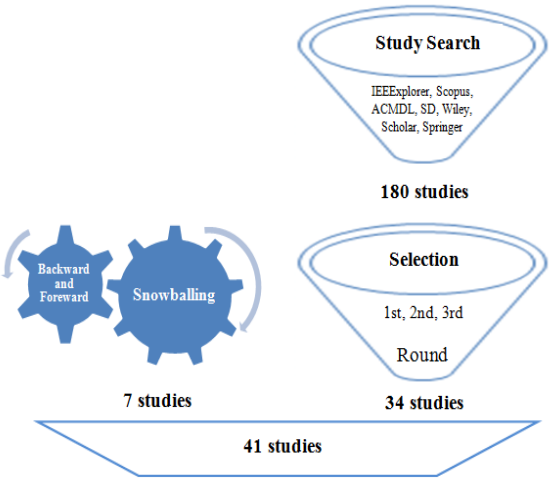

Fig. 2. Results of selection phases

D. Data extraction

The extraction of data was carried out by reviewing the selected studies. The full text of each study was read to extract data to answer every RQs and PQs listed in section 3.1. The data items to be extracted from each paper are shown in Table 3. To keep traceability between processes, an identifier code (Sn) was assigned to each selected study.

TABLE 3. DATA ITEMS TO BE EXTRACTED FROM THE STUDIES.

#	Data Item	Description	Relevant to
D1	Title	The title of the paper.	Overview
D2	Authors List	The full name of all authors of the paper.	Overview
D3	Abstract	The abstract of the paper.	Overview
D4	Year	year when the paper was published	Overview
D5	Involved Countries	The countries where interpersonal trust within virtual software development teams had been investigated.	PQ1
D6	Venue	The name of the venue where the study was published	PQ2
D7	Type of Venue	Journal or Conference	PQ2
D8	Affected Aspects	The aspects of the software development process that were affected by the interpersonal trust within virtual teams	RQ1
D9	Work strategies	The work strategies that have been used to support interpersonal trust within virtual software development teams.	RQ2
D10	Tools	The name of the tool that have been used to support interpersonal trust in virtual software development teams.	RQ3
D11	Software Development Activities	The software development activities affected by the interpersonal trust within virtual teams.	RQ4

IV. RESULTS

A. RQ1: Which aspects of the software development process are affected by the interpersonal trust within virtual teams?

We found 9 papers (22% of total) which report 6 main aspects affected by interpersonal trust.

TABLE 4. ASPECTS AFFECTED BY INTERPERSONAL TRUST

Affected aspects	Studies
Effectiveness	S7, S16, S27, S35, S39
Knowledge sharing	S6, S16, S39
Motivation	S16, S36
Supervision	S1
Cost estimation	S31
Team conflicts	S39

B. RQ2: Which work strategies have been used to support interpersonal trust within virtual software development teams?

We found 19 papers (46% of total) which report 9 work strategies used to support interpersonal trust.

TABLE 5. WORK STRATEGIES

Work Strategies	Studies
F2F meeting	S2, S5, S10, S13, S38, S41
Communications	S3, S11, S28, S38, S40
Leadership styles	S9, S18, S19, S34
Software tools	S11, S14, S38, S41
Group activities	S2, S3, S22
Training	S5, S11, S15
Team structure	S22, S29
Conflict rules	S38
Process Control	S32

C. RQ3: Which kinds of tools have been used to support interpersonal trust within virtual software development teams?

We found 10 papers (24% of total) reporting software tools from 6 different categories.

TABLE 6. KINDS OF TOOLS

Kinds of tools	Studies
Social network	S14, S28
Email awareness	S24, S29
Knowledge sharing	S6, S11
Virtual reality	S23
Collaborative traces	S25
Coordination	S37

D. RQ4: What are the most reported software development activities related to interpersonal trust within virtual teams?

We found 11 papers (27% of total) which report software development activities.

TABLE 7. SOFTWARE DEVELOPMENT ACTIVITIES

Software development activities	Studies
Project management	S9, S26, S34, S41
Software design	S4
Knowledge sharing management	S6
Database modeling	S12
Requirement engineering	S7, S15
System versioning	S16
Programming	S21
Cost estimation	S31

E. PQ1: What are the most active countries researching interpersonal trust within virtual software development virtual teams?

We found 27 papers (66% of total) which explicitly mention the countries involved in a project of software development.

