The Interplay Among Trust, Risk, and Reliance in Global Systems Engineering Teams

Sabrina Marczak[1] Ban Al-Ani[2] David Redmiles[2] Rafael Prikladnicki[1]

[1]Computer Science School
Pontifícia Universidade Católica do Rio Grande
do Sul (PUCRS), Porto Alegre, RS, Brazil
{sabrina.marczak|rafaelp}@pucrs.br

[2]Department of Informatics
University of California, Irvine
Irvine, CA 92697-3425, USA
{balani|redmiles}@ics.uci.edu

***Abstract*— Trust is an integral element of any collaboration. We sought to investigate the interplay among trust, risk, and reliance within the context of Global Systems Engineering (GSE) teams. To this end, we conducted an empirical study of individuals' processes and considerations when presented with hypothetical scenarios that required long-term and short-term commitments, in addition to relinquishing control to others in their team. In this paper, we present the results of our 1-1 interviews of 57 individuals collaborating in GSE teams within five organizations. Our results suggest that study participants often readily trust their peers and those higher in the organizational hierarchy when no long-term commitment is required, and the participant retains control of the scenario. Our study findings also suggest that this finding does not necessarily extend to scenarios in which their decision entailed loss of control and thus higher risk and reliance. Our investigation of an individual's decision-making processes and the influence of trust on these processes provide us with insights that can be used to refine GSE managers' strategies and guide future research.**

Keywords—trust; distributed teams; global systems engineering, virtual teams; decision-making; empirical study.

I. INTRODUCTION

Trust plays a significant role in the efficacy of distributed teams and their decision-making processes. Our previous research focused on discovering and reporting trust processes [1], tool for supporting trust (e.g. [2]); among other aspects related to Global Systems Engineering (GSE) teams (e.g. [3], [4]). We use the term *systems engineering* to refer to all aspects associated with the development of software: e.g. developing hardware, negotiating contracts, and developing software components, among other activities typically carried during any development project. We use the term *team* to refer to two or more people involved in the development process of a single project in some role during the project lifecycle.

In this paper, we report on our efforts to understand the interplay between trust and the decision-making processes of developers working within global systems engineering team, with a specific focus on naturalistic decision-making. Naturalistic Decision-making (NDM) is a term used to refer to how people make decisions in the real-world contexts that are meaningful and familiar to them [5]. Thus, we sought to investigate developers' rationale in different situations where they have the freedom to make decisions about whom they would like to collaborate with and establish working relationships with, which will have long-term and short-term impact on their workday and possibly their career, and to understand the role that trust plays in these team building decisions. This knowledge contributes to managers making more informed decisions on team building and management when the organization structure allows for such choices.

We sought to explore the interplay of trust, risk, reliance, and decision-making within the context of GSE by using team formation scenarios. We report the findings of our empirical study, which focused on identifying how individuals working within the context of global systems engineering (GSE) teams in real-world projects make decisions when they are presented with three related hypothetical scenarios. In one scenario, we present the participants with a situation in which they will be working on an extension of the project they are currently working on. Then the participants are asked to select the team members they want to collaborate with in this new project. In another scenario, they are asked to imagine themselves in a situation in which they have an innovative idea related to their current project and they feel they need to discuss this idea with other(s) to refine it further. We further explained that there is a need to get honest criticism and to keep this idea confidential. In a third scenario, we explain that after their discussion of this idea with others, they feel they are ready to present it to a wider audience and push for its adoption. We further explain that at the last minute, they are unable to present the idea and need to ask someone else to present it in their stead. These three scenarios suggest different levels of risk, reliance, and commitment; we aimed to identify the role of trust in making decisions for each one of them.

Our analyses of participant decisions when faced with such hypothetical scenarios suggest that study participants would typically choose the same team members with whom they are collaborating for the project extension regardless of their sense of trust towards that person, even those that they do not trust to a high degree. Our results also suggest that study participants typically trust their peers and those higher in the organizational hierarchy when presented with the second scenario as they feel there is no long-term commitment to their decision; e.g., they could choose to

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ignore the feedback. However, our analysis also suggests that this finding did not necessarily extend to the third scenario in which their decision also meant they would give control to another individual. Instead, they would rather choose their manager or a person with good communication and presentation skills to talk on their behalf.

An outline of our study background, research design and data analyses, and study findings are presented in the following sections. The paper concludes with a discussion of these findings and the potential contributions to various fields of study.

II. An Understanding of Trust and Decision-Making

Trust has been defined within many contexts and disciplines (e.g. [6], [7]). Our review of this rich body of work has led us to conclude that trust is a belief that the trustee (individual, team and/or organization) will meet the positive expectations of the trustor (individual, team and/or organization). Trust in an individual's skills is often referred to as *cognitive* trust, whereas trust that the person will do the right thing is often referred to as *affective* trust [3]. Individuals typically have a distinct, and often instinctive, sense of cognitive and affective trust towards others. For example, an individual may trust a teammate to program a software component but not necessarily trust that same teammate to take care of a child. In this example, the individual has a high level of cognitive trust but a low level of affective trust towards their teammate.

