Report on the 2nd International Workshop on Requirements Engineering for Sustainable Systems (RE4SuSy)

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***Abstract*—Research has started investigating the support of sustainability within systems and software engineering.Yet there are few workshops that explore the topic, and there is only one so far in requirements engineering: RE4SuSy.**

The 2nd International Workshop on Requirements Engineering for Sustainable Systems (RE4SuSy) was held at RE in 2013. This report summarizes the workshop results and maps out future research directions.

I. Motivation

The topic of requirements engineering for sustainability and for sustainable systems has started to receive more attention within the research community. As a target venue for research in this area, we have started the International Workshop Series on Requirements Engineering for Sustainable Systems (RE4SuSy) in 2012 at the Working Conference on Requirements Engineering: Foundation for Software Quality (REFSQ'12) and continued in 2013 at the 21st International Requirements Engineering Conference (RE'13).

This report summarizes the workshop results of the 2nd RE4SuSy that was held at RE'13 in Rio, Brasil, on July 15th of 2013. The aim of this report is to ensure the continuity and traceability of the discussions initialized at the workshop, to make a common point of reference available for the growing community, and to facilitate collaborations amongst former and future participants.

II. Presentations

The two morning sessions featured presentations of the following contributions, all available in the online proceedings at http://ceur-ws.org/Vol-995/:

- "RE@21: Time to Sustain!"
  Birgit Penzenstadler, Henning Femmer
- "An Assessment Technique for Sustainability: Applying the IMAGINE Approach to Software Systems"
  Alejandra Rodriguez, Birgit Penzenstadler
- "Could Participation Support Sustainability in Requirements Engineering?"
  Martin Mahaux
- "The Social Dimension of Sustainability in Requirements Engineering"
  Timo Johann, Walid Maalej
- "Sustainability and Quality: Icing on the Cake"
  Coral Calero, Manuel F. Bertoa, Ma Angeles Moraga
- "Using Intelligent Agents to Discover Energy Saving Opportunities within Data Centers"
  Alexandre Mello Ferreira, Barbara Pernici
- "Plant Guild Composer: A Software System for Sustainability"
  Juliet Norton, Alex J. Stringfellow, Joseph J. LaViola Jr., Birgit Penzenstadler, Bill Tomlinson

Compared to last year, there was less emphasis on energy consumption and energy efficiency, but more focus on different application areas and sustainability using IT systems as means to facilitate behavior change as well as more encompassing quality modeling that incorporates sustainability as a general objective for software development. This is also visible in the weighted topic model created from the full text versions of the RE4SuSy'13 contributions depicted in Fig. 1.

III. Discussion Sessions

The afternoon sessions of the workshop were used for discussion in breakout groups. The small discussion sessions after each paper presentation had brought up the following general questions about sustainability and software engineering:

- How to define, evaluate, measure sustainability?
- What are the various dimensions of this multi-dimensional optimisation problem, i.e., what is the cost function? Is there any single cost function that can accumulate these dimensions?
- How do sustainability and quality combine and/or compare?
- What is the relation between participation and sustainability?

We split up into two breakout groups: One on *Comparison of sustainability and quality & Indicators and Measures* and one on *Social Dimension & User Participation*. Both groups had vivid discussions with the major points summarized below.

Fig. 1. Weighted topic model according to the full texts of the RE4SuSy'13 contributions.

A. Discussion: Comparison of sustainability and quality & Indicators and Measures

The goal of the working group was to discuss questions regarding the definition, evaluation, and measurement of sustainability and how sustainability and quality combine and/or compare.

