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Is Communication the Key to Success? Investigating the Impact of Agile Practices on Information Systems Development Projects

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ABSTRACT

In recent years, agile methodologies for information systems development (ISD) have increasingly attracted the attention of the research community. Agile ISD methodologies are considered an effective way for managing ISD projects in environments characterized by rapidly changing requirements. Although the body of knowledge on agile ISD is constantly growing, we still lack a detailed understanding of the fundamental processes underpinning agile ISD methodologies. In this paper, we investigate how agile practices affect the team communication processes in order to extend our knowledge on the theoretical underpinnings of agile ISD projects. This is achieved by developing a preliminary research model that is based on a solid theoretical foundation. As a theoretical framework, we employ the unified model of ISD success and extend it with context-specific insights from the cognitive-affective model of organizational communication and media naturalness theory. In consequence, we suggest several propositions for future testing.

Keywords

Agile Information Systems Development, Unified Model of ISD Success, Media Naturalness Theory, Cognitive-affective Model, Organizational Communication.

INTRODUCTION

Information systems development (ISD) projects are often large-scale IT projects including a complex software component (Xia and Lee, 2005). Various studies still point to recurring problems arising in ISD projects such as cost or time overruns, rollouts with fewer features than promised, or total failures (Agrawal and Chari, 2007; Avison and Fitzgerald, 2003; Nelson, 2007). Any ISD project is fundamentally a *social process* that is carried out in an organizational setting (Hirschheim, Klein and Lyytinen, 1995; Newman and Robey, 1992; Robey and Newman, 1996). Consequently, the major problems of ISD projects are "not so much technological as sociological in nature" (DeMarco and Lister, 1987, p. 4). The majority of traditional ISD methodologies, either sequential or iterative, is plan-driven (Royce, 1970) and relies on formal communication mechanisms such as project plans and specification documents (Black, Boca., Bowen, Gorman and Hinchey, 2009; Boehm and Turner, 2004; Kraut and Streeter, 1995). In rapidly changing environments, however, it is hard for formal communication mechanisms to react quickly enough (Byrd, Cossick and Zmud, 1992; Herbsleb and Mockus, 2003; Kraut and Streeter, 1995): "Rather than being bastions of order in an uncertain world, traditional teams may indeed become chaotic should their plan-driven organization be overwhelmed by events" (Vidgen and Wang, 2009, p. 374).

Agile ISD methodologies such as Scrum (Schwaber and Beedle, 2002) complement the traditional, iterative approaches to ISD project management, and have been suggested as a way to react quickly to changing requirements by emphasizing small release cycles and through continuous integration of the customer (Beck and Andres, 2004; Black et al., 2009; Erickson, Lyytinen and Keng, 2005). Those methodologies trade strict control for more flexibility and autonomy, the overall ISD process is not planned and scheduled upfront, and progress is made in small iterative steps, encouraging constant change, frequent interaction, and informal face-to-face communication (Cockburn and Highsmith, 2001; Highsmith and Cockburn, 2001). However, research lags behind practice in understanding phenomena related to agile ISD. One of the most pressing issues is the missing "theoretical glue" (Conboy, 2009, p. 330), which has also led to calls for more theory-based approaches in research (Dingsøyr, Nerur, Balijepally and Moe, 2012). The principles and practices of agile ISD have been derived mainly from past experiences, and the literature is largely anecdotal, lacking empirical evidence and theoretical foundation (Lee and Xia, 2010).