Our review of the literature has led us to conclude that in the absence of trust, individuals are often unwilling to risk reliance on others. Thus, trust can also influence a GSE team member's decision-making processes and play a significant role in the choices they make related to whom they would like to collaborate with and whom they would like to establish working relationships with. Meyerson et al.'s [7] review of literature led them to conclude that while trust can be considered "an attitude that allows for risk-taking decisions" [8], the lack of trust can negatively impact innovation and limit options as individuals keep within the confines and safety of the routine. Other researchers consequently consider the decision to take risks as a measure of trust [9].

Different kinds of decisions need to be made by developers throughout the decision making process. For example, Herblseb and Grinter discuss some of those encountered during development such as decisions about the internals of each module, decisions to develop the code manually based on the design agreements, examining each change request, and decisions on whether, how, when, and by whom it should be fixed [10]. While individuals working in GSE teams do not always have the freedom to make all the decisions needed during their workday, they can often covertly exercise their ability to decide if their needs are not considered [11]. Interestingly, researchers have found that cognitive-based trust interacting with cognitive conflict enhances the quality of decisions made [12].

The term *decision* is broadly define as *committing oneself to a certain course of action*, whereas, *decision-making* refers to *how decisions are made* [5]. Studies of decision-making initially focused on the Classical Decision-making (CDM) perspective, in which it was believed that people would choose among concurrently available alternatives. Later studies moved to the Behavioral (BDM) and the Judgment and Decision-making (JDM) perspectives, in which it was showed that people tend to deviate systematically from the rational choice model even when presented with relatively simple tasks. Current research findings, however, focus more on the Naturalistic Decision-making (NDM), in which decision makers and the context setting in which decision are made are the primary focus of investigation.

NDM is marked by a shift in the relative emphasis placed on expertise and features of field settings in which decisions are made [5]. It refers to the way people, the *decision makers*, use their experience to make decisions in field settings. Therefore, NDM is primarily concerned with describing the cognitive processes of proficient decision makers instead of attempting to predict which option will be implemented once the choice is made as in the previous perspectives. It works under the assumption that people will match an alternative solution to a certain situation in contrast to choosing one among several alternatives because this one has superior expected outcomes to its alternatives.

Behavioral scientists have determined that several common factors characterize NDM regardless of the domain. Some of these include time pressure, uncertainty, ill-defined goals, etc. [5]. We sought to explore the interplay between trust and NDM when the decision maker has personal considerations and issues at risk, the longevity the decision makers (the developers) will have to commit to the outcome of their decision. Interestingly, while we found a rich body of seminal work within the field of trust, decision-making, and GSE, we were unable to discover research that investigates the interplay of all three factors: trust, decision-making processes and global systems engineering. Thus, our research can provide a benchmark for future studies.

III. An Overview of Research Design

We sought to interview individuals collaborating with others on GSE projects within the last 12 months. These were the only two criteria to participate in the study and we found that all those who responded to our invitation to participate were eligible. We consequently recruited a total of fifty-seven subjects from five multinational organizations. Each organization typically has sites distributed across countries in four continents (i.e. North America, South America, Europe, and Asia). One organization is a telecommunication company, another is a large computer manufacturing, and the three others are medium-size software development companies.

Study participants were recruited through a combination of e-mails sent to a cross section of the organizations' mailing list (self-selection) and word of mouth (snowball sampling). We did not seek to interview individuals working in the same team, thus the participation of two or more participants in the study was purely coincidental and was not an aspect that was investigated.

The participant pool consisted of fifty-seven participants, 19 of which were female and 38 male individual working within GSE teams. Participants had an average of ten years' experience working in distributed teams and also ten years' experience in the organization. The participants' roles in the distributed team fell into one of three broad categories: managers - 20 (e.g. project manager, portfolio manager),

developers - 32 (e.g. tester, software designer, business analyst) and support staff - 5 (e.g. lawyer).

Participants were located in 10 countries: the United States (34), Brazil (14), Mexico (2), Costa Rica (1), Ireland (1), Israel (1), Poland (1), China (1), Taiwan (1), and Malaysia (1). All interviews were recorded using a digital recorder and later transcribed by a professional transcription service. Interviews that were not conducted in English were translated by a third party and also transcribed. Transcriptions were then analyzed and manually coded.

The one-on-one semi-structured interviews lasted for an average of one hour and consisted of three main sections. The first set of questions focused on gathering data regarding the participants' background (e.g. years working experience, experience working as a developer).

In the second section, we also requested that the participant select a project that we could use as a benchmark throughout the interview. We constrained their selection to a project in which one or more members were located in a remote location, and that also either ongoing or that they had been involved in within the last 12 months.

Once the participant selected a project that met these two criteria we requested that they describe the type of product that was selected as a benchmark during the interview, the number and location of the various team members involved in the development process, and other information that provides context to their response to questions in the third section. The analysis of the fifty-seven participants' demographics revealed that all participants had collaborated with others on their team on projects (that they used as a benchmark during the interview) for a minimum of 2 months and a maximum of 3 years. Participants reported their team adopted the waterfall and iterative models to guide development. One of the teams follows XP practices.

