Research Article

Enhancing Team Performance Through Tool Use: How Critical Technology-Related Issues Influence the Performance of Virtual Project Teams

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Abstract—Research problem: The project management of virtual teams differs from that of traditional ones. Traditional project risks, such as complexity, the uncertainty of factors influencing the project, and the high interdependency of project tasks must be managed alongside changed temporal, geographic, and cultural dimensions. Only a few studies have investigated the effect of critical technological issues, such as wrong tool selection or limited internet access on performance as well as team and team member satisfaction in virtual work settings. Research questions: How do critical technology-related issues concerning the selection and use of web-based tools influence the performance and satisfaction of virtual project teams? Literature review: Instead of categorizing virtual teams as a type of team that contrasts with traditional or face-to-face teams, the focus has shifted to virtualness as a characteristic present in all teams. Project teamwork is often integrated in university degree programs in order to prepare students appropriately for real-life projects. While these student teams are often not geographically spread across countries, they have a high degree of virtualness because of their diverse team composition, the necessity for working at different places, and the limited face-to-face meeting opportunities. Performance, effectiveness, and satisfaction are central issues in the evaluation and measurement of project teams: Team performance is often evaluated on the basis of acceptance of a specified output by a customer. Through specific mediating processes, team performance can alternatively be assessed by inquiring the team’s perception on their performance. Effectiveness can be defined as the achievement of clear goals and objectives and it is often related to the team’s performance. Finally, satisfaction can be defined as having three dimensions—satisfaction with the team, the satisfaction of meeting customer needs, and general satisfaction with extrinsic rewards and work. Technology use is substantial for distributed teamwork and can be assessed by the extent to which it supports communication, collaboration, and project-management tasks. Methodology: Fifteen teams were observed and interviewed over a two-year period. The resulting data were analyzed using a Grounded Theory approach, which revealed how the selection and use of tools for communication, collaboration, and project management in the different project activities influenced the team’s performance. Results and conclusions: Our results contribute to practice by providing a number of guidelines for the management of virtual teams as well as knowledge required by companies wishing to launch projects with virtual teams. Differing performances of teams can, in many cases, be attributed to such conditions as: internet availability and bandwidth; lack of training for certain tools; the selection and appropriate use of tools; integrated tool support for task management; as well as the promotion of transparency about progress made. It was found that restrictions in internet access of even a single member within a team limited the team’s technological choices, which affected the team’s performance.

Index Terms—Communication, internet, performance, project management, teams, tools, virtual teams.

In recent years, numerous researchers have investigated the factors influencing the success of virtual teams [1]–[4]. Little has been done to understand the alignment of technology with the specific project requirements and team characteristics to improve the team’s effectiveness, the team members’ satisfaction, and team performance [5]. Increased risk levels [6] and media richness [7] have been cited as factors influencing the success of virtual teams. Reduced efficiency of communication leads to decreased trust and commitment within the group which, in turn, increases transaction costs and the time taken to complete the project [8]. It also results in reduced quality of deliverables and reduced satisfaction of the team members. The five-trigger model for team leader interventions in virtual teams identifies inadequate information and communication technology (ICT) as one trigger for intervention [9]. According to Bjørn and Ngwenyama [5], technology mediation is a central theme when investigating virtual teams and it is one that so far has not been sufficiently considered in research. In addition, new web-based project-management tools coming
onto the market are likely to have a strong impact on project-management processes, especially in virtual teams. This paper investigates the critical technology-related issues that influence team performance and team members’ satisfaction of virtual project teams in an attempt to answer the following research questions:

**Q1.** How does the selection and use of tools for communication, collaboration, and project management influence a virtual team’s performance in a project?

**Q2.** How does the selection and use of tools for communication, collaboration and project management influence a virtual team’s and team member’s satisfaction in a project?

**Q3.** How do critical technical issues influence the selection and use of tools for communication, collaboration and project management and how do they affect team performance?

**Q4.** How do critical technical issues influence the selection and use of tools for communication, collaboration and project management and affect team and team member satisfaction?

**Q5.** How does the context of project, team and team member in the selection and use of tools for communication, collaboration and project management influence team performance and team and team members’ satisfaction?

The fieldwork was conducted using multiple methods, including participant observation, assessment of team project outcomes, questionnaires, and interviews.

