Trust Building Process for Global Software Development Teams. A review from the Literature

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Abstract

Due to increasing globalization tendencies in organization environment, Software Development is evolving from a single site development to multiple localization team environment. In this new scenario, team building issues must be revisited. In this paper components needed for the construction of the Trust Building Process are proposed in these new Global Software Development Teams. Based in a thoroughly state of the art analysis of trust building in organizations, this new process comes to narrow the gap between dynamics of trust building and intrinsic characteristics of global teams. In this paper, the components for Trust Building Process are justified and presented, with the purpose of a future assembly in further publications, leaving testing of this assembly far behind.

Keywords: Global Software Development; Human Factors in Software Engineering; Team Socialization; Trust; Trust Building Process

Introduction

Software Engineering (SE) has evolved steadily since its foundation in the conferences sponsored by NATO Science Committee at the end of the 1960s, and will continue its evolution due to internal improvements and some adaptations brought about external changes (Campbell-Kelly, 2003). One of the most important external changes in today's market is Globalization (Wolf, 2004). This new phenomenon has influenced software evolution and has multiplied the production and demand of software products (Arora & Gambardella, 2004). The SE research has also evolved in order to adopt some Globalization characteristics; as a result, a new field called Global Software Development (GSD) emerged to cover specific aspects of global distributed software development (Gorton & Motwani, 1996; Karolak, 1998; Herbsleb & Moitra, 2001; Oshri et al., 2007). Simultaneously, many classical software engineering knowledge areas have also evolved following this global trend, i.e., configuration management (Pilatti et al., 2006), requirements engineering (Damian, 2007).

Software development presents three critical dimensions: people, tools and equipment, procedures and tasks, which are held with processes (CMMI Product Team, 2006).

These dimensions are present in every software development team, either global or local. Focusing on the people dimension, the relevance of team work has been widely proven (Lister & DeMarco, 1999; Humphrey, 1997; Hilburn & Humphrey, 2002; Sharp et al., 2009, Trigo et al., 2010). Team work in GSD environments presents some aspects that require to be minimized in order to carry a successful software development (Hinds & Bailey, 2003; Poltrock & Engelbeck, 1999): trust (Jarvenpaa et al., 1998), communication (Hinds & Mortensen, 2005), coordination (Cramton, 2001) and unhealthy subgroup dynamics (Armstrong & Cole, 2002). In addition to the critical dimension about people in Software development, trust building has been identified as critical processes for GSD teams' effectiveness (Handy, 1995; Dirks & Ferrin, 2001; Aubert & Kelsey, 2003).

The study of trust in IT environment is a part of studies in human capital; a combination of sociology and politics along with organizational and management science (Coleman, 1990; Putnam, 1993; Huysman & Wulf, 2004), and has a vast applicability to different contexts and levels of analysis, therefore a delimitation of the domain of research is required. Some delimitations made regarding globalization are, for example, team trust (Costa, 2003), GSD team trust (Jarvenpaa et al., 1998); trust in software outsourcing relationships (Oza et al., 2006), trust in alliances (Das & Teng, 1998), trust in GSD teams leadership (Derosa et al., 2004; Barczak et al., 2006), but also presents gaps, i.e., building and maintaining methods in GSD teams trust (Moe & Smite, 2008).

According to Zucker (1986), there are three ways to develop trust in a relationship: characteristics-based trust, institutions-based trust, and process-based trust. Characteristics-based trust represents altruistic sources of social norms and kindness, i.e. membership of professional associations or educational achievements. Institutions-based trust represents the macro altruistic source of social norms, i.e., technical/professional standards. Process-based trust represents the micro altruistic sources of friendship, habituation, i.e. mutual adaptation, learning by doing, routinization.

In this paper, the components for the process-based Trust Building Process (TBP) construction for GSD teams will be presented using a review of trust and trust in GSD research literature as a basis. The work is based on the need pointed out by Moe and Smite (2008) and the dynamic character of trust (Miller, 1992; Lewicki & Bunker, 1996), the different character that trust presents along the growing stages of a business relationship (Shapiro et al., 1992) and the multifaceted character (Lewis & Weigert, 1985). This paper is motivated by the lack of presence of building process of GSD teams trust in research literature as Moe and Smite (2008) pointed out. There are efforts that cover building of trust in virtual teams from a practical standpoint, like Duarte and Snyder (2006), but this valuable model does not cover particularities about software engineering. In a learning environment scenario, Coppola et al. (2004) propose a model for building trust for virtual teams. Thus, TBP covers all software engineering processes and particularities to offer a model in which software development virtual teams can enhance their performance.