The third and final section was made of questions that aimed to investigate the antecedents of trust in distributed teams. It consisted of a series of open-ended questions, storytelling and scenarios. Furthermore, they were asked to rank their sense of trust towards their team members on a scale that they created during the interview.

In this third section of the interview, we also presented the participant with three scenarios where the participant is expected to make some decisions; each scenario builds on its predecessor. They were asked to think aloud and provide rationale for their decisions in each of these scenarios. The Appendix presents a sample of the questions asked in our interviews.

A. Data Analysis

All interviews were transcribed, and transcriptions were prepared for analysis in the ATLAS.ti qualitative data analysis software. Our subsequent analysis was guided by grounded theory procedures [13]. Two researchers coded the data, each of whom conducted open-coding on a subset of transcripts with objective of identifying participants' rationale for decision-making in response to the three scenarios they are presented with. The researchers then discussed the code lists each had generated, collapsing and unifying codes where there was commonality. Each researcher then returned to the subset of the documents in order to unify the coding, look for instances of codes that had been identified by the other researcher, and generate new codes as needed. The researchers then worked together to describe the emergent categories.

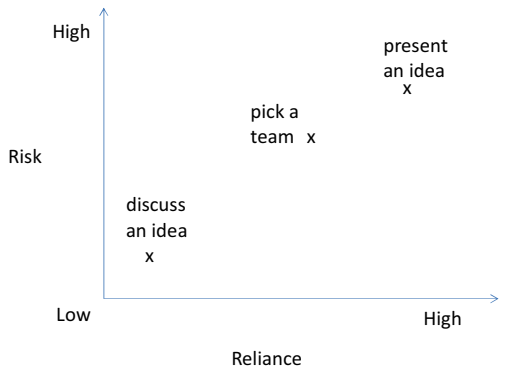
We coded the interviews identifying the roles of the persons the participants decided to trust in each scenario, the rationale they deployed to justify their decision, and other comments relevant to the context of the answers.

We sought to understand the interplay between trust and decision-making processes through the three scenarios we presented to each study participant. First, we asked each participant to assume that they have been asked to work on an extension of the existing project and had the freedom to choose whomever they wanted from their existing team. This scenario exposes the participants to a situation that involves a relatively medium level of risk which will have a long-term impact. We consider this scenario to have mid-level risk for several reasons. We argue that their reliance is distributed among many individuals and participants can still control their reliance and consequent risk by choosing to rely on some team members more than others, the opportunity to change team members also exists to some degree.

Second, we presented the participants with a scenario where they had an innovative idea that would have a positive impact on the project if adopted. The participants were asked whom they would go to in order to discuss their idea. In this scenario, the participant faced minimal risk as they retained control over the impact of their decision. While they could disregard any advice or opinions given by the person they discussed it with, they do risk the person working against the successful adoption of their idea. Thus, while some risk exists, their reliance on others is minimal.

In the third and final scenario, we asked the participants to assume that they had developed their idea fully and they now have a perfect opportunity to present their idea and push for its adoption. A few days before they are due to present their idea, however, they find they cannot for some reason. We then asked the participants who they would ask to present their idea in their stead. In this scenario, the participants are placed in a situation where their decision involves a high level of risk, reliance and a long-term impact as choosing the wrong person can mean that their idea will not be adopted, or someone else taking credit. An overview of the level of perceived risk and reliance presented to each participant in each scenario is summarized in Figure 1.

Fig. 1 Level of perceived risk and reliance per scenario



We coded the dataset per scenario aiming to identify the key concepts reported by our participants. We first identified the roles of the persons the participants decided to trust in each scenario, the rationale they deployed to justify their trusting decision, and other comments relevant to the context of the answers. We had then a set of initial codes per scenario. For instance, we identified that the participants decided on who they would invite to work on an extension of the current project based on their colleagues expertise (code #1), their skill set (code #2), their personality (code #3), in their experience working together in the past (code #4), among other reasons. Next we looked for similarities and particularities among the responses from all participants and conducted further rounds of analysis grouping the codes into major categories, resulting in the three main categories mentioned below, namely: affective trust, cognitive trust, and distance. A more detailed description of these categories is reported elsewhere [3].

IV. RESEARCH FINDINGS

In general, we found no correlation between risk, reliance decisions and the demographic data we collected to describe the participant, the team and the project used as a benchmark during the interview. In short, we found no correlation between decision-making, trust, risk, reliance and the age of the participant, the gender, the size of the team, team distribution, nor the type of project. Furthermore, we found no evidence that the location of the remote team members influences participants' choices. We did find, however, that participants typically chose people who were in close proximity although they did not explicitly state this reason in most discussions.

We did find that study participants responses could be placed in one of three broad categories of considerations, namely their sense of *affective trust*, *cognitive trust*, *distance,* and in the instance of discussing an idea scenario; participants also considered individuals based on *the organization's structure*.