TABLE 8. ACTIVE COUNTRIES

Countries	# Studies
India and USA	13
Ireland	5
Brazil, Malaysia and Norway	4
Canada, Germany and UK	3
Australia, China, Costa Rica, France, Israel, Mexico, Poland, Sweden, Switzerland, Taiwan and Ukraine.	2
Denmark, Greece, Japan, Latvia, Netherlands, Pakistan and Vietnam.	1

When we group the countries by regions, as Fig. 3 shows, we observe that Europe, Anglo America and Eastern Asia are the regions with more reported connexions of software projects involving virtual software development teams.

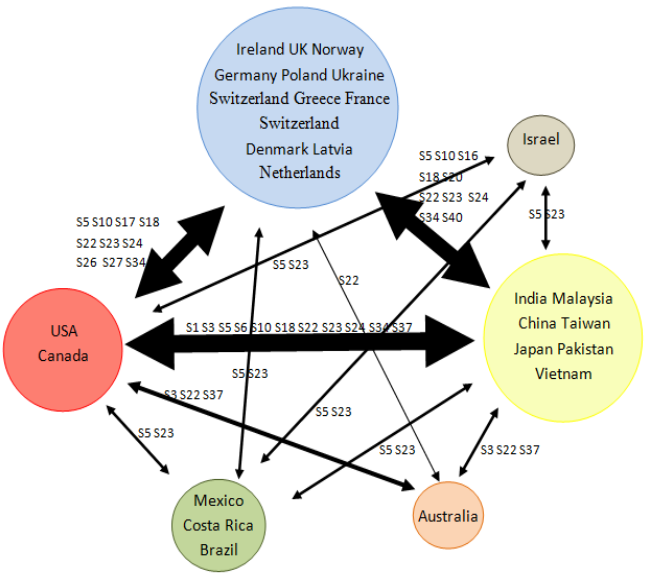

Fig. 3. Regions connected by global software development

F. PQ2: Where the selected studies have been published (Journal or Conference)?

We found that 30 papers (73% of total) have been published in conferences, from these, 6 papers were published in the IEEE International Conference on Global Software Engineering.

Fig.4 shows the number of he selected studies published until August 2016, with two major peaks in 2008 and 2012.

TABLE 9. VENUE

Venue	Studies
Conferences	S1, S2, S3, S6, S7, S8, S10, S12, S13, S14, S15, S16, S17, S19, S,21, S22, S23, S24, S25, S26, S27, S28, S29, S30, S31, S34, S35, S36, S39, S41
Journals	S4, S5, S9, S11, S18, S20, S32, S33, S37, S38, S40

Fig. 5 shows that 8 selected studies involved students as empirical subject and 29 studies involved practitioners from the software industry.

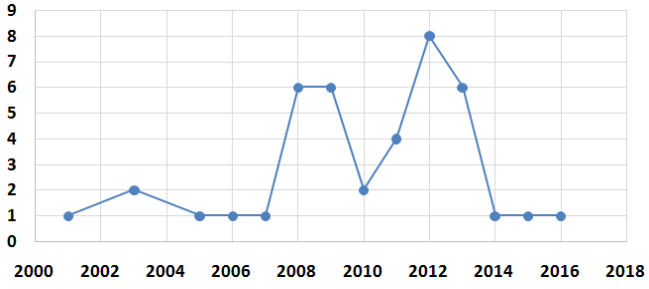

Fig. 4. Number of the selected studies over time period

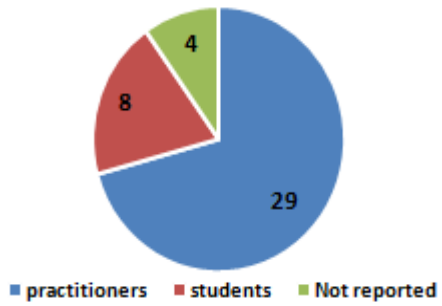

Fig. 5. Number of the selected studies over empirical subject types

V. DISCUSSION

As a general aspect, we think that the number of papers we select (41) for this study is low, and does not allow to argue about possible generalizations of the results obtained. Even the number of non-duplicate works found was low (180), considering the importance that several authors assign to the subject in their works's introduction sections. Our opinion is that interpersonal trust in virtual development teams has not been thoroughly investigated, despite the fact that all authors point out the strong impact it has on software development, both in productivity and quality.