This paper has a two-fold purpose, firstly, redefine the construction and maintenance of trust for GSD teams using a formal model of trust definition as a start point, and secondly, define the components required for the process of building trust in GSD teams. The components in the process for trust creation in GSD teams may shed light in this interdisciplinary research area and may establish the start point for an improvement in the creation of trust in these environments.

Background

Trust is a four place predicate, someone (trustor) trust something or someone (trustee) in respect to something (competence, intentions), depending on the conditions (Nooteboom, 2002). This predicate extends the conceptualization proposed by Hardin (1993), dividing the context or domain over which trust is conferred into conditions and intentions. From a team-work standpoint, trust refers to which team members trust each others as a team, and is a pillar of effective co-operative behaviors with significant effect on change processes and associated risks (Lewis & Weigert, 1985; Shockley-Zalaback et al., 2000), it also engenders cooperation, reduce conflicts, and increase commitments (Morgan & Hunt, 1994). Despite of being fundamental to the successful formation and growth of any new work team (Shaw, 1997; Senge et al., 1994), its influence in team-work, trust is necessary but not sufficient itself for improving and maintaining team performance (Erdem et al., 2003; Costa et al., 2009). Within a team, each member has a defined role that indicates the capabilities, dispositions, motives and intentions that the he or she has, therefore, the role act as an enabler of trust among team members (Barber, 1983; Meyerson et al., 1996). Trust existence is related to risk existence (Morris & Moberg, 1994), if the trustor does not perceive a probability of loss, there is no room for trust (Yamagishi & Yamagishi, 1994); and interdependence between positive expectations about the intentions and behaviors of the trustee, and willingness to be vulnerable in the relationship with the trustee (Rousseau et al., 1998). From viewpoint level, high-trust groups perform better than low-trust groups (Zand, 1972); while on the other hand, an excess of trust is considered counterproductive for team performance, for example questioning and creative criticism are keys for team-work improvement (Manz & Neck, 1997). Additionally, team composition may change and new members may be included, in these situations the lack of previous interaction with new members (Kramer, 1999), the difference of individuals' predisposition to trust other people (Gurtman, 1992; Sorrentino et al., 1995), and the team size (Sato, 1988) should be considered as threaten trust factors.

According to Costa (2003), the factors related to trust in teams can be classified into three groups: team composition, work characteristics, and organizational context. In team composition group there are factors such as adequate job skills to perform the allocated tasks, team cohesion, tenure, and preference of working in team contexts. For work characteristics, information required to effectively performing the tasks jointly with the capacity for processing it, functional dependence (Morris & Steers, 1980), and task ambiguity are considered the main factors. According to Rico et al. (2009), task interdependence is a key antecedent for trust development from the beginning to a middle point of the project (Gersick, 1988; Jarvenpaa & Leidner, 1999), which is associated with interaction, communication and information exchange between team members. Finally, organizational context factors group contains management of climate (Costa, 2003) and empowerment of team members.

One specific type of work teams are GSD teams. GSD teams can be characterized as virtual teams according to Martins et al. (2004), which are becoming a standard at work in the current organizational context (Gibson & Cohen, 2003). They have been defined as two or more individuals, who work together with a mutual goal or work assignment, interact from different locations and, therefore, communicate and cooperate by means of information and communication technology (Bell & Kozlowski, 2002). In the case of GSD teams, the goal, work or assignment are related to a software development project. The influence of trust in GSD teams has been treated in research literature from many different standpoints (Jarvenpaa, Knoll, & Leidner, 1998) and distrust has been treated

too (Lewicki et al., 1998). Trust is especially vital in GSD teams due to the lack of personal face-to-face interactions. The effects of trust in this kind of teams are, mainly, positive leadership (Kaywort & Leidner, 2002), enthusiasm (Meyerson et al., 1996), predictable communication patterns (Jonassen & Kwon, 2001), and significant social communication (Jarvenpaa & Leidner, 1999). On the other hand, the lack of trust between the team's members may interfere with the effectiveness of individuals contribution to team (Bandow, 2004), reduces the transfer of information between members (Newell & Swan, 2000), moves to individual's goals rather than group's goals (Salas et al., 2005), makes them feel the need to double check work performed by others (Kramer & Tyler, 1996), insecure (Bandow, 2004) and, finally, their productivity and quality decrease to lower levels (Dirks & Ferrin, 2001).