This paper is organized as follows. In the literature review, the theoretical orientation of the study is introduced followed by a discussion of key concepts as well as different theories relevant to the phenomenon of selection and use of technology. Thereafter, we present the research approach and sources of data before describing our findings. This paper concludes with a critical discussion of these findings in relation to other theories and research results.

**LITERATURE REVIEW**

This section grounds the study in the literature. It opens with the theoretical orientation for the study continuing by explaining how literature was selected for the review, and by presenting key concepts related to the study, including issues pertaining to the performance and effectiveness of virtual teams, team satisfaction, and the role of tools and technology in virtual teamwork. The section closes with a review of existing theory relevant to the selection, and the use of tools in virtual teams is provided.

**Theoretical Orientation** Our research approach involved developing a theory by making use of the Grounded Theory method. One of the characteristics of the Grounded Theory method is that there are no preformulated hypotheses. Theory building and not theory verification is the main and only aim of Grounded Theory [10]. Arising from this goal, some researchers have argued that with Grounded Theory studies, no review of literature pertaining to the phenomenon under investigation should be done prior to empirical data gathering [11]. This is ostensibly to allow theory to emerge from the data, and to avoid viewing the data through the lens of predefined concepts from literature [12]. On the other hand, Urquhart et al. [10] see the preliminary literature review as an orientation not defining framework, rejecting the notion that no literature review be conducted prior to data collection. In a like manner, for the purpose of orienting this study, a preliminary literature review is conducted. After the emergence of theory from empirical data, the Emergent Grounded Theory is compared with other relevant theories identified through the literature review.

**Selection of Literature for Review** The Grounded Theory approach employed in this study makes use of a paradigm model as a theory-structuring tool [12]. This paradigm model suggests that a Grounded Theory concerning some phenomenon will have conceptual categories relating to action/interaction strategies and consequences. In addition, the phenomenon will be influenced by various causal, contextual, and intervening conditions [12]. For this study concerning the phenomenon of selection and use of web-based tools by virtual teams, Fig. 1 represents the structure of an initial paradigm model. Literature related to the conceptual categories shown in Fig. 1 was searched for, such as project, team and team member context, and the consequences and actions related to the selection and use of web-based tools in virtual teams. We used a selection of prior literature reviews to obtain an overview of the existing state of the field and to garner views of leading researchers in this field. In addition, we followed the relevant literature identified in the citation of these selected papers, such as [13]–[19].
Specific keyword searches were conducted to identify the latest publications in the research field.

**Virtual Project Teams** According to the Project Management Institute (PMI), a project is “a temporary endeavor undertaken to create a unique product, service, or result” [20]. A project team is created for the purpose of completing a specific project, and consists of a collection of people that is assembled for a defined period of time in order to meet a specific goal. Cohen and Bailey extend the definition of a team as follows:

A team is a collection of individuals who are interdependent in their tasks, who share responsibility for outcomes, who see themselves and who are seen by others as an intact social entity embedded in one or more large social systems, and who manage their relationships across organizational boundaries. [21, p. 241]

**Virtual Versus Face-To-Face Teams:** During the last decade, there has been a proliferation of definitions of virtual teams and virtualness of project teams, accompanying the growing literature in this field. Today, the majority of definitions state that virtual teams are functioning teams that rely on technology-based communication while crossing several boundaries. The coordinates of time, place, and organization can be used to highlight the different boundaries and define the characteristics of different virtual teams [15]. Instead of categorizing virtual teams as a type of team that contrasts with traditional or face-to-face teams, definitions focus instead on virtualness as a characteristic present in all teams [17]. In keeping with this perspective, our paper will focus on those characteristics of virtual teams that reflect the virtual dimension found in all project teams.

**Project Teams in an Educational Environment:** The importance of teamwork in the information technology (IT) industry demands that universities prepare students appropriately for real-life projects. Hence, most information systems (IS)/IT degree programs will include student projects, where students engage with a real-life project as part of a team. One of the main benefits of projects in tertiary education is that they expose students to the multiple and diverse disciplines that are characteristic of the daily life of an IT or IS specialist in industry [21]. The following remark made by an alumnus of the University of Cape Town (UCT) suggests that projects expose students to many of the challenges they are likely to encounter in future employment:

The structure of the project that I have been working on was very similar to that of the university projects and I felt far more confident doing this project knowing that I had already done two similar projects and encountered and overcome many of the issues associated with IT projects.