The evidence does not seem to support these investigators' claims about the impact of interpersonal trust. Only nine of the 41 selected papers reported some effects on the development process. Five papers mention "effectiveness", and argue that there is a direct correlation between interpersonal trust and effectiveness, although not a causal relationship. According to the results, the effectiveness of virtual teams is the most affected aspect by the lacking of interpersonal trust. Our SMS shows the importance of interpersonal trust in the performance of virtual teams. While the causes cannot be generalized to other environments, other studies (e.g. [20], [21], [22], [23]) achieved similar results for collocated work teams. There seems to be a similarity between the factors of software development that are affected by the lack of interpersonal trust in both contexts.

Three studies (S6, S16, S39) show that teams with high interpersonal trust facilitate information sharing among their members as well as by fosters norms of reciprocity, motivating collaboration and coordination, and reducing interpersonal conflicts. While low interpersonal trust entails team members to show lack of commitment to the work, be less focused to project goals and do not keep customers involved in the project implementation.

Only two papers (S16, S36) mention motivation, and aspects such as supervision, cost estimation and team conflicts resolution only deserve the attention of one paper each. Factors such as productivity, quality of the final product, reduction of development time, time-to-market or stay within budget, do not seem to be important; at least we have not found any mention of them in the 41 works analyzed.

Face-to-face meeting is the most mentioned work strategy to mitigate the lack of interpersonal trust. However, face-to-face meetings are very costly, and difficult to do with dispersed teams. We believe that communication tools, adding new features such as emotion detection, social computing, pervasive computing, measurement of interactions, measurement of trust among team members, remote awareness, etc., would significantly improve the building and maintenance of trust in virtual teams.

Concerning work strategies, future research should analyze the relationship between work context (team size, cultural diversity, task distributions, software domain, etc.) and suitable strategy kinds for this context. This knowledge will be very useful for practitioners.

We found only four studies mentioning work strategies based on software tools, especially tools that support coordination, group awareness and communications. There are no evidence that allows setting a correlation between used software tools and the level of interpersonal trust. A systematic review of the literature to identify the current weaknesses of such tools and synthesize possible solutions may be worth taking.

About the most reported software development activities related to interpersonal trust, we found that there is a wide diversity of activities (8) and the majority (6 out of 8) is reported by only one paper. It seems to indicate that the virtual teams work in all phases of the process and that interpersonal trust is relevant to the whole cycle of software development.

Project management and requirement engineering are the most mentioned activities. These activities involve a high interaction between stakeholders. It seems that interpersonal trust plays a main role in this type of activities and is less

important in activities with few interactions, such as programming.

Regarding the project management activities, we identified a special interest in leadership styles in virtual teams. One study (S34) concludes that the supportive leaderships, i.e. managers strive to achieve consensus, and concerned about the well–being and satisfaction of team members, are more suitable for virtual teams. While other studies (S9, S26) show that in some cases authority leadership generates more trust to the members of the team, for example teams with a high cultural diversity. There is no consensus about how the leadership must be and more research is needed on this topic.

Beyond the analysis of interpersonal trust, we detect that while there are many countries (27) where field studies have been carried out, India and USA are clearly the most reported ones. Analyzing the global software development connections among geographical regions is interesting to note that Eastern Asia is highly connected with Europe and North (Anglo) America, in spite of the great cultural differences.

Seventy percent of the selected papers were field studies, specifically from software industry. Thus, the results of this SMS reach a high degree of empirical validity.

The authors of the majority of selected studies (73%) have preferred to publish in conferences rather than in journals, this is compatible with research practices in Computer Sciences and Information Systems. Conferences are the ideal venue for professionals to meet and discuss, face to face, about new trends, technologies, tools, pitfalls and so on.

VI. Threats to validity

The most frequent threats to validity are:

- Descriptive validity: threats associated with the description of data and observations (potential bias of the researchers),
- Theoretical validity: two different activities can be affected, the identification/selection of papers (missed studies) and data extraction and classification (researcher's bias),
- Interpretive validity: conclusions drawn are reasonable given the data (researcher's bias),
- Repeatability: the possibility that other researchers obtain the same results by following the same processes (lack of details).

To minimize these potential threats to the validity of this work, we developed a standard form for data extraction and analysis (DEF). All authors, independently, filled out this DEF and the first author integrated the results. When discrepancies arose over the interpretation of the data, they were resolved through meetings. The calculation of the Fleiss' kappa [25] for these activities reached a value of 82% in agreement. Hence, we consider this threat is well controlled.