Trust is dynamic (Kanawattanachi & Yoo, 2002; Six, 2003) and is divided in three types: calculus-based, knowledge-based, identification-based (Lewicki & Bunker, 1996). Alternatively, McAllister (1995) defined two types: cognition-based and affect-based, that according to Six (2003), covers the three types defined by Lewicki and Bunker (1996). All of these types depend on the information exchange about the other team members and how it is renewed regularly, so information plays a central role in trust for GSD teams (Holland, 1998). Additionally, the lack of proper technology used by team members to communicate and exchange information may decrease trust (Chubin et al., 2005).

To lose trust is easier than to gain it, consequently trust building should start as soon as the team is created (Janoff-Bulman, 1992; Meyerson et al., 1996) and must be continually monitored. In order to avoid the loss of trust, monitoring has to focus on the communications and feedbacks made on basis (Suchan & Hayzak, 2001; Jarvenpaa et al., 2004). Team has to minimize the effect of silence and delays due to time differences in communications (Piccoli & Ives, 2003). Also, on the beginning of team building, expectations on team relationships have to be communicated (Bandow, 2004).Trust loss does not mean an increase of distrust in any case. The opposite of trust is not distrust and both can coexist in a relationship; they are separate but linked dimensions (Lewicki et al., 1998). This coexistence is also covered by the existence of a contract in the working distributed relationships; distrust supports the formal contract and addresses expected changes (March & Olsen, 1994), while trust supports the psychological contract and address unexpected changes (Robinson, 1996; Sabherwal, 1999). Therefore, a balance between trust and distrust is required as Lewicki et al. (1998) argued.

GSD teams have to work according to work practices, as any other team. Trust in work starts trusting the method used to produce the assets as mentioned on the 4th level of People-CMM (Curtis et al., 2001). GSD teams have to balance the plan-driven and mutual adjustment in order to set a win-win relationship (Moe & Smite, 2008); also a balance between agility and plan-driven methodologies may be required (Ramesh et al., 2006). Before the apparition of conflicts in team relationship, conflict handling mechanisms have to be established and used when those occur (Jarvenpaa & Leidner, 1999). One of the most frequent GSD team conflict is team performance, but using a constant work monitoring could cause the backside effect, trust losing, so there have to be a balance between structural controls and trust (Gallivan, 2001), eliminating the duplicated controls established because of mistrust on work performance (Kramer & Tyler, 1996). However, monitoring appears to provide team members with information about the actions of other team members, thus enabling actors to coordinate their actions towards team goals, and may also prevent process losses by correcting actions

of others (Costa et al., 2009). Besides, the four types of trust should be controlled (Sabherwal, 1999).

Finally, trust has to be maintained, it is not permanent. Rocco (1998) argued that socializing in meetings and team-building activities maintain and strengthen trust in teams. In this direction, the importance of predictable communication patterns for trust maintenance in GSD teams, especially during later stages of a project (Maznevski & Chudoba, 2000; Piccoli & Ives, 2003; Rico et al., 2009). Specifically, face-to-face meetings have been recognized as developers and restorers of trust (Carmel, 1999; Piccoli & Ives, 2003; Bhat et al., 2006). The trust process is basically a learning process (Barber, 1983) in which some risks are taken (Lewis & Weigert, 1985), so learning abilities should be considered (Nooteboom, 2002). Additionally, GSD teams may include people from different cultures, in those cases, familiarization with cultural diversity (Ali-Barbar et al., 2006) and improvement of language skills, written and spoken mostly, are required (Moe & Smite, 2008). All in all, there is not a similar contribution in the current literature. As a first step, trust characteristics and relevant works for building trust in GSD teams have been established (See Appendix 1). Next steps are the definition of components for building it, the calibration of each component, the assembly of components, and finally the calibration of the process. In next section the definition of components is presented, and following steps will be presented in future works.

