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Understanding technology use in global virtual teams: Research methodologies and methods

Tony Clear, Stephen G. MacDonell *

SERL, School of Computing and Mathematical Sciences, AUT University, Private Bag 92006, Auckland 1142, New Zealand

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ABSTRACT

Context: The globalisation of activities associated with software development and use has introduced many challenges in practice, and also (therefore) many for research. While the predominant approach to research in software engineering has followed a positivist science model, this approach may be sub-optimal when addressing problems with a dominant social or cultural dimension, such as those frequently encountered when studying work practices in a globally distributed team setting.

The investigation of such a team reported in this paper provides one example of an alternative approach to research in a global context, through a longitudinal interpretive field study seeking to understand how global virtual teams mediated the use of technology. The study involved a large collective of faculty and support staff plus student members based in the geographically and temporally distant locations of New Zealand, the United States of America and Sweden.

Objective: Our focus in this paper is on the conduct of research in the context of global software activities, and in particular, as applied to the actions and interactions of global virtual teams. We consider the appropriateness of various methodologies and methods in enabling such issues to be addressed.

Method: We describe how we undertook a substantial field study of global virtual teams, and highlight how the adopted structuration theory, action research and grounded theory methodologies applied to the analysis of email data, enabled us to deliver effectively against our goals.

Results: We believe that the approach taken suited a research context in which situated practices were occurring over time in a highly complex domain, ensuring that our results were both strongly grounded and relevant to practice. It has resulted in the generation of substantive theory and techniques that have been adapted and applied on a pilot basis in further field settings.

Conclusion: We conclude that globally distributed teamwork presents a complex context which demands new research approaches, beyond the limited set customarily applied by software engineering researchers. We advocate experimenting with different research methodologies and methods so that we have a more rounded repertoire to address the most important and relevant issues in global software development research, with the forms of rigour that suit the chosen approach.

1. Introduction

The globalisation of activities related to the production and use of software systems – from helpdesk offshoring through virtual infrastructure support to remote outsourced application development – has produced many significant challenges, opening up fertile ground for those interested in how those challenges can be addressed effectively. Many research questions arise: What version control techniques work in a global development context? Can collaborative technologies enhance global development productivity? How do individuals and groups relate across multiple cultures? What impact do time and space have on activity co-ordination? How does leadership manifest itself in dispersed teams? What role does the mediation of technology-use play in global virtual teams?

Evident in these questions is significant breadth of issues to be addressed, ranging from the largely technical – regarding techniques and tools – to the principally social – concerning culture and leadership. If software globalisation is to succeed, then *all* such issues need attention. And it is not a matter of 'one size fits all' when it comes to how these issues might be investigated – while questions with a technical emphasis may lend themselves to

Abbreviations: AIT, advanced information technology; AST, adaptive structuration theory; AUT, Auckland University of Technology; CTF, collaborative technology fit; Env, Environmental; GSD, global software development; GVT, global virtual team; LT, Local team; SE, software engineering; TUM, technology-use mediation; TUMAST, technology-use mediated AST; UMEA, user-monitoring environment for activities.

* Corresponding author. Tel.: +64 9 921 9073; fax: +64 3 454 6903.
E-mail addresses: tony.clear@aut.ac.nz (T. Clear), stephen.macdonell@aut.ac.nz (S.G. MacDonell).

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quasi-experimental analysis, those that are more social in nature are likely to require a very different research approach.

Our focus in this paper, then, is on issues of research methodology and method in the context of global software activities, and in particular, as they apply to the actions and interactions of global virtual teams (GVTs). Prior work that has applied differing research approaches is presented in the next section, drawn from both software engineering (SE) and information systems literature. We then consider the appropriateness of various methodologies in terms of enabling researchers to tackle research goals and answer questions associated with the actions and interactions of GVTs – addressed in Section 3. We also direct our attention to the applicability of specific research methods in this context. A longitudinal interpretive field study is then reported in Section 4 to demonstrate in detail the approach that we used in seeking to understand how global virtual teams mediated the use of technology. The study involved a large collective of faculty and support staff plus student members based in the geographically and temporally distant locations of New Zealand, the United States of America and Sweden. Finally we draw conclusions from our work in Section 5 and provide pointers to further research questions.