In these considerations of their sense of their affective and cognitive trust towards others in their team and their organization, participants typically stated that they would like to invite those they have higher trust levels to work on an extension of the project while others claimed they would bring the entire team despite the low level of trust they had towards in certain members. Some participants mentioned they would bring those with expertise and with a certain set of skills. A few reported that past experience working together is significant in the decision of who to invite. Interestingly participants often explicitly stated that distance is not a factor they would take into account.

Participants also considered the organization's structure to place a member in a certain position with the hierarchy and discussed their sense of trust in the "organization's" decision-making processes. In these instances, we found that participants would typically go to their peers and those higher in the organization hierarchy for an honest critique of their innovative idea. The majority of the participants reported that they had a sense that their peers have enough knowledge to help on the assessment of the idea, and that they would be critical about it. They also mentioned that going for those higher in the hierarchy inspires trust because of the underlying assumption that their experience placed them in their "higher" position within the organization. A small subset of our participant felt that an innovative idea that would benefit the team should be shared directly by the team. They emphasized the need for transparency.

In addition, we found that many study participants chose their manager to present their idea in the meeting with upper management if they were unable to present the idea and that they would trust them to push for its adoption. They typically rationalized their choice by stating that managers have the power to push the idea forward, and also have the ability to be persuasive and convincing. They also chose people within their organization with good communication and presentation skills. They generally stated that its adoption will be dependent on how well it is communicated and presented. Participants often considered software architects and technical leaders were people with good communication skills. A more detailed account of our findings is presented in the following sections. Participant quotes will include a reference to the study's participant identifier. For example, P41, refers to participant assigned the number 41 as an identifier.

A. Scenario 1: To Work on an Extension of the Current Project

In general, study participants often stated that they would like to invite those they have higher trust levels to work on an extension of the project while others claimed they would bring the entire team despite the level of trust they have in certain members. Some participants mentioned they would bring in those with expertise and with a certain set of skills. A few reported that past experience working together is significant in the decision of who to invite and others that distance is not a factor to be taken into account. Thus, we found that they typically considered their sense of affective trust, cognitive trust and distance in their discussions of their decision-making processes in this hypothetical scenario. We discuss each of these findings in greater detail in this section.

1) Affective trust considerations

We found that close to a third of our participants would decide to select team members they trust the most to join the effort to work on an extension of the benchmark project either because they felt that they had established a kind of rapport or a familiarity. For example, a participant located in the US chose to pick his project leader based on his personality. He claimed that "*great ideas outweigh the pain of working with people (emotionally)*" (P4), whereas, a female participant from Brazil, who performed quality assurance, explained that she chose them because "*these are very dedicated people and it is great working with them*" (P44). Similarly, a female developer located in Mexico (P13) also stated that she would go with everyone that is currently working on the project because of her experience working with them.

Deciding to form a team consisting of the current team members emerged as a common theme as a large number of participants seemed to agree that having some experience working together as a team was more important than individuals' skills and expertise. Many of these participants felt that knowing "what to expect" played an important factor in their decision as the familiarity led to a feeling comfort when working together. For example, a female project manager located in the US stated that "*working together on the current project makes working together in the next*

project easier because one has already established some kind of good relationship" (P3).

Some participants claimed that having experience with team members is more important that the level of trust when selecting whom to work with. They claimed that they would select the current team despite their low sense of trust towards certain team members. A male project manager explained:

"[I] believe they do good work, if they have the right motivation. Chemistry adds value and they work well together, creates more honesty" (P38). Another participant, a female manager located in the US stated that "*all current members, even those with low trust (in Mexico) because I want the remote new site to grow. I am willing to attempt to overcome problems for an opportunity to grow the site despite culture differences*" (P39).

A manager in Brazil said "*it is easier to work with those you already know than reengaging and relearning about someone new*" (P47). Two other participants claimed they would invite the entire team but they did not comment on the trust levels.

2) Cognitive trust considerations

We also found that some participants felt compelled to invite those who they consider experts to work on a project extension. Such discussions of their decision-making rational led to participants explicating the role of cognitive trust. For example, a male project manager claimed that "*expectation [trust] is partially based on expertise but commitment is expected from those one has higher trust in*" (P2), while a strategic planner located in the US stated he would bring people he considered experts "*strictly in terms of processes*" (P33) and another developer located in the US stated he would bring "*experts on the field*" (P43).

We also found that participants would consider the skill sets of their colleagues to decide whom to invite. For instance, a senior manager located in the US mentioned that *"[the selections is] dependent on skills but [the level of] trust also matters*" (P9). In contrast, another participant, a female project manager located in the US, argued that the selection is "*dependent on the skills needed, even if people are at the lower end of the trust spectrum*" (P3). A software designer said "*they are the most competent people in the project and they have a lot of knowledge about it*" (P49). A business analyst located in Brazil stated she would invite two specific teammates for "*their ability of doing networking and get the new idea out to the market*" (P45).