Trust Building Process Definition

Once the state of art about the creating trust process has been characterized (see Appendix 1), the TBP can be created. First of all, a formal model of trust has been selected to extend internal processes of trust according to characteristics of trust in GSD teams.

Formal Model of Trust

The selected model is a formal model of trust based on outcomes presented by Bhattacharya et al. (1998). This model allows a calculative evaluation of trust and still psychologically meaningful. The model represents a world of two individuals indicated by index 1 and 2. These individuals can engage in actions (denoted α_1 and α_2), which jointly determine outcomes (denoted x_1 and x_2). The actions (σ_1, σ_2) randomly determine outcomes (x_1, x_2) according to the translation functions (α_1, α_2) which are random. The model also represents a finite set of all possible outcomes of persons (denoted as X_1 and X_2) and a finite set of all possible actions of persons (denoted as A_1 and A_2). The outcomes have consequences on the two parties (denoted μ_1 and μ_2). Additionally, the individuals have conjectures about the actions of the other party, which influence his or her choice of actions, and therefore the outcomes and consequences. The model includes two interaction types of how individuals interact, simultaneous-actions and sequential-actions. In the first one, the two parties act without knowing the specific action of the other party, while in the second one, one of the parties move first and the other party knows for certain which action that party has taken. The second kind is selected for this paper purpose because it fits the sequential interaction characteristic of knowledge work in teams (Mohrman et al., 1995) and the work across time zones factor of GSD that represents a sequential collaborative interaction (Taweel & Brereton, 2006). This type also reflects the existence of start

points for interactions. Therefore, the level of trust that person 1 has for person 2, where σ_1^* is person 1's choice of actions, is defined as:

$$T_{1,2} \mid a_1^* = \Pr(\mu_1 > 0 \mid a_1^*) = \sum_{x_1 \in \gamma_1} \Pr(\alpha_1 = x_1 \mid a_1^*) = \sum_{x_1 \in \gamma_1} \sum_{a_2 \in A_2} F_1(x_1; a_1^*, a_2) c_1(a_2 \mid a_1^*)$$

On the other hand, the extent to which person 2 trusts person 1 can be shown by:

$$T_{2,1} = \Pr(\mu_2 > 0) = \sum_{a_1 \in A_1} \Pr(\mu_2 > 0 \mid a_1) c_2(a_1) = \sum_{x_2 \in \gamma_2} \sum_{a_1 \in A_1} F_2(x_2; a_2^*, a_1) c_2(a_1)$$

And once person 1 has acted, interpersonal trust becomes pure predictability as can be shown by:

$$T_{2,1} = \sum_{x2 \in \gamma_2} F_2(x_2; a_2^*; a_1^*)$$

That represents the evaluation of the uncertainty associated with the relationship between outcomes and actions. It is important to highlight that this definition is focused on single-action outcomes. Finally, it should be considered that this model includes a directional characteristic of trust (person 1's level of trust in person 2 may be different from person 2's level of trust in person 1).

INSERT FIG 1 HERE
Figure 1. Schematic structure of model of trust based on outcomes

Formal Model of Trust for GSD Teams

Following the indications of Bhattacharya et al. (1998), characteristics of trust function used for building trust in GSD teams will be a set of possible actions included in the work process, formation of conjectures, relationship between actions and outcomes and feedbacks, along with mechanisms for inducing trust around the term $T_{i,j}$, specifically, affecting the formation and efficiency of conjectures about other's actions, in other words, preparing the GSD team to work in GSD conditions.