One of the most fundamental aspects of agile ISD projects that differentiates them from projects using more traditional methodologies is the central role of *communication* (Melnik and Maurer, 2004; Pikkarainen, Haikara, Salo, Abrahamsson and Still, 2008; Sarker, Munson, Sarker and Chakraborty, 2009). Agile methods are characterized by downplaying the role of formal documentation, which implies that development teams rely heavily on informal communication mechanisms in co-located teams. As stated in the Agile Manifesto (Beck, Beedle, van Bennekum, Cockburn, Cunningham et al., 2001), business customers and developers should work together daily and project information should be shared through informal mechanisms such as face-to-face conversation rather than through formal mechanisms such as documentation. Consequently, agile ISD is described as a "cooperative game of invention and communication" (Cockburn, 2002, p. 28). However, 'over-communication' between participants and stakeholders may also become an inhibitor (Vidgen and Wang, 2009) and communication hurdles are present in extended environments where many stakeholder groups and development teams are involved (Pikkarainen et al., 2008). The emphasis on face-to-face conversations may also lead to challenges for team members with weak communication skills (Conboy, Coyle, Xiaofeng and Pikkarainen, 2011).

To sum up, "the importance of communication has been shown paramount in agile development" (Korkala, Abrahamsson and Kyllonen, 2006, p. 76). Although communication is one of the most fundamental aspects of agile ISD projects (Melnik and Maurer, 2004; Pikkarainen et al., 2008; Sarker et al., 2009), our current state of knowledge on the role of communication in agile ISD projects is limited because few studies have attempted to explain the interplay between agile practices and communication within and between ISD teams (Maruping, Venkatesh and Agarwal, 2009a; Pikkarainen et al., 2008). We find this astounding when contrasted with the abundance of statements that refer to communication as being crucial for agile ISD projects (e.g., Pikkarainen et al., 2008; Sarker and Sarker, 2009; Wang, Conboy and Pikkarainen, 2012).

In this research-in-progress paper, we intend to shed light on the role of communication for agile ISD by developing a first theoretically grounded research model. Thus, we aim to contribute to providing the missing "theoretical glue" by investigating the following research question: "*What is the impact of agile practices on the communication mechanisms and communication process within ISD teams?"* The remainder of the paper is structured as follows. In the next section, we develop our research model step-by-step. This is followed by our research design that we intend to employ for testing our research model. In the last section, we summarize the results and point out future research directions.

THEORETICAL BACKGROUND AND DEVELOPMENT OF THE RESEARCH MODEL

It is known that ISD projects fail when risks become problems and known success factors are not met (e.g., Gallivan and Keil, 2003; Joshi, Sarker and Sarker, 2007; Ko, Kirsch and King, 2005). The ISD process itself, however, "has received relatively little research attention in prior literature" (Siau, Long and Ling, 2010, p. 88) and is often treated as a "black box" (Siau et al., 2010, p. 92). More than 30 years after research has first focused on ISD as a social process (Barley, 1986; Guinan and Bostrom, 1986; Robey and Markus, 1984), researchers still voice "a need for theory and [empirical] studies about social behavior and processes of communication, negotiation, and learning and their relation to the broader (historical, political and social) context" (Kautz, Madsen and Nørbjerg, 2007, p. 235). This even becomes more important when investigating agile ISD methodologies that supposedly build on human communication. It is our goal to open this black box and to provide insights on the actual process of agile ISD.

The common reasoning line of our theory development is provided by the *unified model of ISD success* (Siau et al., 2010), which is based on the classic input-process-output model (Hackman, 1987; McGrath, 1984). The unified model of ISD success aggregates past research efforts in each of those three dimensions. For example, the factors of the input dimension include individual, team, and organizational factors, which are further drilled down to sub-factors such as personality and task complexity. Besides these input factors, the ISD process is influenced by the employed ISD methodology. The output variable of the process is ISD success, which is composed of factors such as system success (including system quality) or user satisfaction. The model represents a strong meta-framework that can be used as a lens to understand, investigate, theorize and predict outcomes of ISD given different input factors and process-related variances. Thereby it provides a framework into which other theories (e.g., socio-cognitive theories) can be fitted to make contextually appropriate predictions about the ISD process. A simplified version of this general framework, which serves as foundation of our theory development, is illustrated in Figure 1.