The use of several sources for the automatic search of the primary papers, and a second search strategy (snowballing) to complement the results, reduce the risk of missing some important work. On the other hand, the number of papers selected and analyzed (41 papers) reduces the threat to theoretical validity, since the impact of the loss of a data, given the number of samples, is insignificant.

To reduce researchers' bias during the identification and selection process, we created two groups, with two researchers each. Each group carried out the selection process independently, on the total of the papers identified by the search strategies (100% overlap). Within the groups, each researcher performed the work, independently, with a degree of overlap of 50% of the papers retrieved by the searches. Finally, the first author performed the integration of the results and calculated the degree of inter-group and inter-researchers agreement.

To facilitate the repetition of the study, we will provide all interested researchers with additional material, including a detailed protocol, search strings, inclusion / exclusion criteria and the DEF with all the extracted data.

VII. Conclusion

This work presents the results of a SMS on interpersonal trust in virtual software development teams. The study identifies the impact of interpersonal trust on global software process activities.

Lacking of trust affects the VSDT effectiveness, risking the success of the global software engineering processes. The main proposal to mitigate this problem remains the traditional face-to-face meetings. Given the high costs of holding face-to-face meetings, a new research area that promotes the use of advanced technology-based tools, to construct and keep interpersonal trust in VSDT, seems promising. However, these tools should take into account the cultural differences of users, and intelligently reduce the risks of misunderstandings.

We consider that more research work is needed, more structured, with specific and relevant data on the impact of interpersonal trust. Researchers need a better description of the context and the reported experience. A point to emphasize is the lack of works that replicate experiments, in order to validate results obtained by previous research.

As future work, we will conduct a multinational survey to identify key aspects of interpersonal trust in virtual teams. We are also planning to conduct an experiment involving practitioners from America, Europe and Oceania, to asses the impact of trust level in specific development tasks.

Appendix Selected studies

[S1] Hole, S., & Moe, N. B. (2008). A Case Study of Coordination in Distributed Agile Software Development. In R. V O'Connor, N. Baddoo, K. Smolander, & R. Messnarz (Eds.), Software Process Improvement: 15th European Conference, EuroSPI 2008, Dublin, Ireland, September 3-5, 2008. Proceedings (pp. 189–200). Berlin, Heidelberg: Springer Berlin Heidelberg. http://doi.org/10.1007/978-3-540-85936-9_17

[S2] Sepulveda, C. (2003). Agile Development and Remote Teams: Learning to Love the Phone. In Proceedings of the Conference on Agile Development (p. 140–). Washington, DC, USA: IEEE Computer Society. Retrieved from http://dl.acm.org/citation.cfm?id=942789.942826

[S3] Dorairaj, S., & Noble, J. (2013). Agile Software Development with Distributed Teams: Agility, Distribution and Trust. In Proceedings of the 2013 Agile Conference (pp. 1–10). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/AGILE.2013.7

[S4] Lago, P., Muccini, H., &Babar, M. A. (2012). An empirical study of

learning by osmosis in global software engineering. Journal of Software: Evolution and Process, 24(6), 693–706. http://doi.org/10.1002/smr.565

[S5] da Silva, F. Q. B., Prikladnicki, R., França, A. C. C., Monteiro, C. V. F., Costa, C., & Rocha, R. (2012). An evidence-based model of distributed software development project management: results from a systematic mapping study. Journal of Software: Evolution and Process, 24(6), 625–642. http://doi.org/10.1002/smr.563

[S6] Al-Ani, B., Wilensky, H., Redmiles, D., & Simmons, E. (2011). An Understanding of the Role of Trust in Knowledge Seeking and Acceptance Practices in Distributed Development Teams. In Proceedings of the 2011 IEEE Sixth International Conference on Global Software Engineering (pp. 25–34). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSE.2011.25

[S7] Edwards, H. K., & Sridhar, V. (2003). Analysis of the Effectiveness of Global Virtual Teams in Software Engineering Projects. In Proceedings of the 36th Annual Hawaii International Conference on System Sciences (HICSS'03) - Track1 - Volume 1 (p. 19.2–). Washington, DC, USA: IEEE Computer Society. Retrieved from http://dl.acm.org/citation.cfm?id=820748.821338

[S8] Sangwan, R. S., &Ros, J. (2008). Architecture Leadership and Management in Globally Distributed Software Development. In Proceedings of the First International Workshop on Leadership and Management in Software Architecture (pp. 17–22). New York, NY, USA: ACM. http://doi.org/10.1145/1373307.1373313

[S9] Thomas, D., & Bostrom, R. (2010). Building Trust and Cooperation Through Technology Adaptation in Virtual Teams: Empirical Field Evidence. EDPACS, 42(5), 1–20. http://doi.org/10.1080/07366981.2010.537182.