- Can we talk about sustainability independent of other aspects?
- Sustainability is part of product quality (1st order impact) and of quality in use (2nd order impact), where quality in use is more complicated as users and context are involved. This means there are static aspects as well as dynamic aspects that have to be considered.
- Can we simply fix the problem of breaking down the goals, measuring, and then assigning a cost to everything? No, only in terms of software sustainability understood as maintenance or in the first order impact, but the market place has not yet assigned a value to the different aspects of especially long?term environmental sustainability.
- For carrying this into business analysis, we have to convince the accountants, which can either be accomplished by the cost savings argument that often applies for some first order impacts, e.g. saving energy, or via the image of the company argument that relates to the shareholder value.
- A next important step is to investigate how to measure 2nd order impacts and for that we might benefit from learning from other fields like social enterprise metrics and life cycle analysis.

B. Discussion: Social Dimension & User Participation

The starting point of this discussion group was the question of the relation between participation and sustainability.

- New ways to involve in RE process ? And impact on sustainability ?
- Does more involvement leads to more sustainability ?
- Does different involvement leads to diff sustainability ?
- We need a sustainability definition to understand this.
- Difference with market-?oriented software implies that social networks are a chance to participate.
- Experimental RE and agile development are validated by many users. Software engineers should have the right people do the design for them. Experimental design involves real people.
- (Massive) participation enables smaller communities to be heard. Are we sure about this? Majorities can eat over minorities...
- But it needs to be aligned with participative doing...
- It is related to generalized expertise

- Participation has the opportunity to challenge business models, and replace sustainable concerns at the centre? Stress externalities.
- Large user bases outperform experts. In graphical design for example. Experts have lots of bias, due to their financial links with other companies, lobbies,... Experts may lack creativity, because they don't try enough.
- Crowd can be manipulated - it can be stupid sometimes...
- Diff between massive participation and smaller scale participation. What about imagining other users.
- How participation is different in problem solving or problem definition ?
- Will number of participants conflict with quality of interaction ? Or how to have techniques where involvement can be of high quality and massive ?
- How to find participation techniques that will overcome obstacles?

IV. Results

The results that we derived from both discussions in the final round, where one participant of each discussion group reported the group's results to the rest of the workshop participants, are the following:

- Seeing sustainability as part of software quality and quality in use
- Differentiate short-term and long-term and measures for that
- Idea of calculating the cost for all factors into one equation
- Relation between sustainability & innovation
- Wider view of the problem space
- Emphasis of social aspect and development for different social situations and incentivizing user behavior
- User feedback and innovation from sustainability perspective is new direction
- Trade-offs and how to deal with them
- More problem-driven and/or empirical work might improve research results (tool demos etc)
- Measures & metrics: danger in comparing to traceability, where it is still difficult to compare results from different case studies, plus danger of optimizing measures instead of reaching objectives
- Matured scoping, but goes further than "quality only"

V. Future Steps

The future steps that are the upcoming research challenges and the activities that will bring the research community forward were identified as the following:

- Case study series for measures and metrics
- Sustainability for specific software systems in case studies
- BoK with definitions and case studies, research agenda as starting point but add more content to it and structure further (not only list, maybe wiki)
- User participation methods, define different types of user participation
- What are characteristics for social sustainability?
- Empirical investigation of interplay between user & sustainability
- Work on characteristics for short and long-term sustainability measures
- Make stakeholders see the value of sustainability
- Analysis of interrelationship of the metrics from the case studies
- Analysis of 2nd order impacts
- Explicit part of the call RE4SuSy14: case studies and failure stories
- Value proposition for stakeholders has to be pitched in the audience's language (will maybe turn RE into superset of BA as required to understand all trade-offs in value)

The results and future steps were summarized on a poster (Fig. 2) and presented to the conference participants in the poster session.

VI. Conclusion

The 2nd RE4SuSy brought interesting discussions and a clearer vision of the research agenda. The 3rd edition of the workshop will be held at RE 2015 and include more interactive sessions on a more specific work product to strengthen the collaboration in the community.

