Distributed Agile Development:
Applying a Coverage Analysis Approach to the Evaluation of a Communication Technology Assessment Tool

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ABSTRACT

Organizations have shown a significant interest in the adoption of emerging social technologies to support communication and collaboration needs of their Distributed Agile or Adaptive Development Environment (DADE). However, the challenge is how best to assess contemporary social technologies for supporting communication and collaboration in the DADE. Here, a communication technology assessment tool, called CTAT, is developed as a part of the Adaptive Enterprise Service System (AESS) toolkit by using the design research approach. This paper presents the evaluation of the CTAT construct through its use in the assessment of three social technologies within the context of a DADE. The results of this evaluation indicate that CTAT is shown to be useful, for example, when assessing a particular social technology for a specific DADE communication and collaboration context. The CTAT is intended to be used by senior developers for assessing social technologies for their DADE context.

1. INTRODUCTION

Distributed agile or adaptive development environment (DADE) (Kircher et al. 2001; Poole 2004; Sureshchandra and Shrinivasavadhani 2008) is a combination of both agile (Agile Manifesto 2001) and geographically distributed software development (SD) environments (Prikladnicki et al 2003; Lehtonen 2009). Agile SD teams rely on active and frequent communication and collaboration for increasing throughput (Noor et al. 2008). Communication among geographically dispersed agile teams and stakeholders is one of the key concerns of the DADE (Babar et al. 2006). Agile SD teams working in the multi-site distributed development environment require the support of communication and collaboration technologies (Malone and Crowston 1994; Espinosa and Carmel 2003; Kock 2005; Babar et al. 2007) for effective information and knowledge sharing (Kock 2008; Ackerman et al. 2013). The use of the appropriate communication and collaboration software technology (Kock 2010) would help to source, integrate and analyze information and knowledge from dispersed locations, which may enhance the agile SD team productivity (Schummer and Schummer 2001; Kircher et

al. 2001; Herbsleb and Mockus 2003; DeLuca et al. 2006).

There are a number of emerging social technologies (e.g. Chatter, Skype, HipChat, Twitter, and Yammer) that claim to support communication and collaboration needs of a DADE. However, these emerging online social technologies (Franchi et al. 2013) present both challenges and opportunities for the DADE organizations. Academic research is needed to develop new vendor independent social technology assessment artifacts or tools for assessing these emerging social technologies that claim to support DADE communication needs. This draws our attention to the following key research question.

How best to assess as which of the social technologies really have the capability to support effective communication and collaboration in DADE?

In on our on-going research, we have developed an adaptive enterprise service system (AESS) toolkit. This toolkit provides a set of tools for facilitating the technology-enabled enterprise transformation in the modern context. The overall aim of this toolkit (Gill 2013) is to support the assessment and adoption of emerging technologies (e.g. cloud, social media) for enterprise transformation or adaptation. This toolkit includes a communication technology assessment tool (CTAT) to assist in the assessment of emerging social technologies from the five key perspectives: (1) capability, (2) quality, (3) constraint, (4) risk, and (5) business value. The CTAT has been developed by using the design research (DR) method (Hevner et al. 2004). In the development phase of the DR research method, the construct of the CTAT was developed based on the analysis of the recent literature and face-to-face qualitative interviews of forty senior developers. The CTAT construct was then reported in (Gill and Bunker 2013). In the evaluation phase of the DR method, the consolidated final version of the CTAT is evaluated in detail by using it in the assessment of three well-known social communication tools: HipChat, Skype and Chatter. This paper presents the evaluation results of the CTAT.

This paper is organized as follows. Firstly, it provides the research context. Secondly, it provides an overview of the research method. Thirdly, it summarizes the consolidated final version of the CTAT based on Gill and Bunker (2013). Fourthly, it presents the CTAT evaluation results. Finally, it discusses the research results, limitations, contributions, and future research endeavors.

2. RESEARCH CONTEXT

DADE is a multi-dimensional social system, which can be supported by emerging social communication technologies. DADE organizations need to assess these emerging social technologies for making informed social technology adoption strategies and decisions. In order to address this emerging need, the novel construct of the CTAT (Gill and Bunker 2013) has been developed as a part of the larger AESS toolkit (Assessment - Figure 1). The CTAT can be used for the assessment of social tools for a specific DADE. The AESS toolkit builds on the extensive multi-disciplinary action-design research in the well-known disciplines of enterprise requirements, strategy, architecture, service, and project management. The AESS toolkit provides a number of tools to assist in the assessment, establishment, management, and transformation of a DADE. The AESS toolkit uses the system of systems (Maier 1998), agility (Qumer and Henderson-Sellers 2008a, b), and service science (Spohrer and Kwan 2009) theories to describe the modern DADE as an "adaptive enterprise service system" (Gill 2013).

The AESS toolkit has two main layers: (see Figure 1) inner layer and outer layer. The inner layer assists in defining, operating, managing and supporting the complex DADE. The defining capability defines the DADE architecture context and vision. The operating capability describes the DADE in terms of its interaction architecture, business architecture, information architecture, social architecture, IT architecture and facility architecture. The managing capability is a set of integrated capabilities (e.g.

