Global Requirements Engineering: Decision Support for Globally Distributed Projects

Christian Lescher
Doctoral Researcher at
Technische Universität München
christian1@lescher.de

Dissertation Advisor:
Prof. Bernd Brügge, Ph.D.
Technische Universität München
Department of Informatics
Chair for Applied Software Engineering
Boltzmannstraße 3
D-85748 Garching, Germany
bruegge@in.tum.de

Research Area:
Decision Making in Global Requirements Engineering

Research Proposal (max. 25 words):
introduce a framework for decision support in global requirements engineering, based on theories and experiences in decision making under consideration of chaordic organization

1. Introduction

Global Software Engineering has gained in importance over the past decade. Many companies today conduct development projects in globally distributed teams. Coordination and communication over distance are key issues of global software engineering [3]. In many cases, this communication is related to requirements.

In this work, we try to gain new insights by looking at global requirements engineering from the perspective of "decision making": Instead of looking at artifacts (requirements, architectural compontents, etc.), we can look e.g. at how decisions are made, what implications they have, or how they are communicated within globally distributed teams.

Equally important, we also see the impact of the organizational form on decision making: The concept of so-called "chaordic" organization, which involves self-organizing teams ("chaos") and a frame organization ("order"), seems to be a promising approach, which we will discuss below. Also the analysis of communication relationships in globally distributed teams (social network analysis) is a proven method to detect problems early on.

In this dissertation, these three aspects are combined to introduce a framework for decision support in global requirements engineering. We investigate leaders, followers and their interactions and aim at identifying patterns to better understand and improve decision making in global requirements engineering.

2. Related Work and Research Hypotheses

In this chapter, related work of the main topic areas is described. Each section concludes with a research hypothesis.

2.1. Negotiation and Decision Making

Requirements Engineering (RE) essentially relies on negotiation and decision making, involving multiple stakeholders. In current research, requirements engineering is looked at from the perspective of “decision making” [10][11][12][13]. This opens up the opportunity to deeper understand the fundamentals of

978-0-7695-3710-8/09 $25.00 © 2009 IEEE
DOI 10.1109/ICGSE.2009.37

requirements decisions and makes it possible to apply classical theory of decision making to RE.

Equally important to the "formal" decision making are people-related aspects. Decisions are made based on gut feelings, based on emotions. Trust plays an important role in team collaboration. In the article *Patterns for Collaboration*, Linda Rising and Mary Lynn Manns depict it as follows [14]:

One of the most interesting things we have learned in the years of research and case studies [...] was this: we all make decisions based on emotion and then justify those decisions with facts. There is not only sociological data to support this, but (here's the scary part) we are hardwired to do this. We survived the evolutionary battles because of this tendency. We didn't fight sabertoothed tigers and members of other tribes by using a formal decision-making process. We acted based on gut feelings, and we still use that approach today.

Based on this information, we formulate the following research hypothesis:

Hypothesis H1. Applying theories and experiences of decision making (formal and people-related) to global software development will allow for a deeper understanding of global requirements engineering.

2.2. Chaordic Organization

In his book "One From Many - VISA and the Rise of Chaordic Organization", the former CEO of the VISA credit card organization, Dee Hock, expresses the need for new organizational forms in the information age [15]. Hock states that each period of history had its predominant organizational form. He distinguishes between the age of *hand-crafting*, the age of *machine-crafting* (industrial age), and the age of *mind-crafting* (information age). According to Dee Hock, command-and-control organizations were the predominant form of the machine-crafting age, but are no longer suitable for the information age, we are currently in. Hock created the term "chaordic" – a compound word of "chaos" and "order" – and postulates that chaordic concepts of organization will end the dominance of today's organizational structures:

In the age of hand-crafting, the dominant forms of organization were the all-powerful churches, kingdoms, and hard-craftsmen guilds. Just as the age of machine-crafting led to the emergence of today's organizations, ending the dominance of guilds, kingdoms, and churches, so too will the age of mind-crafting give rise to new, more chaordic concepts of organization that will end the dominance of today's organizational structures. (page 225 of [15])

The success factors of the VISA story can be summarized as follows:

- Self-organization (comparable to agile approaches)
- Creation of a suitable frame organization (open, fair-minded, equal distribution of power)
- Negotiation and soft skills

Globally distributed development projects – as highly complex, mind-crafting efforts – seem to fit well into this concept. This leads to the following research hypothesis:

Hypothesis H2. The success factors of Dee Hock's chaordic organization – self-organization, frame organization, negotiation and soft skills – are also major success factors of globally distributed projects.