Interestingly one participant, a system architect located in the US, stated he would pick a person that is not part of the team if necessary to locate the expected skills:

"(...) pick strangers for the team based on skills. If necessary one needs to expand the number of people one can trust. And to get to know the skill of some stranger, one goes to someone he trusts (trust network)." (P1)

In such instances, we found that participants considered their trust in others cognitive skills when deciding to form a team.

3) Distance considerations

Participants did not generally seem to consider the location of their team members, despite the challenges distance introduced to their collaboration. When the interviewer explicitly asked whether they considered the location during their decision-making process, participants often stated that a team member's location is not relevant in the selection process. For example, one male manager located in the US explicitly stated that "*The country does not matter as long as the person can meet the agreed commitments*" (P37), whereas, a female architect, located in the US, mentioned that "*prior positive experience with people is important, despite whether it is face-to-face or not, it probably doesn't matter"* (P7).

B. Scenario 2: To Receive an Honest Critique and To Keep the Discussion Confidential

Study participants often stated which specific team members they would go to for an honest critique about their innovative idea and, following, they argued about their choices. While the vast majority of participants simply indicated roles highlighting they had no specific colleague in mind, a few reported they would not go to a specific person but rather someone whose position implied knowledge, expertise and consequently they regarded as trustworthy. Only one participant stated that he would go to people he did not trust to provide constructive criticism (low affective trust), to find out what such a person will "*throw at*" him when he pushed for its adoption. Another participant, a male manager located in the US, stated the following: "*I would pick [those] I have low trust in to neutralize* the low trust people by engaging them and making them feel they*'re part of the solution."* (P38).

We observed that our study participants' rationale for their selection did not generally include explicit references to their sense of trust towards that individual. Indeed, only five participants stated that they would seek a person's opinion because they trusted the individual. They did, however, state that their selection was based one or more factors typically associated with or included in definitions of cognitive and affective trust e.g. skills, common goals, etc. We also observed that participants located within the USA are less likely to base their decision on skills associated with language, or physical proximity when compared to those located elsewhere.

1) Affective trust consideration

We found that our participants generally felt that they would like to discuss their concepts with a peer. They claimed that peers often have a sense of closeness that led them to trust their judgment of new ideas. A relationship described by some participant as being "*honest*", "*healthy*" and with whom they had "*shared experiences."* For example, a female test leader working for the organization for eight years disclosed (P57):

"*Any time I need an advice, or I have an issue related to work, or I have a new idea, I go to 'James'. He inspires me trust to a point that if he told me to jump out of a bridge that he would be there to catch me, then I would because I know he will be there for me. Once in a while, though, he says that one of my ideas is crazy and he asks me to forget about it. I get a bit sad, consider if I should go ahead anyways, but then I always decide to trust his judgment. He is the most experienced guy in the company, he is here since day 1, so he knows what is likely to fly or not.*"

One male project manager, working with teams in Brazil and the USA, reported that he would "*openly talk with everyone*

in the team since it is about discussing an idea that might bring good results to the project and to the team." (P51). He also felt that "*no one deserves the privilege of being the chosen one to hear the idea*." He believes it should be discussed openly among the members in the team during a specific meeting for such purpose.

A senior project manager from Brazil mentioned that he would recommend his senior US business partner. He mentioned that they have already gone through a similar situation and the replacement worked very well. Another participant, a senior tester located in China, stated that he would choose someone he had been working with for the last 18 years and established a mutual sense of trust as a result.

We also investigated to whom the participants would go if they had to keep the discussion about the innovative idea confidential. Study participants often stated that they would discuss the idea with those who they know that would provide an honest feedback and positive criticism. A female test analyst working with teams in India for about five years said "*I would feel comfortable taking criticism from those who are close. I know they are honest, so it is okay to have my ideas criticized*" (P56). A senior project manager from Brazil mentioned "*I know they will react positively to whatever I put at the table, despite how they feel about the idea*" (P46).

2) Cognitive trust considerations

We found our participants generally discussed team members' skills and ability to provide insightful feedback on an innovative idea. For example, one senior project manager from Brazil stated:

"*I would invite a few of my peers to a room, present them with my proposal, see the reactions and try to work over the reactions. (...) my peers have enough knowledge that I can trust their reactions.*" (P46)

Another participant, this time a project manager, mentioned that he would go to his senior developers and to the senior tester knowing they would "*offer a sharp and honest opinion. They would help me to have a focused discussion and we would soon reach an agreement*" (P51).

A system architect reported she would go to one teammate that "*has a rare depth of knowledge and critical-thinking without putting people down*" (P7). Others mentioned they would consult with those "*who tend to be decision makers*" (P3) and "*who have the right mix of political knowledge to address the issue*" (P9), suggesting that some level of influence is important.