Figure 1. The adaptive enterprise service system toolkit – context diagram (Gill 2013)
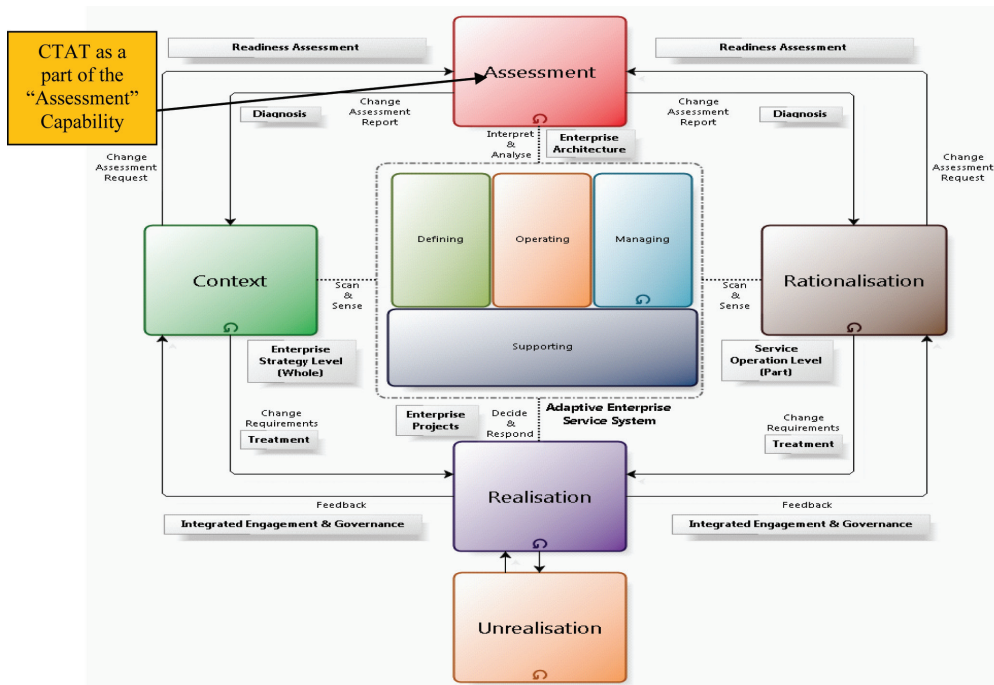
enterprise strategy, architecture, project, service and requirements management) for managing the DADE. The supporting capability is a set of integrated capabilities (e.g. enterprise operating model, supply chain, intelligence, asset library, and method engineering) for supporting the other DADE capabilities. The outer layer presents the five adapting capabilities (e.g. context awareness, assessment, rationalization, realization, and unrealisation) to guide the continuous adaptation of the DADE in response to internal and external changes. The outer layer enables the DADE adaptation through the assessment and adoption of emerging technologies. This paper is focused on the assessment capability of the AESS toolkit, which includes the CTAT. The detailed discussion of the AESS toolkit is beyond the scope of this paper. However, a detailed description of the AESS toolkit can be found in (Gill 2012; Gill 2013).

The CTAT, as a part of the assessment capability of the AESS toolkit (see Figure 1),

provides a practical support for assessing the emerging social communication and collaboration technologies from capability, constraint, quality, risk, and business value perspectives. The context capability scans and senses changes (e.g. emerging social technologies) through human and non-human agents (e.g. market research reports, trends). It then sends a change assessment request to the assessment capability (e.g. a request to assess the social technology within the context of DADE). The assessment capability assesses the changes (e.g. social technologies) in the context of DADE by using the CTAT. The assessment capability then sends the communication technology assessment report to the context capability. The assessment report results may trigger rationalization (e.g. identify the individual business area or service where social communication technology would be appropriate to adopt) and realization capabilities (e.g. proceed with the actual adoption of the social technology). The

realization capability may trigger the creation of new projects or programme of works for managing the adoption of social technology. The assessment report results may also trigger unrealisation capability, which may defer the social communication technology adoption opportunity for the time being.

The CTAT has been developed based on the extensive literature review and qualitative empirical study involving forty senior developers from thirty one Australian organizations (Gill and Bunker 2013). The CTAT, as a part of the AESS toolkit (Figure 1 – Context Diagram), provides an assessment index to assist in the assessment of social technologies in the DADE context. The scope of this paper is limited to the evaluation of the CTAT construct.

3. RESEARCH METHOD

The CTAT has been developed by using the design research (DR) paradigm (Hevner et al. 2004). DR is an appropriate approach to developing and evaluating the novel artefacts. It has been suggested (Peffers et al. 2006) that DR approach is a way to link research and practice. DR, as a constructive research process, assists in the development and evaluation of the novel artefacts. We can classify an artefact as a construct, model, method or instantiation (March and Smith 1995; Hevner et al. 2004). A construct is a conceptual expression of a problem. A model describes the relationships between the constructs. A method is a kind of an algorithm or a set of practices. Instantiation refers to the realization of an artifact in a particular environment or real context. According to the philosophy of technology (Tondl 1974), an artifact can be classified as a tool, machine or automation. A tool is an artifact where a human is a source of energy and control. A machine is an artifact where a human is a source of control. An automaton is an artifact where both a human and artifact share the control. The scope of this study was to develop and evaluate the CTAT. The CTAT is classified as a "Tool" artifact according to the philosophy of technology (Tondl 1974). Therefore, a DR

method was found to be appropriate and was applied to this research to develop the CTAT artifact. The development and evaluation of an artefact are complex processes and include a number of stages (Osterle et al. 2010). The following six DR process steps were adopted (Peffers et al. 2006) for the development and evaluation of the CTAT.

- **Step 1:** Identified the research problem and motivation based on the initial literature review;
- **Step 2:** Identified the research objectives;
- **Step 3:** Developed the initial conceptual construct of the CTAT based on the literature analysis;
- **Step 4:** Developed the CTAT based on the qualitative empirical study and published in Gill and Bunker (2013);
- **Step 5:** Consolidated the CTAT construct; and
- **Step 6:** Evaluated the CTAT construct by using it in assessing the emerging social communication technologies.