GSD team, like any 'normal' software development team, is created after the project kick-off and will go beyond steps and milestones until its finalization (Humphrey, 1999). Before building trust, it should be considered that this task is not free; it takes time, effort and money (Creed & Miles, 1996). It is important to take into account that trust has to be built as soon as a relationship starts in order to achieve high-levels of trust (Jarvenpaa & Leidner, 1999), so team building process represents the best step to begin with the building trust process. According to Holton (2001), standard team building tools can be used to enhance trust in virtual teams. Additionally, during team building process, team members establish their own goals and commitments and the team's ones too, and communicate the expectations (Locke & Latham, 1984; Zand, 1997; Bandow, 2004). With this communications, each team member will know each other's roles, goals and expectations, establishing a start point for mutual learning (Barber, 1983). Moreover, if there is cultural diversity between team members, some

familiarization activities are required, mainly focused on language and working culture (Ali-Barbar et al., 2006). At the same time, risk management needs to consider that trust existence is parallel to risk existence (Coleman, 1990; Das & Teng, 1998), therefore, risk management needs to consider situations when trust is at a low level, or even lost, in its management; additionally, high levels of trust have to be considered because these levels may result in a lack of control in processes. Finally, risk management covers with special emphasis failures and risks occurred on past project preventing to occur on current ones, therefore if trust was a failure cause of some past GSD projects then trust has to be managed as a potential risk.

When a team has been created, it chooses the project methodology considering a balance between plan-driven and agile methods (Ramesh et al., 2006; Moe & Smite, 2008). On the one hand, plan-driven methods like Personal Software Process (Humphrey, 1995) or Cleanroom (Prowell et al., 1999), have common characteristics, i.e. focus on repeatability and predictability, detailed plans, workflows, roles, responsibilities, and work product descriptions, focus on verification and validation, on-going risk management. On the other hand, agile methods, such as Extreme Programming (Beck, 1999) or Scrum (Schwaber & Beedle, 2001), are based on an adaptive and iterative development with frequent inspections and adaptations along with a teamwork culture based on self-organization and accountability. A method for balancing both methods is proposed by Boehm and Turner (2003). This method proposes to take advantage of their strengths and compensate their weaknesses. In order to do that, team members are enhanced to understand their environment and organizational capabilities. Based on this model, GSD teams may reach a balance between agile and plan-driven methods according to GSD characteristics and taking into account risks associated with trust.

Once the team is built, a team socialization process starts under the premise of mutual learning (Barber, 1983). In this process, socialization activities are carried in order to build trust in a gradual and mutual manner (Bhide & Stevenson, 1992). If the project budget allows it and it is not within project restrictions, face-to-face meetings are performed and used as strengtheners and maintainers of trust (Rocco, 2001; Holton, 2001; Costa, 2003; Six, 2003). During this process, activities for improve language skills are performed, if needed, in order to prevent misunderstandings in future communications (Moe & Smite, 2008). These processes are executed if trust evaluation results are not as expected, and secheduled on the project calendar.

During project activities, structural and informal controls may coexist (Lewicki et al., 1998). Taking into account this fact, both informal and structural controls should be established considering that their levels are not related in a strictly inverse manner and that both may coexist (Ring & Van de Ven, 1992; Das & Teng, 1998; Sabherwal, 1999; Lewicki & Bunker, 1996; Bandow, 2004). Inside structural controls, monitoring activities have to be minimized (Jarvenpaa et al., 2004); however, they should be present in order to prevent process losses by correcting others actions (Costa et al., 2009) and established controls should focus on the guarantee of work process and performance (Kramer & Tyler, 1996; Sabherwal, 1999; Moe & Smite, 2008). These controls are also related to risk management as indicators of possible risk occurrence, and the result outputs are inputs for the conflict handling process.

Additionally to the feedbacks defined in Bhattacharya et al. model, that are the base for work process performance, communications are required to maintain trust, and minimize the effect of silence and delays due to time differences (Jarvenpaa et al., 2004; Piccoli & Ives, 2003). Communication should include both, positive and negative,

feedbacks in order to eliminate situations such as unknown project state and possible surprises that may lead to distrust (Zand, 1997). Also, team members have to put special interest in communicating the commitments achieved (Jarvenpaa, Knoll, & Leidner, 1998). Communicating commitments achievement increase team cohesion and team culture (Humphrey, 1999).

As long as GSD team interacts, conflicts, confusions, and disagreements emerge as natural parts in the convergence of the creative process of software development (Humphrey, 1999). These includes conflicts related to trust (Jarvenpaa & Leidner, 1999; Six, 2003), that should be taken into account with special care due to the fragility of trust and the easiness to lose it (Janoff-Bulman, 1992; Meyerson et al., 1996). Once a conflict is solved, trust is evaluated and the socialization process is executed. Additionally, conflict handling process related to trust have to be linked with risk management in order to cover the life cycle of trust handling as a risk.