**Performance, Project Effectiveness, and Team Satisfaction** Performance, effectiveness, and satisfaction are central issues in the evaluation and measurement of project teams. These issues are discussed in the literature with regard to assessment, interrelationship, influencing factors [23], and perception [24].
Team Performance: Team performance can be related to the acceptance of a specified output (such as a product or service) by a customer within or outside the organization [25]. This view on team performance is thoroughly examined in literature on team processes and performance [26]. Alternatively, team performance could be assessed based on Bandura's [27] collective efficacy by inquiring of the team's perception on their performance through specific mediating processes [28].

Project Team Effectiveness: A core element in evaluating and measuring teams is effectiveness. Effectiveness can be defined as the achievement of clear goals and objectives. There are three criteria of team effectiveness:

(a) The productive output of the team ... meets or exceeds the standards of quantity, quality, and timeliness of the team's clients (and is not based on the team's estimate of how well it thinks it did);
(b) The social processes the team uses in carrying out the work enhance members' capabilities to work together interdependently in the future; and
(c) The team's contributions to the well-being and growth of its members, allowing members to learn new things and help their personal needs to be satisfied. [29, p. 23, 27, 28]

Effectiveness also encompasses the quality of the final product and the degree of enjoyment the members of the project experience [26]. Therefore, it can be concluded that team effectiveness can be determined by:

- enhanced productivity as a result of the increased levels of interaction between team members arising from teamwork;
- the degree to which team members enjoy the project experience;
- the quality of the final product produced by the team in achieving the desired goal.

Performance has a direct relationship with effectiveness [30]. The effectiveness of a team leads ultimately to improved team performance. Team satisfaction has been addressed as part of team effectiveness in this discussion; however, often in literature, team effectiveness only covers issues of team productivity, and team satisfaction is addressed separately [17], [31], and [32].

Team and Team Member Satisfaction: Team satisfaction has been defined "as the extent to which a team is able to provide satisfaction to its individual members." [33, p. 525]. A team is seen as a social network that has to care for its members in providing opportunities for personal development and growth. In measuring team member satisfaction, three kinds of satisfaction are distinguishable:

- satisfaction with the team;
- satisfaction with meeting customer need; and
- general satisfaction with extrinsic rewards and work [34, p. 505].

Often, satisfaction is related to the phenomenon under investigation and accordingly assessed with respect to the phenomenon, such as decision making and team satisfaction [35] or leadership style and team satisfaction [36].

Selected Research Results on Performance and Satisfaction in Virtual Teams: Researchers have tried, with mixed results, to examine the various factors that influence virtual team affective and/or performance outcomes. Differences between results are partly attributable to the nature of the project/task and the type of virtual team (such as undergraduate student team, global team, hybrid team) [17]. The following tables show some key findings in the area of team affective outcomes (see Table I) and performance outcomes (see Table II).

Team Performance and Effectiveness in an Educational Environment: Project teams in an educational environment are seldom assessed in terms of project success or project failure, as the main emphasis is on the transfer of knowledge and the acquisition of experience. Projects at an undergraduate level are often the first time that team members have been involved in developing a comprehensive IS, and these projects may not be of a high enough standard for immediate implementation in a business environment as at the predetermined hand-in date. In some capstone courses [45], such as the one presented in this paper, a comprehensive assessment strategy encompassing various instruments to accomplish formal summative assessment, formal continuous assessment, and informal formative assessment is used to enhance the quality of projects and their chances of successful implementation [46]. It can thus be argued that teams achieving very low marks are more likely to deliver a project failure, and that teams with high marks are more likely to deliver a project success. Much of the data gathered for this study were based on students' perceptions of the success of their project. This
was done through interviews with the students, lessons-learned questionnaires and the peer evaluations of the teams, and forming a specific mediating process [28]. It has been found that perceived project success is as important as the objectively determined success of the project [47], [48]. In the context of students’ project experience, the perceived success of a project is thus closely related to the team’s perceived performance [28] which is then related to its effectiveness.