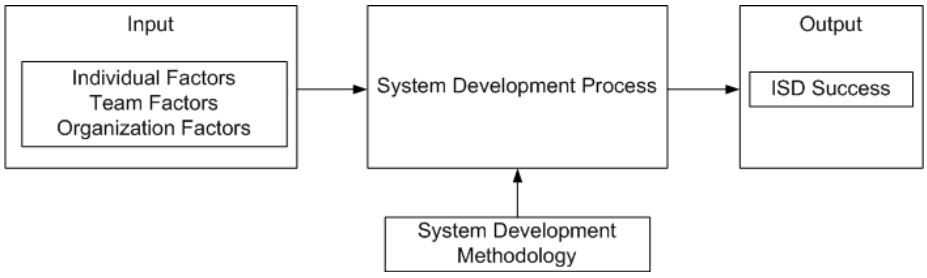

Figure 1: The Unified Model of ISD Success (Siau et al., 2010)

As a first step in our reasoning, we define the *input variables* that are used as our control variables. We restrict ourselves to the input variables that are considered important for agile ISD projects. First, we propose including *experience* as control variable because the experience of the team members has a very strong influence on the development outcome (Siau et al., 2010; Turk, France and Rumpe, 2005). Agile ISD is also reported to be mainly suited for small, co-located teams that develop non-critical software (Ågerfalk, Fitzgerald and Slaughter, 2009). In consequence, we suggest including *team size*, *team distribution*, and *project domain* as control variables in order to consider divergent results for the use of agile ISD in different domains.

In terms of the *ISD methodology*, we are interested in the use of *agile* ISD methodologies. A universal definition of agility does not exist, but recent research tries to pinpoint the concept of agility (Conboy, 2009; Sarker et al., 2009). The most widely accepted definition of agility is formulated in the Agile Manifesto (Beck et al., 2001), which is derived from best practices of practitioners and neither theoretically nor empirically grounded. It lies beyond the scope of this paper to define an agility construct. In accordance with related studies (Maruping et al., 2009a; Maruping, Zhang and Venkatesh, 2009b), we suggest to measure agility by observing the degree of the use or implementation of *agile practices* such as daily stand-up meetings and pair programming. The more agile practices are employed, the higher is the degree of agility.

Given the providence of communication for agile ISD, we suggest leveraging socio-cognitive theories and models that focus on human communication and social interactions to open up the process of ISD. We employ the *cognitive-affective model of organizational communication* (Te'eni, 2001) which is one of the most comprehensive attempts to conceptualize organizational communication. The model is comprised of three basic concepts that complement the process view of the unified model of ISD success: (1) *communication inputs*, (2) a cognitive-affective *communication process*, and (3) *communication impact* (Te'eni, 2001). Specifically the communication process is of interest to us because it helps to conceptually uncover the black box of the ISD process as regards communication. We focus on two specific parts of the communication process which distinguish agile ISD from plan-based methods, namely the employed medium and message form (Beck et al., 2001; Pikkarainen et al., 2008). The physical medium is used for transmitting the message, and the message form refers to characteristics of the transmitted message, such as size and formality of the message.

The used media and message forms can be further detailed using recent insights from *media naturalness theory*, which is based on a modern version of the theory of evolution by natural selection (Kock, 2004; Kock, 2005; Kock, 2009). As face-to-face conversation has evolved as the primary medium for human communication during evolution, the central media naturalness proposition states the following: "*Decreases in the degree of naturalness of a CMC [computer-mediated communication] medium lead to increases in the degree of cognitive effort required from an individual to use the medium for communication to accomplish a collaborative task*" (Kock, 2004, p. 333). In other words, more as well as less transmitted information than provided by the face-to-face medium has negative implications on the cognitive effort that is needed for processing and understanding the transmitted message.