2. Background and related work

In discussing approaches to assessing validity in the research process McGrath [36, p. 14] has suggested that research:

> *"involves (a) some content that is of interest (b) some ideas that give meaning to that content, and (c) some techniques or procedures by means of which those ideas and content can be studied".*

He terms these the substantive, conceptual and methodological domains, and then defines the research process as "the identification, selection, combination and use of the elements and relations from the substantive, conceptual and methodological domains." (p. 16). While there is much research related to global software development (GSD) in both the substantive and the conceptual domains, the focus in this paper is on the methodological domain, and relevant research approaches are reviewed below.

2.1. Research paradigms

The underlying assumptions upon which a researcher may conduct an enquiry can differ markedly and provide a foundation for very different styles of research. As Dittrich et al. [16] note, qualitative research "may come in many different flavours... be used under different epistemological paradigms, and with different theoretical underpinnings". One useful categorisation of research paradigms positions them within three distinct approaches [41], each based upon a distinctive worldview and perspective on the nature of knowledge. From these originate three quite distinctive perspectives on the conduct of scientific enquiry, which Habermas [28] has depicted in a framework of "knowledge interests" presented in Table 1.

If we regard a research paradigm as a mechanism through which a researcher can assert the validity of particular truth claims, then we can view these as three distinct forms of truth supported by differing scientific approaches. For each of these belief systems a different research paradigm exists – the traditional or "classical" science 'objective' paradigm, the social sciences 'interpretive' paradigm, and the critical sciences 'evaluative' paradigm. Each paradigm comes with its own strengths and weaknesses, and as a result is better suited to answering particular research questions.

2.2. Research methods in global software development

The study of global virtual teams and global software development has seen researchers contributing from differing traditions, with the software engineering and information systems disciplines contributing strongly to the extant literature. Software engineering has tended to favour the 'empirical-analytic' tradition of the natural sciences [2,33]. Such is the extent of the use of experimental methods in software engineering that a systematic review of quasi-experimentation in software engineering research was reported by Kampenes et al. [31]. Studies utilising these and similar natural science methods such as surveys were shown by Glass et al. to be predominant in software engineering in a review of work reported in 2002 [24]. Information systems researchers in contrast have moved towards a greater acceptance of research based upon the 'hermeneutic sciences', and the accompanying qualitative methods of the interpretive paradigm [34,39].

While there does appear to be a growing acceptance of qualitative methods in software engineering, as reported in a recent special issue on "qualitative software engineering research", very different approaches may be taken in the conduct of qualitative research:

> *Qualitative research with a positivistic underpinning might be the most accessible one from a traditional software engineering background: qualitative researchers, like quantitative researchers, may present their conclusions about the data as objective, truthful statements about the world* [16].

Thus the researchers' epistemological stance is important in the design and conduct of research. However, as Glass et al. [23] have noted, there has been a tendency in academia for the hard – the technical – to drive out the soft – the behavioural. The increasingly prevalent challenge in software engineering research, however, and in global software development research as an illustration of this, is that such an approach may be inadequate when it is impossible to separate the software from the technology and, in turn, from the system and its human actors, their beliefs and perceptions. When isolation of the software as fits a reductionist research model is neither feasible nor tolerable, yet we need to arrive at insights that are both useful and defendable, the challenge is to adopt and become comfortable with new research methods. For instance, in a study investigating how virtual teams created "shared meaning" [6], the authors applied an "interpretive case study methodology", arguing that:

> *This methodology is appropriate because it focuses on the complexity of human sense-making in emerging situations and attempts to understand the phenomenon through the meanings that participants assign to actions and situations.*

In a later study building upon the work of Glass et al. [24], Segal et al. [47] classified the "research approach" of 46% of studies in the

Table 1
The knowledge constituted interests of Habermas [28].

Interest	Knowledge	Medium	Science
Technical	Instrumental (causal explanation)	Work	Empirical-analytic or natural sciences
Practical	Practical (understanding)	Language	Hermeneutic or 'interpretive' sciences
Emancipatory	Emancipatory (reflection)	Power	Critical sciences