2.3. Global Requirements Engineering

Globalization is considered as one of the major research challenges in requirements engineering [4]. According to Herbsleb [3], impeded communication, differing domain expertise, incompatible environments, and cultural differences are major challenges in global requirements engineering. Herbsleb sees "coordination over distance" as "the key phenomenon of global software development" [3]. Thus, communication is a key issue.

Analyzing communication data turned out to be a helpful approach for understanding behavior of globally distributed development teams. Dutoit and Brügge showed that metrics on communication artifacts can be used to gain significant insight into the development process that produced them [6].

A common approach for analysis of communication data is the so-called Social Network Analysis: Based on communication data – either collected via a survey (questionnaire filled out by team members) or derived from other sources such as e-mail, or change management system – the communication relationships between team members are analyzed (e.g. who is communicating more than 3 times per week over e-mail or phone). The same method can be also used for awareness relationships (e.g. does person X know what person Y is working on). The resulting network can be displayed as a graph, and analyzed applying methods of graph theory. This allows identifying irregular behavior early on, e.g. by comparing existing communication relationships with the communication that would be expected. When conducted regularly,

social network analysis also allows detecting changes in communication over time, which might be an early warning indicator for latent problems in a project (e.g. a problem detected during integration test, resulting in intensive communication between the involved teams). In [7] Kate Ehrlich and Klarissa Chang provide a good overview of the Social Network Analysis methodology in global software engineering. Damian et al. conducted social network analysis in various contexts, e.g. analyzing communication relationships in so-called requirement-dependency social networks (i.e. social networks of teams, which work on requirements that are dependent on each other) [8].

Based on the fact that communication metrics provide valuable information for analyzing global software engineering projects in general, we assume that social network analysis is also helpful in the context of decision making in global requirements engineering. This leads us to the third hypothesis:

Hypothesis H3. Communication and awareness networks (observed in social network analysis) are essential indicators for decision making in global requirements engineering.

3. Research Focus

Combining the hypotheses H1, H2 and H3, research focus is on defining a framework to support decision making in global requirements engineering, considering both formal and people-related aspects.

For this, we investigate leaders, followers, and their interactions. We call individuals who make decisions *leader* and individuals who implement decisions *followers*. This allows identifying patterns in leader-follower relationships in global requirements engineering.

Aspects for observation are:

- How requirements-related decision are made
- Impact of decisions
- Communication of decisions
- Awareness about decisions
- Frequency and impact of decision changes

In particular, we also observe different decision behavior and quality in command-and-control organizations compared to chaordic organizations.

4. Methodology

Occurrences of leader-followers patterns and their contexts are analyzed. Objects for analysis are *case studies* and a *quasi-experiment* based on real data from an industry partner. Methodologies used include *semi-structured interviews* to analyze how decisions are made, tools and methodologies from decision theory (e.g. decision diagram, sensitivity analysis, decision matrix technique [16]) to analyze impact of decisions and decision changes. Communication of and awareness about decisions are observed using *Social Network Analysis methodology*. Further measurement indicators are used to e.g. assess frequency of decision changes.

For validation of concepts, *controlled experiments* are used. The controlled experiments are conducted with student groups. Two settings are planned: a) a "two-room" experiment, and b) a "global" experiement (in cooperation with CMU and SEGAL). Fault injection is used to analyze behavior in such situations. The experiments are executed with varying frame conditions. Differences between command-and-control and chaordic organization are reflected by different experiment settings.

Literature research complements the work. Both study of publications on the aforementioned topics as well as case studies of large-scale projects with rich data open to public (e.g. NASA Columbia and Challenger Space Shuttle [17][18]) are considered.