Based on this insight, we propose to distinguish in the following between the message forms *communication formality* and *communication informality* in order to investigate the impact of agile ISD on the communication processes. Communication informality is defined as the employment of more natural communication media such as spontaneous face-to-face conversations and unstructured meetings that are characterized as personal and interactive (Kock, 2004; Kraut and Streeter, 1995; Smith, Smith, Olian, Sims, O'Bannon et al., 1994). In contrast, communication formality is defined as the use of less natural communication media such as highly structured meetings and impersonal, non-interactive written communication in the form of documentation (Kock, 2004; Kraut

and Streeter, 1995; Smith et al., 1994). The Agile Manifesto (Beck et al., 2001) as well as previous studies (Melnik and Maurer, 2004; Pikkarainen et al., 2008; Sarker et al., 2009) acknowledge that agile ISD downplays the role of formal communication and promotes informal communication, which entails that we expect positive effects of agile practices on informal communication and negative effects on formal communication in comparison to plan-driven ISD methods. In terms of the direction of the relationship, it has been shown that there is a one-way flow from agile practices to communication informality because communication activities are facilitated by agile practices such as daily scrums and not the other way round (McHugh, Conboy and Lang, 2011). We therefore expect that the flow direction for communication formality is similar:

Proposition 1: There is a positive impact of agile practices on communication informality.

Proposition 2: There is a negative impact of agile practices on communication formality.

As conceptualized by the cognitive-affective model of organizational communication, we include the communication impact in the form of *mutual understanding* and *relationships* (Te'eni, 2001) in our model in order to further uncover the black box of the ISD process. Mutual understanding is defined as "the degree of cognitive overlap and commonality in beliefs, expectations, and perceptions about a given target" (Cohen and Gibson, 2003, p. 8). Early work on ISD indicates that mutual understanding is generated by efficient and frequent communication between the involved parties (Churchman and Schainblatt, 1965; Guinan and Bostrom, 1986; Tan, 1994). We adopt this view and transfer it to the use of agile practices, recognizing the earlier identified distinction between communication formality and informality. Specifically, we suggest that more natural, informal communication reduces the cognitive effort for creating mutual understanding, whereas the opposite applies for formal communication (Kock, 2004):

Proposition 3: Communication informality has a positive impact on mutual understanding.

Proposition 4: Communication formality has a negative impact on mutual understanding.

In terms of *relationships*, previous research has identified three characteristics of good team relationships in ISD (Festinger, 1950; Guinan, Cooprider and Faraj, 1998): (1) team members share positive feelings for each other, (2) there is a sense of loyalty and responsibility, and (3) there is a common goal. Previous results indicate that frequent informal communication activities resulting from the use of social agile practices improve the relationships of team members (McHugh, Conboy and Lang, 2012). By frequently interacting face-to-face with other team members, a stronger bond between the individuals is established in comparison to formal, written documentation as promoted by plan-based ISD methods:

Proposition 5: Communication informality has a positive impact on the relationships of team members.

We do not expect a significant negative relationship between the two concepts formal communication and the relationships of the team members because the relationships among the team members are hardly affected by reading formal documentation.

The *development output* of agile ISD is a successfully developed software-based IS or software product. Mutual understanding among team members and with the customer is important for building a shared understanding that is expected to induce positive effects on *ISD success*:

Proposition 6: A high degree of mutual understanding has a positive impact on agile ISD success.

Earlier studies find that relationships are not significantly related to the performance of ISD project teams (Guinan et al., 1998). We intend to reinvestigate this finding in the context of agile ISD projects because compelling arguments suggest that relationships are important for agile ISD. ISD projects can take several months or years, or have the same team members in follow-up projects, so there is a considerable need for a good relationships between the team members in order to succeed with the project (Guinan et al., 1998). If team members do not get along well, the agile ISD process, which is based on intense teamwork and frequent communication among team members, is endangered. Therefore, we suggest:

Proposition 7: Good relationships have a positive impact on agile ISD success.

Table 2 provides an overview of the identified constructs.