Finally, the evaluation process used in this paper as evaluation for the model presented, may be used as a guide for trust evaluation process. The evaluation of trust has to produce results that indicate that the level of trust that it is supposed to be maintained during team cooperation is actually achieved and maintained. Measurements of trust for this purpose should cover the three levels of trust that exists: calculus-based, knowledge-based identification-based trust (Lewicki & Bunker, 1996). If the expected results are not satisfying, socialization process is executed.

Once the TBP and its parts are defined, the value of trust can be defined for each one of the milestones it has. Before a GSD Team is built, trust can be evaluated with the aid of Battacharya's model, and subsequent evaluation steps are based on their model (Bhattacharya et al., 1998). After the Build GSD Team process, personal actions sets, denoted in model as A_1 and A_2 are reduced because each member will have goals and commitments that will reach with actions covered by the project methodology; this reduced set of actions will be represented by Z_1 and Z_2. Before the team start to work, project methodology is balanced; this balance will be reflected in trust evaluation, reducing the set of actions as noted and has the purpose of establishing a project methodology that fits with GSD and specific project characteristics. In addition, project methodology reduces the random factor of the function that translates actions into outcomes; this is denoted in model as α_1 and α_2 and with project methodology as $\varphi1$ and $\varphi2$. Within project methodology, risk management may include trust as a risk factor. This factor can be obtained from trust evaluations done during project life. Next trust evaluations are produced in an iterative cycle of sequential actions that are required to achieve the project success.

The iterative cycle starts with the Team Socialization Process which goal, over building trust, is to fix the conjectures of team members about team and individuals actions required in order for project to succeed; this change is denoted by $k_1(\bullet)$ and $k_2(\bullet)$ and replace $c_1(\bullet)$ and $c_2(\bullet)$ in Battacharya's model. After the socialization process, team interacts with the purpose of developing software that meets the requirements using a balanced project methodology as base for its actions, commitments and controls. During theses interactions and in addition to feedbacks, communications should help maintaining the set of possible actions that each member has to do. These communications are reflected in the trust evaluation as an external factor that may minimize the level of trust due to the lack of it; this factor will be noted as two variables: $m_{1,2}$ and $m_{2,1}$ that represents the level of communication between members in both directions. As a special communication, commitments are communicated reducing the possible actions of team members; this will be noted with Z'_1 and Z'_2.

During the iterative cycle, conflicts can emerge as a result of an unexpected outcome or action, or a lack of communication or feedback. The Conflict Handling Process has the purpose of handling conflicts from a proactive perspective; that is analyzing consequences (μ_1 and μ_2) and taking actions required to prevent future conflicts like the one handled. After a conflict is handled, trust is evaluated in order to know if the conflict has had an impact in the trust level. If a conflict has lowered the rust level, this could influence the trust level on the next evaluation; that is represented by $t_{2,1}$.

The trust evaluation process is launch after conflict handling process, as mentioned earlier, and at project milestones or at calendar based events. Trust, according to limitations identified in previous steps,can be defined by:

$$T_{2,1} = \sum_{x2 \in \gamma_2} F_2(x_2; z_2'^*; z_1'^*) * (m_{2,1} + t_{2,1})$$

It should be noted that conjectures are not included in this definition. This omission is caused by trust post-action measurements, which disables the possibility of considering conjectures.