5. Expected Contribution of This Research

We expect to gain more insights on decision making in global requirements engineering as well as suitable organization forms for globally distributed projects. Possibly we can define metrics based on leader-followers patterns, which can be generally used for decision support.

6. References

[1] D.E. Damian, D. Zowghi, Requirements Engineering challenges in multi-site software development organizations. Requirements Engineering Journal, 2003. 8: pages 149-160.

[2] D. Damian. Stakeholders in Global Requirements Engineering: Lessons Learned

From Practice. In IEEE Software, Volume 24, Issue 2, March-April 2007, pages 21 – 27.

[3] J.D. Herbsleb. Global Software Engineering: The Future of Socio-technical Coordination. Future of Software Engineering, 2007. FOSE '07, 23-25 May 2007 Page(s):188 – 198.

[4] B. Cheng, J. Atlee. Research Directions in Requirements Engineering, in Future of Software Engineering 2007, L. Briand and A. Wolf, Editors. 2007, IEEE-CS Press.

[5] J.M. Bhat, M. Gupta, S.N. Murthy. Overcoming Requirements Engineering Challenges: Lessons from Offshore Outsourcing. IEEE Software, 23, 5 (2006), p. 38-44.

[6] A.H. Dutoit, B. Brügge, Communication Metrics for Software Development. In *IEEE Transactions on Software Engineering*, 1998, pages 615-628.

[7] K. Ehrlich, K. Chang. Leveraging expertise in global software teams: Going outside boundaries. ICGSE '06: *Proceedings of the IEEE International Conference on Global Software Engineering (ICGSE'06)*. Washington, DC, USA: IEEE Computer Society, 2006, pp. 149-158.

[8] S. Marczak, D. Damian. Information Brokers in Requirement-Dependency Social Networks. International Requirements Engineering, 2008. RE '08. 16th IEEE, 8-12 Sept. 2008, pages 53 – 62.

[9] B. Berenbach. Impact of organizational structure on distributed requirements engineering processes: Lessons learned. In GSD '06: 2006 International workshop on Global software development for the practitioner, pages 15–19, New York, NY, USA, 2006. ACM Press.

[10] R. Regnell, B. Paech, A. Aurum, C. Wohlin, A. Dutoit, J. Natt och Dag. Requirements Mean Decisions! – Research Issues for Understanding and Supporting Decision-Making in Requirements Engineering. 1st Swedish Conference on SE Research and Practice, Ronneby, Sweden, 49-52, 2001

[11] A. Aurum, C. Wohlin, Applying Decision-Making Models in Requirements Engineering. Proceedings of Requirements Engineering for Software Quality, Germany, September 2002. Selected for special issue.

[12] A. Aurum, C. Wohlin, The Fundamental Nature of Requirements Engineering Activities as a Decision-Making Process. Information and Software Technology, Vol. 45, No. 14, pp 945-954, 2003.

[13] A. Aurum and C. Wohlin. Aligning Requirements with Business Objectives: A Framework for Requirements Engineering Decisions. Proceedings Requirements Engineering Decision Support Workshop, Paris, France, 2005.

[14] M.L. Manns, L. Rising. Patterns for Collaboration. Cutter IT Journal, February 2005, pages 17-22.

[15] D. Hock. One From Many - VISA and the Rise of Chaordic Organization. Berrett-Koehler Publishers, Inc., 2005.

[16] Theoretical Foundations for Decision Making in Engineering Design, http://www.nap.edu/catalog.php?record_id=10566

[17] D. Vaughan. The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA.University of Chicago Press, 1996.

[18] Report of Columbia Accident Investigation Board. http://www.nasa.gov/columbia/home/CAIB_Vol1.html

[19] C. Lescher, J.D. Herbsleb, M. Bass. Collaboration in Global Software Projects at Siemens: An Experience Report. ICGSE '07: *Proceedings of the IEEE International Conference on Global Software Engineering (ICGSE'07), 2007.*

[20] C. Lescher, J.D. Herbsleb, M. Bass. A Coordination Risk Analysis Method for Multi-Site Projects: Experience Report. ICGSE '09: *Proceedings of the IEEE International Conference on Global Software Engineering (ICGSE'09), 2009.*