Construct	Definition
Agile Practices	Key practices are pair programming, continuous integration, refactoring, unit testing, collective ownership, and coding standards (Larman, 2003; Maruping et al., 2009a). Besides those technical practices, more social agile practices such as daily stand-up meetings and retrospectives also affect the ISD process (Schwaber and Beedle, 2002; So and Scholl, 2009).
Communication Informality	Communication informality is the degree to which ISD teams favor less formal communication channels, such as face-to-face conversations, spontaneous conversations, and unstructured meetings as well as other personal, interactive communication channels (Kock, 2004; Kraut and Streeter, 1995; Smith et al., 1994).
Communication Formality	Communication formality is the degree to which ISD teams favor more formal channels, for example, highly structured meetings, written communication and other relatively non-interactive and impersonal communication channels (Kock, 2004; Kraut and Streeter, 1995; Smith et al., 1994).
Mutual Understanding	Mutual understanding is defined as "the degree of cognitive overlap and commonality in beliefs, expectations, and perceptions about a given target" (Cohen and Gibson, 2003, p. 8).
Relationships	Good relationships are characterized by: (1) team members share positive, friendly feelings toward each other, (2) there is a sense of loyalty and responsibility toward each other, and (3) a common goal exists (Festinger, 1950; Guinan et al., 1998).
ISD Success	For agile ISD, we define ISD success as high user satisfaction (Beck et al., 2001; Black et al., 2009) and high project performance (Lee and Xia, 2010; Wallace, Keil and Rai, 2004).

Table 2: Summary of Constructs and Measurement Scales

Our theory development is summarized in the preliminary research model that is depicted in Figure 2. To sum up, our model opens up the black box of the ISD process by investigating the impact of agile practices on informal and formal communication mechanisms within the ISD project teams, which we in turn conceptualize to lead to a higher degree of mutual understanding and better relationships, resulting in higher ISD success. In this, we conceptualize the ISD process as a set of concepts for identifying drivers and factors of the interactions within agile ISD (Sambamurthy and Kirsch, 2000).

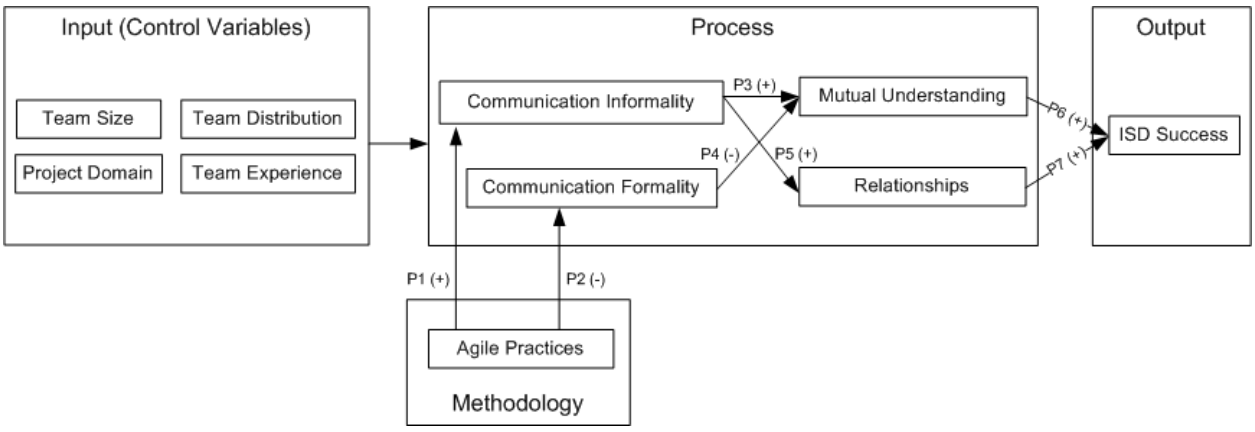

Figure 2: Preliminary Research Model

RESEARCH DESIGN

Our research design is explanatory in nature with the goal of developing a theory for "explaining and predicting" (Gregor, 2006) the effects of using agile practices in ISD projects on communication and the ISD outcomes. We will investigate the conceptualized propositions from different angles (Myers, 2009) by employing a *multi-method design*, which includes both quantitative and qualitative research methods (Gable, 1994).