Trust Building Process Components

Once trust building has been reformulated, components needed to build trust in GSD teams should be defined. Based on the literature, four components are identified. The first identified component includes face-to-face meetings, team building activities and communicative skills improvement and may be called Prior Social Capital Process. Prior social capital refers to the degree of familiarity among team members either through past work experiences (Goodman & Leyden, 1991) or friendship (Jehn & Shah, 1997); it can be determinant to the trust level at the start of a project: teams with a low prior social capital demonstrate a lower level of initial team trust than teams with high prior social capital (Costa et al., 2009). The second identified component includes familiarization (if there is cultural diversity between team members) (Powell, 1996; Sydow, 1998), communication of expectations, both individual and project expectations, and establishment of goal and commitments for each member and for team (Locke & Latham, 1984; Zand, 1997; Bandow, 2004); this component may be called Build GSD Team Process. Nearly related with this component, the third one is associated with a project methodology using a balance between plan-driven and agile methods (Ramesh et al., 2006; Moe & Smite, 2008), risk management linked with the management of trust during a project (Coleman, 1990; Das & Teng, 1998; Schöbel, 2009), considering trust as a risk factor, and conflict handling if the trust level is threatening project execution (Jarvenpaa & Leidner, 1999; Six, 2003). This third component may be called Project Trust Management Process. The next component is Trust Management Process, which includes evaluation of the trust level between team members and trust climate, feedback between team members (both positive and negative ones) (Zand, 1972; Zand, 1997), communication of commitments (Jarvenpaa, Knoll, & Leidner, 1998), informal controls and structural controls (Ring & Van de Ven, 1992; Das & Teng, 1998; Lewicki et al., 1998; Sabherwal, 1999; Bandow, 2004).

These components may interconnect with each other. For example, in order to improve the trust level and trust climate between members, Trust Management Process may connect with Prior Social Capital Process and Project Trust Management. During the trust evaluation, if measured level of trust is near the one estimated as risk in risk management (Project Trust Management component) then socialization activities are

requirement (Prior Social Capital Process). Another example may be produced when team members had not worked together; in this case, Build GSD Team component is connected to Prior Social Capital Process for the members to meet each other and produce a more familiar environment and shared meaning of the project.

The components of the model and its relations, both between them and with Bhattacharya et al. model, are presented on Figure 2. The dot lines represent possible connections between components as described above. The other lines represent feedback relations between components and components of Bhattacharya et al. model; that is: expectations, conjectures, actions, outcomes, feedback, and consequences, and specializations of these components described in the Formal Model of Trust for GSD Teams section.

INSERT FIG 2 HERE

Figure 2. Proposed Components for the construction of TBP

Discussion

The state of art shows controversy between the relevance of trust and its influence. On the one hand, factors that influence trust and its building in GSD environments are widely recognized in the literature. It should be noted that these factors are also important in more general environments with similar characteristics such as virtual teams and outsourcing relationships too. On the other hand, despite of their recognition and acceptance, the weight of each factor has not been addressed from a practical viewpoint, there are only approaches for its relevance, consequently, the influence of each factor in trust has not been measured as an isolated factor.

The difficulty of trust analysis as a factor that needs to be calculated, and also each factor that influences it, requires using formal models such as the introduced by Battacharya et al. (1998) with the purpose of defining trust in a formal manner instead of textual definitions. This definition has been used as a base for an initial trust definition in GSD environments. It needs to be calibrated with the weight of each factor that is included, namely: communications and conflicts. Additionally, other factors that influence the definition need to be taken into account: i.e., risk management, balance between plan-driven and agile methodologies, team building activities, and socialization activities. In order to formally introduce these factors in the definition, the weight of each one needs to be known. This requirement is similar to calibration performed for dynamic models (Abdel-Hamid & Madnick, 1989) and COCOMO II (Boehm et al., 1995), under the premise that software projects change along its lifecycle, by both its factors and its efforts, and are different in each organization; therefore models require to be calibrated.

Conclusion

In the current literature, there are approaches for building trust like in virtual teams, for example, Coppola et al. (2004) presented a case for a learning environment, but there is not a specific one for GSD, neither a more general one for virtual teams. In addition, the lack of studies about the weight of trust and its factors in GSD teams, teams makes impossible the calculation of the trust level taking into account the influence of each

factor, so just a black-box analysis can be carried out. The presented components for building trust in GSD teams may shed light in this opaque process that is widely recognized as important, albeit their construction is not addressed. Moreover, components would create a research base for building trust in GSD teams and add value to common theoretical frameworks about trust (Schiller & Mandiwalla, 2007).

The presented definition of the components for the construction of the process for building trust in GSD, along with the formal model proposed by Battacharya et al. (1998), and its specification to GSD environments, point to a formalization of trust building in GSD environments. These definitions do not cover all the factors, and the weight of each one is not clarified, therefore, it was not possible to perform neither a study of neither each TBP component nor the construction of the process. This represents a promising future work line.