3) Distance considerations

A fifth of our participants stated that they would go to those they feel closer to and be able to collaborate face-to-face. For example, a Brazilian tester working with global teams for over ten years reported that she would go to a person who speaks the same language. She claimed that *"(...) sometimes it is hard to express my ideas in English. It does not matter that I am fluent and that I am doing this [working] for over a decade with almost the same people, it just does not flow, there are days it has to be in Portuguese*" (P45). Her statement exemplifies that language is still a challenge in global systems development despite the seniority of the person or of the team itself. We also found that in several instances, while distance was not explicitly stated as being a consideration, participants often decided to consult a person who lives in the same country.

4) Trust in organizational decisions

We found that over half of our participants' rationale for their decision included references to a colleague's skills - skills they assume others have based on their job title, ability to think critically and challenge their idea, diverse perspective, specialized knowledge or expertise, etc.

Some reported they would go to a higher person because "*they are more senior and have more experience than me to help me out with my idea*", said a senior project manager located in Brazil working with a team distributed among Brazil, India, Ireland and the USA (P47) or "*stamp of approval*." Others reported they would select a higher person because "*they can better say whether or not the idea is sound. (...) you know, they have seen and done more than me.*" commented a female developer located in Brazil and working with teams in Asia and Europe (P55).

Another example of decision-making that is influenced by a participant's cognitive trust towards a team member is evident in the following statement made by a male participant located in Malaysia:

"*The person knows where I'm coming from. And I think that person would have the same level of interest and I would say the same understanding of motives. And I would trust that person with whatever decisions - would entrust that person to make those decision in my absence whatever decisions. If I decide it doesn't go and need a second revision, I would trust the person absolutely.*" (P20)

Many of the participants located in the USA also stated that they would seek the opinion of decision makers who were able to "*fulfill*" their expectations and "*make things happen*" based on their position in the "*organizational structure*" (e.g., P4). Some participants stated, moreover, that they would follow their organization's processes for the presentation and adoption of an idea.

Interestingly, we had one senior male project manager located in Brazil and working with teams in Brazil, Slovakia, and the USA claiming he would not go to any of his direct reports "*to avoid creating false expectations that this new idea might create new job opportunities, job position changes, or even foster any kind of career development*" (P46).

Furthermore, we found some instances where participants stated that they would not keep the idea confidential. A junior male software designer working for one year with agile distributed teams in Canada, US, India, and UK reported that "*the project is open and as such it should not keep anything from anyone. There are no secrets in this project*." Similarly, a female developer working with teams in China, Malaysia, India, and Mexico for over six years said that "*there are no reasons to keeping things confidential from others in the team*" (P55).

A similar argument was discussed by a senior male developer that does not trust anyone in the team to keep it confidential. He said "*I know that sooner or later the story will be in someone else's ears*" (P53). His skepticism for this matter is contradictory with his high levels of trust in his teammates.

C. Scenario 3: To Present the Idea

Interestingly, we discovered a great deal of divergence in participant's rationale when deciding who should present their idea. In this instance, participants typically focused on selecting an individual whose cognitive skills would increase the likelihood of adoption.

1) Affective trust considerations

A technical consultant located in the US said he would invite a person based on the respect he has towards her. This participant also said he would make an invitation based on "*the personality of a successful presentation*" (P10).

A male program manager located in the US said that anyone in the team could make the presentation:

"*All people in the team could do it (because they went to the 1-2 years planning process (conversion to a product development team). I would distrust only if someone demonstrated himself to be incapable (or cannot keep it confidential) over time*" (P2)

A manager located in the US argued "*Doing the right thing is more important that getting credit for it - take the people to represent to who are able to make it happen*" (P4).

2) Cognitive considerations

We found that here again, participants focused on their level of cognitive trust towards others in their decision-making processes. Participants chose a team member who has good presentation and communication skills to speak on their behalf and to push the innovative idea to upper management in their absence. A software designer said:

"*I would send the software architect because he has as much knowledge as I have about the project and he is a great presenter. He is clear and very sharp in presenting ideas to the team. He would be a good choice*" (P49).

A female developer mentioned she would ask a certain senior developer to replace her because "*he has this ability to explain very well ideas using technical details that are often clear to anyone in the team*" (P55). Another two participants (P10 and P37 located in the US) also claimed that the good presenters have to be highly trusted people.

Another participant located in the US reported she would like to invite a person with a similar job position than her in the organization, even if this person is not part of the team (P6). Another participant claimed: "*I would invite people who are most politically astute, not necessarily the ones who are trusted the most*" (P7).

Interestingly, one participant, a manager located in the US, would invite only people she trusts the most "*for knowing these are people with high knowledge on the topic*" (P39) while, in contrast, another manager would only invite people he trusted the least.

Participants also reported they would ask their managers to represent them in the meeting since the managers have the power to pushing ideas forward and to discussing equally with senior management. A project manager said: "*I would send my senior manager. He is a person that can keep up with a discussion and negotiate with upper management*" (P49). A senior test leader indicated her manager because "*he is convincing and persuasive. That is what is needed for a discussion with upper management*" (P57). One participant, a strategy planner located in the US, stated: "*this is the manager's role responsibility, it is part of her function*" (P33) and another, a female project manager, stated: "*the manager is honest, consistent, has integrity (reputation), it is just the matter of making him trust the idea first*" (P3). Another participant, located in Taiwan, stated that he would "*get a senior manager in their group to sell the idea for me*" (P14).