Firstly, based on the initial literature review, the research problem and motivation were identified (Step 1). Secondly, the objectives of the proposed solution CTAT were identified (Step 2). Thirdly, based on the review of the existing literature, initial communication technology assessment areas (categories), assessment factors (sub-categories), and their relationships were identified and labeled e.g. development of the initial conceptual construct of the CTAT (Step 3). Fourthly, these identified initial assessment areas (categories) and assessment factors (sub-categories) of the CTAT were used as a lens to obtain feedback from forty senior developers from Australia via face-to-face open-ended qualitative interviews. These forty senior developers' interviews were analyzed by using the qualitative analysis aspects of the grounded theory approach (Glaser 1978). Finally, the CTAT has been developed based on the literature review and senior developers' interview results. The CTAT, as an output from the DR process, was then reported in Gill and Bunker

(2013). This paper focuses on the evaluation of the CTAT.

There are a number of mechanisms that can be used to evaluate the CTAT. One way to do is to evaluate the DR output from its usefulness perspective, which is appropriate for the tool type artifacts – such as CTAT. The usefulness of the developed artifact (e.g. CTAT) is the "degree to which an artifact contributes to the achievement of a results, at a level broader than the artifact itself; this measure is applicable to the tools" (Carvalho 2012). The ultimate objective of the CTAT usefulness test is to identify the gaps or omissions in the CTAT. Bucher et al. (2006) suggested a coverage analysis approach to identify the gaps in the artifact. This paper adopts the coverage analysis technique from The Open Group Architecture Framework (Harrison 2011) in order to identify the gaps in the CTAT. The CTAT coverage analysis test was performed by using it in assessing three well-known social communication and collaboration tools (e.g. HipChat, Skype and Chatter) in the DADE context. The coverage analysis test helped us in identifying whether the CTAT provides sufficient coverage or number of assessment categories and factors for assessing the communication technologies for a DADE. The CTAT description and evaluation results are reported in the following sections.

4. THE CTAT

As discussed earlier, the construct of the CTAT was developed based on the extensive literature review and qualitative empirical study (e.g. forty developers' interviews). The detailed literature review, interview study results, and the resultant CTAT construct have been discussed in detail in Gill and Bunker (2013). This section presents an overview of the five consolidated assessment areas (capability, quality, constraint, risk and business value) and underlying forty seven assessment factors of the CTAT construct based on Gill and Bunker (2013) (see Tables 1-5).

The capability assessment area (Venkatesh and Davis 1996; Denis and Valacich 1999;

Wiredu 2005; Ambler 2009; Gill and Bunker 2013) refers to the social technology features (functional aspects) that may support DADE communication and collaboration. This assessment area contains twenty five consolidated assessment factors (see Table 1). These factors can be used for performing the vendor independent assessment of a particular social technology capability for a specific DADE communication and collaboration context. Organizations may add additional capability assessment factors suitable to their local context.

The quality assessment area (Venkatesh and Davis 1996; DeLone and McLean 2002; Wiredu 2005; Ambler 2009; Gill and Bunker 2013) refers to the quality (non-functional) aspects of the social technologies. This assessment area contains seven key assessment factors (see Table 2). These factors can be used for assessing the quality of a specific social technology for a specific DADE communication context. Organizations may include additional quality assessment factors suitable to their local context.

The constraint assessment area (Daft and Lengel 1986; Wiredu 2005; Gill and Bunker 2013) refers to the social technology specific restrictions in the context of a DADE. The constrain assessment area contains two assessment factors (see Table 3). These factors can be used for assessing the constraints of a specific social technology for a specific DADE communication context. Organizations may add additional constraint assessment factors suitable to their local context.

The risk assessment area (Herbsleb and Moitra 2001; Ralyte et al. 2008; Persson et al. 2009; Gill and Bunker 2013) refers to the social technology specific risks in the context of a DADE. The risk assessment area contains only one key risk assessment factor (see Table 4) that can be used along with other traditional assessment factors for assessing the risk of losing communication and information when using a specific social technology for a specific DADE communication context. Organizations may add additional risk related assessment factors suitable to their local context.

Table 1. Capability assessment factors

Ref.	Capability	Description
1	Record Formal Communication	Does it support capturing formal communication (e.g. files or documents, links, records)?
2	Record informal Communication	Does it support recording informal communication (e.g. conversation)?
3	Manage Communication Templates	Does it support communication template management (e.g. email templates)?
4	Support Communication Version Control	Does it support managing the different versions of the communication artefacts in a distributed development environment (e.g. check in and checkout files with different versions)?
5	View Prior Recorded Communication	Does it support viewing the communication history (e.g. view the recorded communication)?
6	Coordinate Communication	Does it allow managers or team leads to coordinate communication, which is required to guide the discussions in a group of geographically distributed developers (e.g. groups)?
7	Facilitate Project Monitoring	Does it support project monitoring (e.g. monitor team communication and tasks)?
8	Facilitate Project Management	Does it support project management (e.g. manage team communication and tasks)?
9	Find Developers for Collaboration	Does it support finding the developers for a potential collaboration (e.g. locate developer with specific skills)?
10	Support Searching	Does it support searching things of interest (e.g. file, group)?
11	Support Communication Traceability	Does it support communication history tracking (e.g. book marks, trace communication attached to file or record or people)?
12	Support Information Sharing	Does it support information sharing (e.g. link, file sharing within group, profile)?
13	Support Communication Structuring	Does it support communication structuring (categories, index and cross-link)?
14	Manage Communication Workflow	Does it support communication workflow management (e.g. set notifications)?
15	Generate Automatic Follow Up Communication	Does it support automatic follow up communication (e.g. automated time based communication workflow)?
16	Follow Communication	Does it support following the communication items and people (e.g. follow developer, follow records, and follow groups)?
17	Enable Communication Governance	Does it support communication governance process?
18	Manage Communication Group	Does it support creating and managing the communication groups? (e.g. private groups, public groups)?
19	Enable Interactive Modelling	Does it support real-time interactive modelling? (e.g. data model)?
20	Manage Changes to Communication Artefacts	Does it support real-time change management of communication artefacts? (e.g. different version of the data model)?
21	Support Integration	Does it support integration with project knowledgebase and development environment?
22	Support Multimode	Does it support multiple usage modes (e.g. desktop, online)?
23	Support Multichannel	Does it support multichannel communication needs?
24	Manage Access Control	Does it support managing access to shared communication?
25	Manage Backup	Does it support taking communication data backups?