Finally, there are three main future researches that arise from this work. Firstly, the creation of a maturity model for trust specifically in GSD teams is proposed. Once the main key factors have been identified across the literature, the maturity of trust in a team requires to be addressed according characteristics such as its fragility (Meyerson et al., 1996), coexistence with distrust (Lewicki et al., 1998) and cost (Creed & Miles, 1996). Secondly, the identified key components for trust and its building require to be assembled in order to test the influence of each component in the building process. Thirdly, once the components are weighted, a contrast between using the process for building trust and not using it may provide information about the relevance of the process for building trust. Knowledge of the influence of each component before contrasting the process usage becomes relevant due to the independently contrast of each process component as a white-box test. Once all the components are contrasted, a black-box test may be performed.

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Appendix 1

Trust Characteristic	References
Trust is dynamic.	(Miller, 1992; Lewicki & Bunker, 1996; Kanawattanachi & Yoo, 2002; Six, 2003)
Trust is a fundamental to successful formation and growth of any new work team.	(Shaw, 1997; Senge et al., 1994)
Trust has a strong influence on interpersonal and team behaviour.	(Golembiewski & McConkie, 1975)
Trust process is a mutual learning process.	(Barber, 1983)
Trust tends to develop more naturally in familiar contexts.	(Powell, 1996; Sydow, 1998)
Trust has to be developed in a conscious and gradual manner.	(Bhide & Stevenson, 1992)
Trust development requires interaction, communication and information exchange.	(Warkentin, Sayeed & Hightower, 1997; Williams, 2001; Gibson & Manuel, 2003; Beranek & Martz, 2006).
Trust is associated with risk and risk taking.	(Coleman, 1990; Das & Teng, 1998; Schöbel, 2009)
Trust has to be developed as soon as a relationship starts.	(Jarvenpaa & Leidner, 1999)
Socialize the relationship with meetings and team building activities, in order to maintain and strength	(Rocco, 1998; Costa, 2003; Six, 2003)

trust.	
Face-to-face meetings develop and repair trust.	(Carmel, 1999; Holton, 2001; Piccoli & Ives, 2003; Bhat et al., 2006)
The participant's expectations have to be communicated to the others. Establish goals and commitments for each team member and for the team as a unit.	(Locke & Latham, 1984; Zand, 1997; Bandow, 2004)
Communications are needed to maintain trust, minimize the effect of silence and delays due to time differences.	(Leifer & Mills, 1996; Jarvenpaa et al., 2004; Piccoli & Ives, 2003)
Effective use of communications on early stages of team's development and projects.	(Senge et al., 1994; Anderson et al., 2007)
Predictable communication patterns are important for trust maintenance in GSD teams, especially during later stages of a project.	(Maznevski & Chudoba, 2000; Piccoli & Ives, 2003, Rico et al., 2009)
Communicate positive and negative feedback.	(Zand, 1972; Zand, 1997)
Feedback on a regular basis to confirm commitments.	(Jarvenpaa, Knoll & Leidner, 1998)
Establish informal controls and structural controls considering that their levels are not related in a strictly inverse manner and that both may coexist.	(Ring & Van de Ven, 1992; Das & Teng, 1998; Lewicki et al., 1998; Sabherwal, 1999; Bandow, 2004)
Balance between plan-driven and agile way.	(Ramesh et al., 2006; Moe & Smite, 2008).
Establish the controls needed for the guarantee of the work process and work performance.	(Kramer & Tyler, 1996; Sabherwal, 1999; Moe & Smite, 2008)
Establish a minimum level of monitoring needed. Replace monitoring by communications and feedback.	(Jarvenpaa et al., 2004; Costa et al., 2009)
Establish mechanism for handling conflicts of trust.	(Jarvenpaa & Leidner, 1999; Six, 2003)
Trust and distrust may coexist.	(Lewicki et al., 1998; Kramer & Cook, 2004; Schöbel, 2009)
Familiarization with cultural diversity growth trust.	(Ali-Barbar et al., 2006)
Language skills influence trust.	(Moe & Smite, 2008)
Building trust is not free; it takes time, effort and money.	(Creed and Miles, 1996)
Proactive style of work favours the increase of trust.	(Warkentin, Sayeed & Hightower, 1997; Beranek & Martz, 2006)

Table 1. Characteristics of creation of trust in GSD teams