A software designer claimed that his choice would be the software architect of his team since he is, in addition to a good presenter, a good listener. He argued "*I think it is important that the person that will be there in front of the managers is also a good listener, he needs to listen carefully to choose his rebuttal arguments well*" (P49). A second participant (P37) also indicated that is important to select someone who is a good listener to make the presentation.

Three participants defended that it is relevant to send a teammate with good technical knowledge. For instance, a male manager located in the US claimed that "*technical knowledge important so then the person can answer to tough questions*" (P40). Another participant, an engineer located in the US, said: "*knowledge about the system is very important*" (P41). Yet another participant located in the US stated: "*having technical knowledge is significant because the person can present as she would like*" (P42).

In contrast, a female quality assurance argued she does not welcome too much technical expertise when interacting with upper management. She said: "*I would not pick either a developer or a tester because they have so much technical knowledge that they often cannot step aside from it*" (P44).

3) Distance considerations

We found that participants typically did not seem to consider the location of the person in this scenario. Discussions were dominated with factors that demonstrated participants were primarily concerned with their representative's presentation skills, technical or domain knowledge, position or role within the organization, among other similar considerations. We found some rare instances of decisions influenced by locations, as this statement from a requirements engineer located in the US explains (P11) that he would choose someone who is local:

"*So I can sit down and walk through the - in different meetings and - just because I would have, then, the trust that I can convey what I want them to convey*"

This statement demonstrates that while distance is considered, it is trust in the participant's ability to convey the idea that is the main concern rather than trust in the teammates in remote locations. Furthermore, while the lack of concern with respect to distance is implied by its absence in the discussions of most participants, others explicitly stated they would not consider distance when making their decision. For example, we found two participants (P9 and P10) who argued that location does not affect the selection process. One of these participants is a Technical Consultant whereas the other has a managerial role within an organization.

We did find, however, that some participants resisted the idea of risking relying on someone else to present their idea in their stead. For example, a developer located in the US, stated he would "*try to reschedule it*" (P22), whereas another system architect also stated he would try to present the idea himself and "*call in from vacation*" (P1).

V. STUDY LIMITATIONS

We strove to offset the limits that may have been introduced in the recruitment process (self-selection and snowball sampling) by increasing the sample size, and diversity of sites included in our participant pool to increase our confidence regarding our insights into the interplay of trust and decision-making within GSE teams.

Our study is one of a few which gains insights from practitioners through an open discussion of current projects. Although for the understanding of decision-making processes we asked the participants to consider hypothetical situations, we asked them to consider their working experience and provide us with responses that would represent their decisions in real-world projects. Therefore, our findings report anticipated behavior of a large set of practitioners with a variety of roles, working experience, and knowledge about their companies. Furthermore, the interviewees are not limited to software engineers, but range from very technical jobs (e.g., developers) to support staff (e.g., lawyers). This inclusion is also not typical of studies of trust in distributed teams. The researchers have no conflicts of interests with the interviewees.

VI. DISCUSSION

Our investigation of the interplay among trust, risk, and reliance within the context of Global Systems Engineering (GSE) teams revealed that while a rich body of work explores trust, decision-making, and GSE, we did not find this was also true of research into the interplay of all three. Thus our research can be used as a baseline for future work into this domain.

We empirically investigated this interplay *in situ*, with participants from 5 companies located in 10 countries across the globe, through three interrelated hypothetical scenarios. Reported responses indicate anticipated behavior of our research participants illustrating what would have eventually happened in practice. We found that participants considered various aspects when making their decisions about who they would like to collaborate or work with, generally discussing issues pertaining to affective trust, cognitive trust in the organizational hierarchy and distance. In these scenarios, we found that cognitive and affective trust played the more dominant role with distance having a less influential impact [14].

In one scenario, the participants were asked to imagine a hypothetical situation where they would work on extension of current project. This scenario implies a reliance on others, where project may fail because of wrong choices. Furthermore, there is a high degree of reliance there and there is also shared responsibility.

In this scenario, most of our study participants typically chose the team members from their current project to minimize risk. Many participants felt that they could anticipate behavior and adjust reliance accordingly, while others stated that they would go to those who are familiar to them. Thus, while these participants did not explicitly mention risk, they do attempt to minimize risk by seeking only those they are familiar with. Here, we found that participants did not generally consider the distance that separated them from their teammates. Their primary focus was affective and cognitive trust rather than physical distance.

In another scenario, participants are asked to imagine having an innovative idea related to the extension of the current project and a need to ask others for their opinion/advice. This scenario creates a situation that the participants find that they are exposed to minimal risk because they can disregard unsatisfactory discussion/advice and go to others. There is also minimal reliance because they in the end are relying on their perception of what constitutes as sound information. They can decide to go to whomever they choose and yet still have the freedom to take their advice or opinion. Here, the impact is minimal and can be corrected if the participants reaches a conclusion that their trust is misplaced. We found many instances in which participants stated they would discuss their idea with several roles, specially their peers. We also found that participants would seek advise from those higher in the organization hierarchy because their "higher" position inspires trust in their advices. Interestingly, we found that a minority thinks that a discussion with everyone would benefit the team and they would not keep the discussion confidential. They emphasized the need for transparency rather than distance.