[S10] Moe, N. B., Cruzes, D. S., Dybå, T., & Engebretsen, E. (2015). Coaching a Global Agile Virtual Team. In Proceedings of the 2015 IEEE 10th International Conference on Global Software Engineering (pp. 33–37). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSE.2015.26.

[S11] Casey, V. (2010). Developing Trust in Virtual Software Development Teams. J. Theor. Appl. Electron. Commer. Res., 5(2), 41–58. http://doi.org/10.4067/S0718-18762010000200004.

[S12] Paul, S. & He, F. (2011). Diversity, group behavior, and performance of short duration ad hoc virtual teams: Findings from a laboratory experiment. In 17th Americas Conference on Information Systems 2011, AMCIS 2011 (Vol. 2, pp. 1511–1522). Detroit, MI. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84870186849&partnerID=40&md5=8c60dbc14f95a22c7d73d8ce8a0fc6d0

[S13] Junior, I. H. de F., Azevedo, R. R. de, Moura, H. P. de, & Silva, D. S. M. da. (2012). Elicitation of Communication Inherent Risks in Distributed Software Development. In Proceedings of the 2012 IEEE Seventh International Conference on Global Software Engineering Workshops (pp. 37–42). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSEW.2012.18

[S14] Calefato, F., Gendarmi, D., & Lanubile, F. (2009). Embedding Social Networking Information into Jazz to Foster Group Awareness Within Distributed Teams. In Proceedings of the 2nd International Workshop on Social Software Engineering and Applications (pp. 23–28). New York, NY, USA: ACM. http://doi.org/10.1145/1595836.1595842

[S15] Ocker, R. (2009). Enhancing Learning Experiences in Partially Distributed Teams: Training Students to Work Effectively Across Distances. In Proceedings of the 42Nd Hawaii International Conference on System Sciences (pp. 1–10). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/HICSS.2009.192

[S16] Da Cruz, G. A. M., Huzita, E. H. M., & Feltrim, V. D. (2016). Estimating trust in virtual teams: A framework based on sentiment analysis. In M. L. H. S. M. L. C. O. C. J. Missikoff M.M. Cordeiro J. (Ed.), ICEIS 2016 Proceedings of the 18th International Conference on Enterprise Information Systems (Vol. 1, pp. 464–471). SciTePress. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84979640982&partnerID=40&md5=beebac9e625a2a7e38eee4397ed041f4

[S17] Rassias, N., & Kirytopoulos, K. (2014). Evaluating risk factors in the operation of virtual teams in ICT projects. 2014 IEEE International Conference on Industrial Engineering and Engineering Management. http://doi.org/10.1109/IEEM.2014.7058827

[S18] McNab, A. L. .,Basoglu, K. A., Sarker, S., & Yu, Y. (2012). Evolution of cognitive trust in distributed software development teams: A punctuated equilibrium model. Electronic Markets, 22(1), 21–36. http://doi.org/10.1007/S13525-011-0081-z

[S19] Zhang, M., Chand, D., & David, G. (2007). Exploring control modes in globally distributed it work. In Association for Information Systems - 13th Americas Conference on Information Systems, AMCIS 2007: Reaching New Heights (Vol. 4, pp. 2813–2825). Keystone, CO. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84870178180&partnerID=40&md5=1583d56bacd696de82aefdd474b6d7a9

[S20] Arun Kumar, S., & Thangavelu, A. K. (2012). Exploring the influence of partnership quality factors towards the outcome of global software development projects. International Review on Computers and Software, 7(5), 2159–2172. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84869825785&partnerID=40&md5=88c1674a41df8de307de1a1401bf8a32

[S21] Dittrich, Y., & Giuffrida, R. (2011). Exploring the Role of Instant Messaging in a Global Software Development Project. In Proceedings of the 2011 IEEE Sixth International Conference on Global Software Engineering (pp. 103–112). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSE.2011.21