The business value assessment area (Davis 1989; Green et. al 2010; Gill and Bunker 2013) refers to the value contribution that can be expected from a specific social technology in the context of DADE communication and collaboration. The business value assessment area contains twelve key assessment factors (see Table 5). These factors can be used for assessing the value contribution of a specific social technology for achieving the DADE communication and collaboration strategic goals. This draws our attention to the DADE and social

Table 2. Quality assessment factors

Ref.	Quality	Description
1	Reliable	Is it reliable?
2	Simple	Is it simple?
3	Easy	Is it easy to use?
4	Scalable	Is it saleable for managing different sizes of projects and teams?
5	Secure	Does it support secure communication?
6	Real-time	Does it support real-time communication?
7	Interoperability	Does it support communication interoperability via standardization?

Table 3. Constraint assessment factors

Ref.	Constraint	Description
1	Capacity	What are its constraints related to its capacity to support multiple communication cues (e.g. body language, voice tone, inflection, natural language)?
2	Affordance	Could it be used in multiple ways to allow an individual or teams to effectively communicate (e.g. usability constraint)?

Table 4. Risk assessment factor

Ref.	Risk	Description
1	Loss of Communication	What is the risk of losing communication and information?

Table 5. Business value assessment factor

Ref.	Value	Description
1	Save Time	Does it help saving time?
2	Reduced Effort	Does it help reducing unnecessary efforts?
3	Reduce Documentation	Does it support avoiding unnecessary documentation?
4	Reduced Risks	Does it support reducing communication risks?
5	Prove Quality of Work	Does it support proving the quality of work (e.g. communication as an evidence for testifying the work i.e. file shared, edited, and viewed)?
6	Resolve Conflicts	Does it support resolving conflicts?
7	Improve Time to Market	Does it support improving the service or product time to market?
8	Enhance Coordination	Does it support enhancing effective coordination?
9	Enhance Knowledge Sharing	Does it support enhancing knowledge sharing?
10	Reduce Ambiguity	Does it support reducing communication ambiguity?
11	Single Source of Truth	Does it support providing a single source of truth?
12	Train Newly Inducted Staff Members	Does it support training a newly inducted staff members through the use of prior communication logs?

technology alignment concept. Organizations may add additional business value related assessment factors suitable to their local context.

This research would continue to investigate and extend the identified list of assessment areas and factors. The CTAT evaluation, which is presented within this paper, would help us to identify the new assessment categories and factors for the CTAT. The five key assessment areas (categories) and forty-seven assessment factors (sub-categories) have been configured into a CTAT assessment index. The CTAT assessment index has been implemented as a software application by using the force. com cloud application development platform (Salesforce 2008). This software has been developed to provide a practical software tool based support and contribution to industry (see Figures 2 and 3). Figure 2 describes the overall architecture of the CTAT software. The CTAT architecture has four main components: user interface, assessment processor and repository (information and metadata objects management) (see Figure 2). The CTAT user interface can be accessed by developers via the Internet browser for performing the assessment of a particular communication technology for a DADE. The assessment processor component of the CTAT contains assessment logic. The actual assessment instances and related assessment information are stored and managed in the assessment repository.

Figure 3 shows the key user interface components of the CTAT software that implement the CTAT software architecture (see Figure 2). The technology tab of the software is used to capture the information about social technologies. The assessment index tab of the CTAT is used to manage the list of assessment areas and related factors (see Tables 1-5). The actual assessment instances are initiated via the assessment tab. The assessment tab allows capturing assessment instance details for each social technology by using the assessment categories and factors from the assessment index. The social technology assessment information can be shared with other developers working in geographically dispersed locations via a web browser. The purpose of this paper is to present the evaluation of the CTAT assessment categories and factors (main novel contribution of this research) contrary to evaluating the CTAT software prototype. The CTAT software has been deployed in force.com platform and can only be accessed via provided user login name and password. The next section discusses the CTAT evaluation.

5. THE CTAT EVALUATION

Three well-known social or communication technologies HipChat, Skype and Chatter were selected for the CTAT evaluation purpose. The information about these tools, published in the public domain, was used as an input in the CTAT evaluation process. The CTAT assessment categories and factors were used as a test criteria to assess HipChat, Skype and Chatter social technologies in the DADE context. The main objective of this evaluation was to understand the practical applicability of the research-based CTAT assessment categories and factors, and identify any gaps in contrast to suggesting and promoting one commercial social communication tool over others. The users of the CTAT should make their own judgment when assessing and selecting these social tools. This section provides an overview of the HipChat, Skype and Chatter social technologies followed by their assessment results in Tables 6-10.