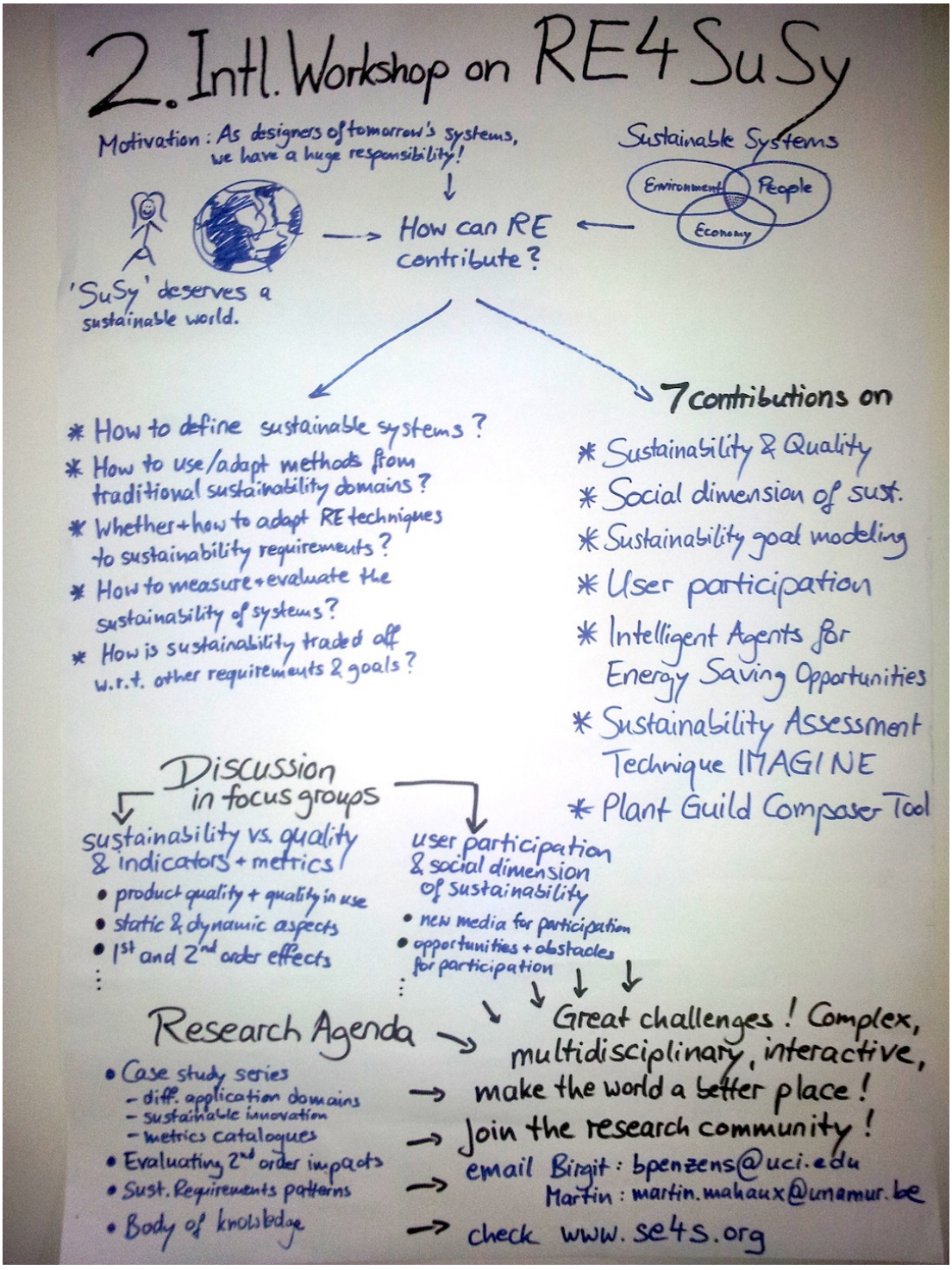

Fig. 2. Summary of results of the RE4SuSy'13 workshop discussions.