[S22] Vanzin, M. A., Ribeiro, M. B., Prikladnicki, R., Ceccato, I., & Antunes, D. (2005). Global Software Processes Definition in a Distributed Environment. In 29th Annual IEEE/NASA Software Engineering Workshop (pp. 57–65). http://doi.org/10.1109/SEW.2005.27

[S23] Bartholomew, R. (2008). Globally distributed software development using an immersive virtual environment. Electro/Information Technology, 2008. EIT 2008. IEEE International Conference on. http://doi.org/10.1109/EIT.2008.4554328

[S24] Al-Ani, B., Bietz, M. J., Wang, Y., Trainer, E., Koehne, B., Marczak, S., & Prikladnicki, R. (2013). Globally Distributed System Developers: Their Trust Expectations and Processes. In Proceedings of the 2013 Conference on Computer Supported Cooperative Work (pp. 563–574). New York, NY, USA: ACM. http://doi.org/10.1145/2441776.2441840

[S25] Trainer, E. H., Al-Ani, B., & Redmiles, D. F. (2011). Impact of Collaborative Traces on Trustworthiness. In Proceedings of the 4th International Workshop on Cooperative and Human Aspects of Software Engineering (pp. 40–47). New York, NY, USA: ACM. http://doi.org/10.1145/1984642.1984649

[S26] Al-Ani, B., & Redmiles, D. (2009). In Strangers We Trust? Findings of an Empirical Study of Distributed Teams. In Proceedings of the 2009 Fourth IEEE International Conference on Global Software Engineering (pp. 121–130). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSE.2009.20

[S27] Plotnick, L. .,Hiltz, S. R. ., Ocker, R. ., Rutkowski, A.-F., & Rosson, M. B. . (2008). Leadership and trust in partially distributed software development teams. In 14th Americas Conference on Information Systems, AMCIS 2008 (Vol. 4, pp. 2502–2508). Toronto, ON. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84870349461&partnerID=40&md5=65aaf413b2dcb4d820ae02b18ad3fb77

[S28] Mikawa, S. P., Cunnington, S. K., & Gaskins, S. A. (2009). Removing Barriers to Trust in Distributed Teams: Understanding Cultural Differences and Strengthening Social Ties. In Proceedings of the 2009 International Workshop on Intercultural Collaboration (pp. 273–276). New York, NY, USA: ACM. http://doi.org/10.1145/1499224.1499275

[S29] Al-Ani, B., Marczak, S., Prikladnicki, R., & Redmiles, D. (2013). Revisiting the Factors That Engender Trust of Global Systems Engineers. In Proceedings of the 2013 IEEE 8th International Conference on Global Software Engineering (pp. 31–40). Washington, DC, USA: IEEE Computer Society. http://doi.org/10.1109/ICGSE.2013.13.

[S30] Basharat, I., Nafees, T., & Abbas, M. (2013). Risks factors identification and assessment in virtual projects of software industry: A survey study. In Proceedings of 2013 Science and Information Conference, SAI 2013 (pp. 176–181). London. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84892547757&partnerID=40&md5=a3f02d6945ea35efdeb2fbccc8b9264c.

[S31] Azzeh, M. (2013). Software cost estimation based on use case points for global software development. In 2013 5th International Conference on Computer Science and Information Technology, CSIT 2013 - Proceedings (pp. 214–218). Amman. http://doi.org/10.1109/CSIT.2013.6588782.

[S32] Gallivan, M. J. (2001). Striking a balance between trust and control in a virtual organization: a content analysis of open source software case studies. Information Systems Journal, 11(4), 277–304. http://doi.org/10.1046/j.1365-2575.2001.00108.x

[S33] Stewart, K. J., &Gosain, S. (2006). The Impact of Ideology on Effectiveness in Open Source Software Development Teams. MIS Q., 30(2), 291–314. Retrieved from http://dl.acm.org/citation.cfm?id=2017307.2017313.