5.1. HipChat

HipChat (2012) is a business-purpose social computing tool that can be used to support DADE communication and collaboration needs. It provides instant messaging capability for supporting real-time text, voice and video communication among the developers working in the DADE. It can be installed as a local desktop application. It can also be accessed via an Internet browser. It is also accessible on a smart mobile device (e.g. iPhone, iPad, Android) to enable communication anytime and anywhere
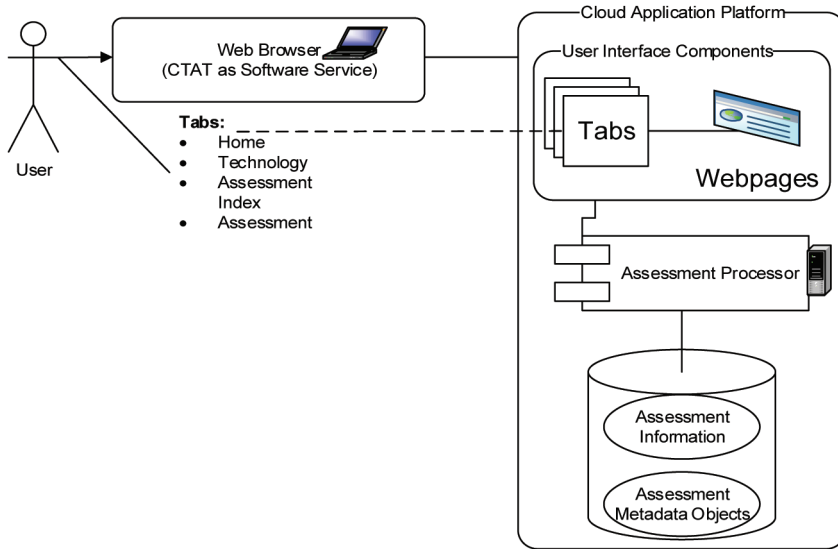
Figure 2. The CTAT software architecture

Figure 3. The CTAT software interface components

where the mobile service is available. The key features of the HipChat are: group messaging, one-to-one messaging, SSL encrypted messages, APIs and integration, email alerts, SMS notifications, guest, private and public-access mode, file sharing and storage, chat and file history management, emotion and spell checking.

5.2. Skype

Skype (2012) is a well-known social computing tool that can be used for enabling communication and collaboration among developers working in the DADE. Skype seems to support text, voice and video communication through

Table 6. Application of the capability assessment

Ref.	Capability	HipChat	Skype	Chatter
1	Record Formal Communication	C	C	C
2	Record Informal Communication	C	C	C
3	Manage Communication Templates	G	G	G
4	Support Communication Version Control	G	G	G
5	View Prior Recorded Communication	C	C	C
6	Coordinate Communication	C	C	C
7	Facilitate Project Monitoring	C	C	C
8	Facilitate Project Management	C	C	C
9	Find Developers for Collaboration	C	G	C
10	Support Searching	C	C	C
11	Support Communication Traceability	C	C	C
12	Support Information Sharing	C	C	C
13	Support Communication Structuring	G	G	G
14	Manage Communication Workflow	C	G	C
15	Generate Automatic Follow Up Communication	G	G	G
16	Follow Communication	C	G	C
17	Enable Communication Governance	C	C	C
18	Manage Communication Group	C	C	C
19	Enable Interactive Modelling	G	G	G
20	Manage Changes to Communication Artefacts	G	G	G
21	Support Integration	C	G	C
22	Support Multimode	C	C	C
23	Support Multichannel	C	C	C
24	Manage Access Control	C	C	C
25	Manage Backup	C	C	C
26	**New – Support Customisation (N)**	**G**	**G**	**C**
27	**New – Enable Activity Feed Tracking (N)**	**G**	**G**	**C**
28	**New – Enable Social Profiling (N)**	**C**	**C**	**C**
30	**New – Provide Recommendations (N)**	**G**	**G**	**C**

Table 7. Application of the quality assessment

Ref.	Quality	HipChat	Skype	Chatter
1	Reliable	C	C	C
2	Simple	C	C	C
3	Easy	C	C	C
4	Scalable	C	C	C
5	Secure	C	C	1
6	Real-time	C	C	C
7	Interoperability	C	G	C
8	**New – Support Business (N)**	**C**	**G**	**C**

Table 8. Application of the constraint assessment

Ref.	Constraint	HipChat	Skype	Chatter
1	Capacity	C	C	C
2	Affordance	C	C	C

Table 9. Application of the risk assessment

Ref.	Risk	HipChat	Skype	Chatter
1	Loss of Communication	C	C	C

Table 10. Application of the business value assessment

Ref.	Business Value	HipChat	Skype	Chatter
1	Save Time	C	C	C
2	Reduced Effort	C	C	C
3	Reduce Documentation	C	C	C
4	Reduced Risks	C	C	C
5	Prove Quality of Work	C	C	C
6	Resolve Conflicts	C	C	C
7	Improve Time to Market	C	C	C
8	Enhance Coordination	C	C	C
9	Enhance Knowledge Sharing	C	C	C
10	Reduce Ambiguity	C	C	C
11	Single Source of Truth	G	G	G
12	Train Newly Inducted Staff Members	G	G	G
13	**New – Enhance Customer Relationship**	**C**	**C**	**C**
14	**New – Enhance Staff Relationship**	**C**	**C**	**C**
15	**New - No Server Maintenance**	**C**	**C**	**C**
16	**New – Affordable**	**C**	**C**	**C**

the Internet. It can be installed as an application running on the local desktop, mobile device and TV. The key features of the Skype are: peer-to-peer individual and group (e.g. conference call) calling to computer (e.g. installed with Skype), land line and mobile devices. It can be used through Wifi. It can be used to send SMS messages and forward calls. It can be used to share screens during video and voice commu- nication. It can also be used to send and receive files. Essentially, it is a soft phone that enables communication over the Internet and follows the pay-per-use pricing model. The quality of communication largely depends on the Internet bandwidth both at the communication sender and receiver ends. The low Internet bandwidth would result in the poor Skype communication quality. Skype claims to support communica-

tion among developers working in the DADE. Skype, unlike HipChat, was originally designed for mainly personal level communication.