First, we will conduct an in-depth *single case study*. Despite the problems inherent in the subjectivity of case studies, this approach is suitable for gaining new insights in under-researched areas - such as communication in agile ISD project teams - by investigating ISD in a real life context (Yin, 2003). We plan to test the feasibility of our preliminary research model in a practical setting in order to sharpen propositions and constructs of the model, before testing the model on a larger scale (Hunter, 2004). The case study will be conducted in a medium-sized software development company in the financial sector that employs a total of 70 employees within its development department. First, in-depth *semi-structured interviews* will be conducted in order to gain an initial understanding of the interplay of agile ISD practices and the communication mechanisms. All interviews will be semi-structured, using a pre-designed guideline (derived from the research model and related literature) as a checklist, but allowing room for deviations and open questions. Second, *field observations* will be conducted. The goal of this part of the case study is to learn how agile ISD is actually performed in day-to-day development. The qualitative data will be coded, starting with pre-defined concepts derived from our model and coupled with open coding to identify novel concepts. As a third stage, a quantitative *questionnaire* will be rolled-out within the whole company in order to confirm the findings of the previous stages.

To ensure generalizability beyond the case setting, we will test the final research model on a larger scale by employing a *quantitative survey design* (Straub, Gefen and Boudreau, 2004) that is based on the results of the theory development and the case study. At this stage, we propose the following measurement scales for the identified constructs. First, we will investigate if we are able to adapt scales for measuring the more "social" agile practices such as on-site customers and co-located office space when operationalizing our research model (e.g., Maruping et al., 2009a; So and Scholl, 2009). For testing the impact of agile practices on the communication process, we intend to measure the frequency and amount of more natural, informal communication media such as face-to-face communication as well as the frequency and amount of less natural, formal communication media such as documentation. Existing measurement scales can be adapted for measuring mutual understanding (Biocca, Harms and Gregg, 2001; Katz and Te'eni, 2007; Ko et al., 2005) and the quality of relationships among team members (Guinan et al., 1998). Similar to IS success, ISD success is a multi-faceted construct so that there is no standard measurement (DeLone and McLean, 1992; Siau et al., 2010). The facets of ISD success that should be included in the measurement depend on the specific research question. We propose to measure ISD success in the case of agile ISD projects in terms of user satisfaction. User satisfaction is stated to be the highest priority of agile ISD (Beck et al., 2001; Black et al., 2009). Other scales for ISD success, such as on-time and on-budget completion, may also be considered (Lee and Xia, 2010; Wallace et al., 2004). If necessary, new items will be carefully designed following established guidelines (Benbasat and Zmud, 1999; O'Leary-Kelly and Vokurka, 1998). Before the survey is rolled-out among practitioners, a pilot test will be undertaken in order to test the scale reliability and validity. Structural equation modeling will be used for analyzing the survey data.

CONCLUSION

We developed a preliminary research model that is theoretically based on the unified model of ISD success (Siau et al., 2010), the cognitive-affective model of organizational communication (Te'eni, 2001) and media naturalness theory (Kock, 2004). The resulting research model describes the agile ISD process in terms of inputs, outputs, as well as the process itself. The agile ISD process is opened up by distinguishing between informal and formal communication media, and their impact on mutual understanding and relationships, which in turn affects ISD success. Our preliminary research model opens up several possibilities for future research. A promising field of future research area is the interdependency between principles and practices from lean management and the communication processes within ISD teams. Lean management is gaining more and more popularity in ISD and complements other agile ISD approaches (Wang, Conboy and Cawley, 2012). We also presented our own further research design that is intended for refining and testing the model. The design is composed of a qualitative case study which is followed by a large scale, quantitative survey.

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