In the third scenario, participants are asked to choose someone else to present the innovative idea for adoption. It implies choosing someone to present self i.e. self-presentation. In this scenario the participants is placed in a situation where their decision will lead to a complete reliance on the person presenting the idea and risking the failure of adoption. Thus, the responsibility is not shared. Overall we found that location was not the first consideration. Rarely did participants base their decision on their consideration of location. While we found that some participants chose between affective trust and cognitive trust, its trend is inconclusive within our sample. For instance, we found that a participant would invite certain colleague based on the respect he has towards her while another would invite anyone in the team for thinking they all qualify for the task. We also found that a representative number of participants would like to appoint their managers to make the presentation for considering that they have the skills to negotiate and to deal with upper management. Others would invite a person with good communication and presentation skills to ensure that the idea was going to be well presented.

Overall, we found that many participants relied on their sense of trust in the structure of their organization rather than trust in the person. In these instances participants discussed the role the person plays in the structure e.g. participants stated they went to their supervisor for feedback.

These findings suggest that a GSE team member's sense of trust plays an influential role in their decision-making processes when offered an opportunity to make decisions that involve varying degrees of control, risk and reliance. While no common theme emerged from their discussions of their decision-making processes within the three scenarios, we did observe that their decision-making processes did not rely solely on others ability to meet their expectations of their cognitive abilities and many discussed their level "*comfort"* and "*familiarity."* We also observed that distance was more likely to play a role when participants were located in non-English speaking countries.

VII. CONCLUDING REMARKS

In this paper, we sought to analyze the interplay between trust and the team formation decision-making processes of

developers working within global systems engineering teams. We provided a specific focus on naturalistic decision-making (NDM), which takes into account the setting in which the decision is made and how the setting influences the decision process itself. By taking this approach we aimed at understanding how developers make decisions in real-world projects. More specifically, we sought to investigate developers' rationale in different situations where they have the freedom to make decisions that will have long-term and short-term impact on their workday, and possibly their careers, and to understand the role that trust plays in these decisions. We presented the participants of our study with three scenarios and asked them to report what actions they would take for each one. In the first scenario, we asked the participants to consider an extension of the current project they are working on and that they have to invite people to compose the team. Participants reported they would invite everyone in the team despite the level of trust in order to maintain the team building feeling. They would also invite those they are familiar with and have a certain set of skills. In the second scenario, we asked the participants to consider that they had an innovative idea for the extension project and that they wanted to discuss this idea further with others to receive advise about it. Participants reported they would seek advice from peers or those higher in the organization hierarchy. In the third and last scenario, we asked them to consider that the innovative idea had to be presented to upper management but yet, a few days earlier, they learned they could not attend the meeting and had to appoint a person to speak on their stead. There was no common trend among responses but some of the participants indicated they would invite their manager to replace them and others that they would send a person with good communication and presentation skills.

Our research makes two major contributions to the field of GSE, namely:

- *GSE team formation and management:* We have identified a need to close the gap between management decision-making processes in forming teams and assigning roles, and the personal choices by individuals who are actually expected to collaborate with others.
- *Research community:* Our work can be considered a benchmark for future studies, as we did not find any previous work which explores the interplay of trust, decision-making processes, and global systems engineering.

APPENDIX

Interview script. A sample of the questions asked in the interview is presented below.

Section 1. Project related questions

Please describe the most recent project that involved distributed collaboration:

(1) What kind of product were you involved in developing? (I.e. Innovative, new, upgrade)

(2) How many team members do you need to interact with regularly? What are their locations?

(3) Why do you interact with them? (E.g. location, worked with them before, they have technical knowledge, need to coordinate, interdependencies, etc.) How often?

(4) What is the nature of your collaboration?

(5) How do you interact with them? (E.g. phone, e-mail, telepresence, face-to-face, Twitter, Facebook, etc.)

Section 2. Trust related questions

Scenario 1. Cognitive trust – Ability dimension

If you had to pick 7-10 people who you really, really trust to work with you on a follow on of the current product for a new market opportunity- who would you pick for key positions?

- Sc1.1 Who would you choose from your current team?

- Sc1.2 How did you decide who to choose?

Scenario 2. Affective trust - Integrity dimension

You've come up with an innovative way to *** [insert what they do].

You'd like to bounce your concepts off someone else in you current team. Who do you think you would discuss it with:

- Sc2.1 for an honest critique?

- Sc2.2 to keep your discussion confidential?

Scenario 3: Affective trust - Benevolence dimension (kindness, generosity, inclination to be kind)

You're unable to present your idea to upper management, who would you choose to represent you and push for its adoption in your stead [position]?

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