5.3. Chatter

Chatter (2012) supports communication among developers working in the DADE. Chatter is a cloud-based social platform that has been developed by Force.com (Salesforce 2008). It has been built on and integrated into the Force.com software as a service application development platform. Chatter allows developers to communicate and collaborate while developing, testing and deploying software systems in the DADE. The key features of the Chatter are: share personal information, task-related information, real-time data feeds, public or private individual or group communication management, resource sharing, and workflow notifications. It can be configured to help developers to find other developers with certain skills in the DADE. It also has Chatter administrator to fully control, track and customize it to the needs of a specific DADE.

5.4. Evaluation

The following sub-sections present the evaluation results of the CTAT by using it in the assessment of the HipChat, Skype and Chatter communication and collaboration tools (see Tables 6-10). The gap analysis technique (for the purpose of CTAT coverage analysis) was adopted from The Open Group Architecture Framework (TOGAF) (Harrison 2011) to evaluate and identify the gaps in the CTAT. If a specific social technology complies to the specific assessment factor listed in the CTAT, then the factor compliance cell would be marked as "C" ("C" represents coverage) otherwise it would be marked as "G" ("G" represents a gap in the social technology under study). For example, the "Manage Communication Template" feature (see assessment factor under the capability assessment category – Table 6) is not supported by the HipChat. Therefore, "G" is assigned in the relevant HipChat cell, whereas HipChat seems to support the "Record Formal

and Informal Communication" feature, therefore, "C" is assigned in the relevant HipChat cell. Please note that "G" denotes the gap in the social technology instead of a gap in the CTAT. If a particular technology supports a specific feature (e.g. Support Customisation), and there is no such corresponding assessment factor in the CTAT list to assess that feature, then a "New – Assessment Factor Name" is placed in the CTAT's assessment factors list and is marked as "N" ("N" represents new). "N" denotes the gap in the CTAT coverage. Here, the main objective of this evaluation was to determine whether the assessment categories and factors listed in the theoretical CTAT construct provide sufficient coverage and make sense and are "fit for purpose". Here "sufficient" and "fit for purpose" means that the CTAT should provide at least 75% or more test coverage. Here, the test coverage measures the number of assessment factors provided by the CTAT for evaluating the social technologies under consideration. Please see Tables 6-10 for the evaluation details.

5.4.1. Capability Assessment

The capability assessment category contains twenty-five assessment factors. These factors were used as an analytical lens to review HipChat, Skype and Chatter. The capability assessment results indicate that these twenty-five assessment factors provided the essential capability test criteria for facilitating the assessment of these three communication tools within the context of DADE. However, during the CTAT evaluation, additional five assessment factors were found that were not present in the original CTAT construct, however, they were supported by the relevant social communication technologies. These additional five assessment factors are highlighted in bold and marked as "N" in Table 6. It can be observed from this analysis (see Table 6) that the capability assessment factors provided approx. 83% test coverage (25 assessment factors out of 30) and shows that it is of an acceptable quality and "fit for purpose". The results from this evaluation are summarized below.

5.4.2. Quality Assessment

The quality assessment category contains seven assessment factors that were used as a lens to review HipChat, Skype and Chatter. The quality assessment results indicate that these seven assessment factors provided the essential quality test criteria for facilitating the assessment of these three communication tools within the context of DADE. However, during the CTAT evaluation, an additional assessment factor was found. This factors was not present in the original CTAT construct, however, it was supported by the relevant social communication technologies. This additional assessment factor is highlighted in bold in Table 7. It can be observed from the analysis (see Table 7) that the quality assessment factors provided approx. 87% test coverage (7 out of 8) and is of an acceptable quality and "fit for purpose". The results from this evaluation are summarized below.

5.4.3. Constraint and Risk Assessment

The constraint and risk assessment categories contain two and one key assessment factors, respectively. These assessment factors were used as a lens to review HipChat, Skype and Chatter. The constraint and risk assessment results indicate that these assessment factors provided the essential test criteria for facilitating the assessment of these three communication tools within the context of DADE. Surprisingly, no new factor was found during this assessment. It can be observed from the analysis (see Tables 8 and 9) that these assessment factors provided 100% test coverage and is of an acceptable quality and "fit for purpose". The results from this evaluation are summarized below.

5.4.4. Business Value Assessment

The business value assessment category contains twelve assessment factors that were used as a lens to review HipChat, Skype and Chatter. The business value assessment results indicate that these twelve assessment factors provided the essential business value test criteria for facilitating the assessment of these three communication tools within the context of DADE. However, during the CTAT evaluation, additional four assessment factors were found. These additional assessment factors were not present in the original CTAT construct, however, they were supported by the relevant social communication technologies. These additional four assessment factors are highlighted in bold in Table 10. It can be observed from the analysis (see Table 10) that the business value assessment category provided approx. 75% test coverage (12 out of 16) and is of an acceptable quality and "fit for purpose". The results from this evaluation are summarized below.

6. DISCUSSION

This section discusses the CTAT evaluation results, limitations, practical and theoretical implications.

6.1. Evaluation Results and Limitations

The original construct of the CTAT offered an index of five assessment categories and forty seven embedded assessment factors. The CTAT evaluation uncovered additional ten assessment factors that were not available in the original CTAT construct. These new factors were supported by the relevant social communication technologies (see Tables 6, 7 and 10). These additional ten assessment factors are highlighted in bold in Table 11. It can be observed from the overall analysis (see Table 11) that the CTAT provided approx. 82% test coverage (47 assessment factors out of 57). Since the overall evaluation score is 75% or more, therefore, it can be suggested that the CTAT is of an acceptable quality and "fit for purpose". Further, the future evaluations of the CTAT may uncover additional assessment factors, which is impeccably appropriate as it is an evolving construct and needs to be revised based on future studies. Organizations may consider adding additional assessment categories and factors suitable to their local context. The identified additional ten assessment factors are added to the updated

CTAT construct. The CTAT construct builds on both the theory (e.g. literature review) and practice (e.g. forty developers' feedback). The assessment of the dynamic social communication technology is not an easy task. The CTAT needs to be considered with a view of its limitations, since the body of literature and practices are both dynamic in nature, and it should thus be considered an on-going work to be updated by developers and future research studies. The CTAT construct does not claim to provide an exhaustive list index of assessment categories and factors. Developers may tailor, extend this tool and include additional assessment categories and factors according the specific context.