[S34] Furumo, K., de Pillis, E., & Buxton, M. (2012). The Impact of Leadership on Participation and Trust in Virtual Teams. In Proceedings of the 50th Annual Conference on Computers and People Research (pp. 123–126). New York, NY, USA: ACM. http://doi.org/10.1145/2214091.2214125

[S35] Nevo, D., & Furneaux, B. (2012). The power of communities: From observed outcomes to measurable performance. In International Conference on Information Systems, ICIS 2012 (Vol. 4, pp. 2890–2910). Orlando, FL. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84886503881&partnerID=40&md5=da42150cba84c363dcf2a9a7668b235b

[S36] Vujdan, E. K., Thanh-Nam, T. S., Kai, R., & Lutz, K. (2013). The role of motivational factors in distributed software development teams: An empirical investigation. In ECIS 2013 - Proceedings of the 21st European Conference on Information Systems. Utrecht: Association for Information Systems. Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84905841530&partnerID=40&md5=6e7f6e3d04c443ef80a192fbf9d2587b

[S37] Al-Ani, B., & Redmiles, D. (2009). Trust in Distributed Teams: Support Through Continuous Coordination. IEEE Softw., 26(6), 35–40. http://doi.org/10.1109/MS.2009.192

[S38] Moe, N. B., & Šmite, D. (2008). Understanding a Lack of Trust in Global Software Teams: A Multiple-case Study. SOFTWARE PROCESS IMPROVEMENT AND PRACTICE, 13(3), 217–231. http://doi.org/10.1002/spip.v13:3.

[S39] Dorairaj, S., Noble, J., & Malik, P. (2012). Understanding Lack of Trust in Distributed Agile Teams: A grounded theory study. In Evaluation Assessment in Software Engineering (EASE 2012), 16th International Conference on (pp. 81–90). http://doi.org/10.1049/ic.2012.0011.

[S40] Paasivaara, M., Durasiewicz, S., & Lassenius, C. (2008). Using scrum in a globally distributed project: a case study. Software Process: Improvement and Practice, 13(6), 527–544. http://doi.org/10.1002/spip.402.

[S41] Mathrani, A., Parsons, D., & Stockdale, R. (2009). Workgroup structures in offshore software development projects: A vendor case study. In Proceedings - IEEE International Enterprise Distributed Object Computing Workshop, EDOC (pp. 344–351). Auckland. http://doi.org/10.1109/EDOCW.2009.5331972.

ACKNOWLEDGMENT

This work has been partially supported by National University of San Juan and the research project entitled "Group Cohesion on Global Software Engineering" E1043.

REFERENCES

[1] Ichijo, K., von Krogh, G., and Nonaka, I.: Knowledge enablers. In G. von Krogh, J. Roos, and D. Kleine (eds.), Knowing in Firms: Understanding, Managing and Measuring Knowledge. London: Sage, 2000, pp. 173-203. (2000).

[2] Mayer, R. C., Davis, J. H., and Schoorman, F. D.: An integrative model of organizational trust. Academy of Management Review, 20, 3, 709-734. (1995).

[3] Deutch, M.: Trust and suspicion. Journal of Conflict Resolution, 2(4), 265–279. (1958).

[4] Lewis, J. D., Weigert, A.: Trust as a social reality. Social Forces, 63(4), 967–985. (1885).

[5] Komiak S. X., Benbasat I.: Understanding Customer Trust in Agent-Mediated Electronic Commerce, Web-Mediated Electronic Commerce, and Traditional Commerce. Information Technology and Management, v.5 n.1-2, p.181-207. (2004).

[6] Komiak S. Y. X., Benbasat I.: The effects of personalization and familiarity on trust and adoption of recommendation agents, MIS Quarterly, v.30 n.4, p.941-960. (2006).

[7] Handy, C.: Trust and virtual organization. Harvard Business Review, 73, 3, 40-50. (1995)

[8] Hughes, R., Rosenbach, W., and Clover, W.: Team development in an intact, ongoing work group: A quasi-field experiment. Group and Organization Studies, 8, 2, 161-186. (1983).

[9] Klimoski, R.J., and Karol, B.L.: The impact of trust on creative problem solving groups. Journal of Applied Psychology, 61, 5, 630-633. (1976).

[10] Alge, B.J., Wiethoff, C., and Klein, H.J.: When does the medium matter? Knowledge-building experiences and opportunities in decision-making teams. Organizational Behavior and Human Decision Processes, 91, 1, 26-37. (2003).

[11] Kanawattanachai, P., Yoo, Y.: Dynamic nature of trust in virtual teams. Journal of Strategic Information Systems, 11, 3-4, 187-213. (2002).

[12] Jarvenpaa S. L., Shaw T., Staples D.: Toward Contextualized Theories of Trust: The Role of Trust in Global Virtual Teams. Information Systems Research, v.15 n.3, p.250-267. (2004).