6.2. Practical Implications

This section provides a step-by-step practical process illustrating how the CTAT assessment categories and factors could be used by the developers to assess a communication technology for a particular DADE context.

6.2.1. Step 1: Select Candidate Communication Technology

As noted earlier, there are a number of communication technologies (e.g. HipChat, Chatter) to choose from. This step is focused on selecting the communication technologies that need to be assessed in the DADE context. A developer may assess each selected communication technology by using the CTAT and then compare the results to make an informed decision about

their adoption or de-adoption. For example, a developer may choose to first assess the Hip-Chat or Skype. However, prior to proceed with the assessment, a developer needs to tailor and prioritize the CTAT assessment categories and underlying factors according to the context in hand (see steps 2-5).

6.2.2. Step 2: Identify Business Value Factors

It is important to develop a prioritized list of desired business value assessment factors, which will be used to assess the to-be-adopted communication technology. The CTAT provides the business value assessment category that includes sixteen assessment factors (see Table 10). The CTAT business value assessment component or category does not claim to provide an exhaustive list of business value factors. A developer or practitioner may tailor and include additional business value assessment factors suitable to the local context. It is not practical to assume that all the sixteen business value assessment factors will be having the equal priority or importance. Therefore, a developer needs to assign a priority to each business value assessment factor (e.g. very high, high, medium, low, and very low). The output of the first step is a tailored and prioritized list of business value assessment factors that can be used for the assessment of the to-be-adopted communication technology from the business value perspective.

Table 11. Result summary

Ref.	Category	Number of Factors in Original CTAT Construct	New Factors Identified During CTAT Evaluation	Total	CTAT Coverage %
1	Capability	25	**5**	30	25/30 = 83%
2	Quality	7	**1**	8	7/8 = 87%
3	Constraint	2	**0**	2	2/2/ = 100%
4	Risk	1	**0**	1	1/1 = 100%
5	Business Value	12	**4**	16	12/16 = 75%
	Overall	47	**10**	57	47/ 57 = 82%

6.2.3. Step 3: Identify Capability Factors

This step focuses on developing a prioritized list of desired capability assessment factors, which will be used to assess the to-be-adopted communication technology. The CTAT provides the capability assessment category that includes thirty capability assessment factors (see Table 6). The CTAT capability assessment component or category does not claim to provide an exhaustive list of communication technology capability assessment factors. A developer may tailor and include additional capability assessment factors suitable to the local context. Similar to step 2, it is not practical to assume that all the thirty assessment factors will be having the equal priority or importance. Therefore, a developer needs to assign a priority value to each capability assessment factor (e.g. very high, high, medium, low, and very low). The output of this step is a tailored and prioritized list of capability assessment factors that can be used for the assessment of the to-be-adopted communication technology from the capability perspective.

6.2.4. Step 4: Identify Quality Factors

The previous step focused on developing the capability or functional feature assessment factors. This step focuses on identifying a prioritized list of quality assessment factors, which will be used to assess the to-be-adopted communication technology. The CTAT provides the quality assessment category that includes eight quality assessment factors (see Table 7). The CTAT quality assessment component or category does not claim to provide an exhaustive list of communication technology quality assessment factors. A developer may tailor and include additional quality assessment factors. Similar to steps 2 and 3, a developer needs to assign a priority value to each quality assessment factor (e.g. very high, high, medium, low, and very low). The output of this step is a tailored and prioritized list of quality assessment factors that can be used for the assessment of

the to-be-adopted communication technology from the quality perspective.

6.2.5. Step 5: Identify Constraint and Risk Factors

The CTAT provides a set of communication technology constraint and risk assessment factors (see Tables 8 and 9). The CTAT does not claim to provide an exhaustive list of constraint and risk assessment factors. A developer may tailor and include additional assessment factors. Similarly, a developer needs to assign a priority value to each constraint and risk assessment factor (e.g. very high, high, medium, low, and very low). The output of this step is a tailored and prioritized list of communication technology related constraint and risk assessment factors that can be used for the assessment of the to-be-adopted communication technology from the constrain and risk perspectives.

6.2.6. Step 6: Assess Communication Technology

Finally, a developer or practitioner may use the tailored and prioritized CTAT assessment categories, underlying factors and coverage analysis approach for assessing the to-be-adopted communication technology such as HipChat, Chatter, Skype etc. A developer can assess the compliance or coverage of each communication technology against the tailored and prioritized CTAT assessment categories and underlying factors (as illustrated in Tables 6-10). The coverage analysis results would show how strongly (high compliance instances) or weakly (low compliance instances) a communication technology compliances to the factors listed for each assessment category. As discussed earlier, a developer can also use the CTAT software to capture and share the assessment results or knowledge with other developers or teams located in the geographically dispersed locations (please see Figure 3). The CTAT and coverage analysis approach seem useful for evaluating the communication technologies (as explained here in this paper). The CTAT seems useful for providing the necessary vendor-independent test

criteria in terms of assessment factors for assessing a particular communication technology (as demonstrated in Tables 6-10) that claims to support DADE communication and collaboration among developers.

The main purpose of this paper was to demonstrate the applicability of the CTAT in contrast to making any recommendations about the use of some specific social technology such as HipChat, Skype or Chatter. These communication technologies were used as test cases for performing the evaluation of the CTAT construct. The assessment results of the technologies under study indicate that there is no single communication technology that may be sufficient to fulfill the DADE communication needs. It is suggested that developers may consider a combination of different communication technologies and tailor an active communication and collaboration workspace suitable to their local DADE context. The communication technology assessment results produced by the CTAT can be further used for developing a DADE communication strategy. The communication strategy will provide a holistic business oriented approach to the selection and use of a specific communication technology for a particular DADE context.

6.3. Theoretical Implications

Recent research initiatives, similar to the one presented within this paper, can be found in the context of social computing and distributed development literature (El-Goarany et al, 2008; Nguyen et al. 2008; Ruikar et al. 2009; Tamburri 2012). Ruikar et al. (2009) highlighted the communication delay related challenges of the distributed development environment. El-Goarany et al. (2008) described the social technologies as service networks to support the DADE communication needs. However, there is no such assessment tool that can be used to assess these social communication tools and validate this claim. Most recently, Tamburri (2012) proposed the development of the agile social structure requirements and tools to support communication in the DADE. The focus and contribution of our research are not

to develop a social tools to support the DADE communication but the focus is to develop a tool (such as that of CTAT) to support the assessment of these emerging social tools in the context of DADE communication needs. The CTAT was developed because there was no such tool available in the public domain when this research was first initiated.

The proposed CTAT construct has been compared with the well-known IS success model (Delone and MacLean 2003), and it has been found that the IS success model only seems to discuss the general quality (e.g. system quality, information quality and service quality) and net business benefit of the technology. It does not provide the specific assessment factor level details in the context of DADE communication technology assessment. However, we can propose to extend the IS success model of Delone and McLean (2003) with the CTAT assessment index, which contains specific social communication technology assessment categories with embedded assessment factors (see Figure 4). The extended IS success model (see Figure 4) and the CTAT assessment index can provide a necessary social communication technology assessment support, which is linked to the developer's intentions to use the social communication technology, actual social communication technology use, satisfaction (post social technology adoption assessment), and actual technology adoption benefit realization. The extended IS success model and the CTAT assessment index seem to work well and provides necessary details and practical communication technology assessment support. This possible merger of the IS success model and the CTAT will be further explored in our future research.

7. CONCLUSION

This paper presented the evaluation of the research-based practical CTAT by using it in the assessment of three well-known social communication tools: HipChat, Skype and Chatter. The CTAT evaluation, presented within this paper, is an attempt to link the research-based CTAT contribution to the practice. The CTAT

Figure 4. The CTAT assessment index embedded in the extended IS success model
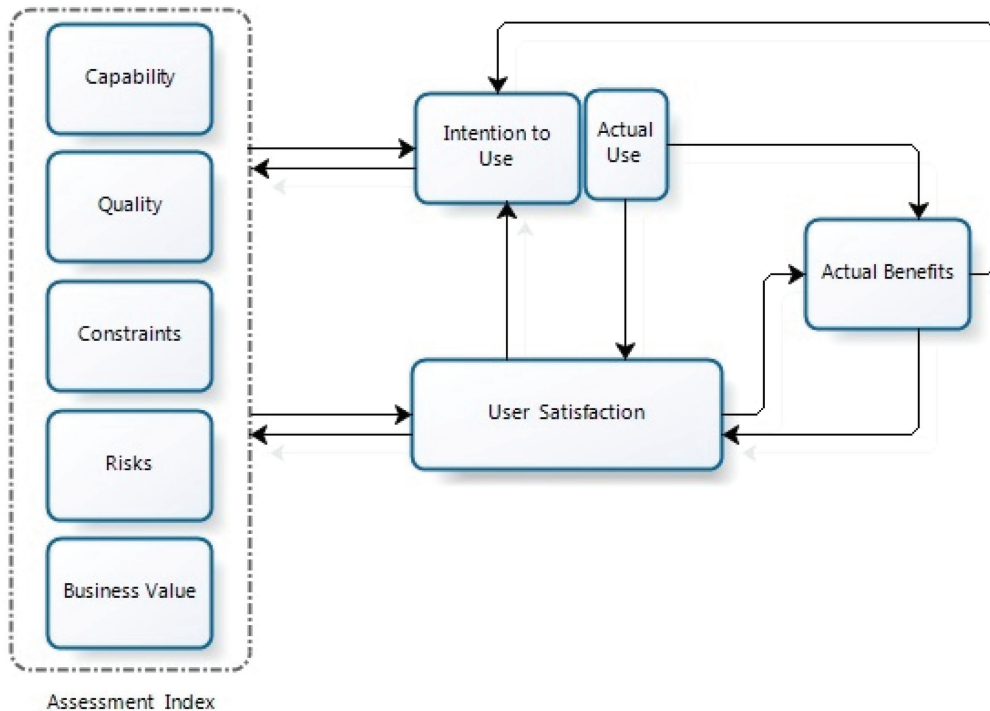
evaluation provides a number of new insights to both researchers and practitioners. The CTAT evaluation results indicate that it provides the necessary assessment categories and factors to practitioners for systematically assessing the to-be-adopted social communication technologies for the DADE. Further, it indicates that social communication tools under study differ in their scope, and a single tool may not fully support the DADE communication needs. Consequently, practitioners need to configure an integrated communication technology environment by combining a range of different communication technologies. The CTAT assessment categories and factors aim to reduce the practitioners' uncertainties about the social communication technology adoption. It provides a practical tool-based support and a coverage analysis approach to practitioners'. The practitioners can tailor CTAT for systematically assessing the complex and dynamic communication technologies for their local DADE context. In future, we intend to extend the CTAT research in the area of social technology enabled crowd sourcing for the complex agile software project and communication management.

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