[13] Petersen, K., Vakkalanka, S., &Kuzniarz, L. (2015). Guidelines for conducting systematic mapping studies in software engineering: An update. Information and Software Technology, 64, 1-18.

[14] Arksey H, O'Malley L. Scoping studies: Towards a methodological framework. International Journal of Social Research Methodology, 8(1): 19–32. (2005).

[15] Niazi, M., Ikram, N., Bano, M., Imtiaz, S., & Khan, S. U.: Establishing trust in offshore software outsourcing relationships: an exploratory study using a systematic literature review. IET software, 7(5), 283-293. (2013)

[16] Chatfield, A., NajemShlemoon, V., Redublado, W., Darbyshire, G.: Creating value through virtual teams: a current literature review. 24th Australasian Conference on Information Systems (pp. 1-11). (2013).

[17] Da Silva, F. Q., Prikladnicki, R., França, A. C. C., Monteiro, C. V., Costa, C., Rocha, R.: An evidence-based model of distributed software development project management: results from a systematic mapping study. Journal of software: Evolution and Process, 24(6), 625-642. (2012).

[18] Wohlin C.: Guidelines for snowballing in systematic literature studies and a replication in software engineering, in: M.J. Shepperd, T. Hall, I. Myrtveit (Eds.), EASE, ACM, 2014, p. 38. (2014).

[19] Kitchenham, B., Charters, S.: Guidelines for Performing Systematic Literature Reviews in Software Engineering, Version 2.3. EBSE Technical Report, 2007, Keele University and Durham University. (2007).

[20] McAllister, D. J. Affect-and cognition-based trust as foundations for interpersonal cooperation in organizations. Academy of management journal, 38(1), 24-59. (1995).

[21] Morgan, R. M., Hunt, S. D.The commitment-trust theory of relationship marketing. The journal of marketing, 20-38. (1994).

[22] Smith, J. B., Barclay, D. W. The effects of organizational differences and trust on the effectiveness of selling partner relationships. The Journal of Marketing, 3-21. (1997).

[23] Costa, A. C., Roe, R. A., Taillieu, T.Trust within teams: The relation with performance effectiveness. European journal of work and organizational psychology, 10(3), 225-244. (2001).

[24] Porter, C.E., Donthu, N., and Baker, A. 2012. "Gender Differences in Trust Formation in VirtualCommunities," Journal of Marketing Theory & Practice (20:1), Winter2012, pp 39-58.

[25] Fleiss, J.L., Levin, B., Paik, M.C.: Statistical Methods for Rates & Proportions, 3rd Edition, Wiley, NJ. (2003).

Sergio Zapata received his computer Compuer Science degree from the National University of San Luis in 1989 and MS degree in Compuer Science in 2015. He worked in software industry during 20 years. Actually is fulltime professor in Institute of Informatic of National University of San Juan (Argentina). Your interest areas are global software engenieering, software requirements engineering and software metrics. He has published several papers in international refereed journals and representative congresses in interest areas.

José L. Barros-Justo holds a degree in Computer Science (1986) and a PhD degree in Software Engineering since 2006. He worked at Hewlett-Packard, K-Centro Training and i.d.e.a. informatics. Since 1994 he has been working as a full-time professor (tenured track) at the University of Vigo (Spain). Dr. Barros-Justo has served as committee member in International Conferences such as ICSR, CAiSE and Quatic. His research interests include: software reuse, evidence-based software engineering, aspect-orientation, requirements patterns, controlled vocabularies and software development methodologies.

María R. Romagnano is researcher in the Institute of Informatics of National University of San Juan. Ms. Romagnano has a BS in Information Systems (2002) of the National University of San Juan, Argentina; a Masters in Computer Science (2010) from the National University of La Matanza, Argentina. He is currently a PhD student of Engineering, National University of Cuyo, Mendoza, Argentina. She has benefited from three research grants (initiation, improvement and doctoral). She has participated in 10 research projects and 25 publications (twelve as first author). Her research interests include Artificial Intelligence and Software Engineering.

Magdalena Arron holds a Computer Science degree from National University of San Juan (1995). She is part time professor in the Departament of Informatics of National University of San Juan. Ms. Arrónhas 10 yearswork experience in information systems intogoverment organizations. She is ISO/IEC 27001 auditor from Information Systems Audit & Control Association (ISACA). Her interest topics are information systems, informatic audit, software quality and software engineering.