**Tools and Technology in Virtual Project Teams**

Mobile technology, globalization and the internet, supported by the almost ubiquitous availability of high bandwidth, is reducing the need for face-to-face human interaction. Computer-mediated communication plays an increasing role in many people’s lives, and may well transform the virtual team from an innovative source of competitive advantage into the dominant organizational project form [49]. Technologies, such as groupware, videoconferencing, mobile phones, and the internet, all support the work of teams. Prior to the establishment of a research agenda in the field of virtual teams, research into team-based structures and groupware technology attracted wide interest and led to the development of research fields, such as computer-supported cooperative work (CSCW) and computer-mediated collaboration (CMC), which, in turn, included group support systems (GSS). Based on the research in CSCW, a number of concepts were identified as relevant for research in the field of virtual teams, as follows [50]:

- Awareness is an element of collaborative work describing the need of team members to monitor and support the mutually dependent team activities enabling the work progress [51]. The understanding here is that for successful collaborative work, the multiple participants are required to coordinate their activities [52].
- Coordination or articulation of work describes the processes of aligning, scheduling, allocating, as well as integrating the individual activities with regard to the whole collaborative process. The group or team must subdivide the work load into individual units, distribute them among themselves, and after the work has been done, integrate the results [53].
- Tailorability covers the adaptation of the team and/or individual’s used technology/tools to their (or his/her) particular work situation [54].
- Negotiation is necessary to find consensus in a team regarding cooperation, team goals, and work participation of the different team members [50].

Besides these issues, one of the most important aspects of CSCW research is the understanding that the social context plays an important role in cooperative teamwork [55], [53].

**Communication and Communication Technology**: Communication is at the heart of distributed and traditional project teams; and many issues faced by virtual teams, such as conflict management as well as trust and team cohesion, are rooted in team communication behaviors and processes. Therefore, research in the field of CMC plays an important role for virtual teams. CMC research compares the effects of different communication media in different groups (face to face, computer mediated) [56].

Technology provides an essential channel of communication, especially in a distributed environment. Collaborative work technologies can be classified according to four main dimensions [57]:

### TABLE I

**Research Findings on the Team Affective Outcomes of Virtual Teams**

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<thead>
<tr>
<th>Findings on Team Affective Outcomes</th>
<th>Researcher Group</th>
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<tbody>
<tr>
<td>In general lower level of satisfaction in virtual teams than in face-to-face teams.</td>
<td>(Thompson &amp; Coover, 2002)</td>
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<tr>
<td>Satisfaction in virtual teams seems to be affected by the team’s gender composition; all female virtual teams report higher level of satisfaction than all male virtual teams.</td>
<td>(Straus, 1996)</td>
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<tr>
<td>The cohesion of a team has been associated with greater team satisfaction.</td>
<td>(Lind, 1999)</td>
</tr>
<tr>
<td>The more that teams move away from the traditional form (regarding their degree of virtuality; team time worked together, member and distance virtuality), the more the traditional measures (member perceptions of performance and member satisfaction) of team effectiveness are negatively impacted.</td>
<td>(Savicki, Kelley, &amp; Lingenfelter, 1996)</td>
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<tr>
<td>(Maznevski &amp; Chudoba, 2000)</td>
<td>(Schweitzer &amp; Duxbury, 2010)</td>
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Two aspects of communication that emerge consistently in research related to virtual teams are frequency of communication, and face-to-face communication. Frequent communication enhances shared team identity and moderates the distance-conflict relationships. Frequent communication increases the level of trust in teams. Further findings are that predictable communication with regular feedback has been associated with improved team performance. Other research considers face-to-face communication as necessary to foster trust, reduce task conflict, enhance team dynamics, and, in turn, increase team effectiveness. Face-to-face meetings, particularly in the team-forming phase, appear to enhance virtual team trust and play a critical role in the early development of the team.

Even though frequency and face-to-face communication are important aspects of team communication, they alone do not ensure effective teamwork. Teamwork is also dependent on how well the team members are socialized into the organizational context. Research in the field of CMC is related to the question of how CMC affects the outcome of collaborative teamwork with regard to, for example, team member satisfaction, decision quality, or team effectiveness. Also commonly investigated in current research in CMC are factors influencing communication such as ethos, social communication, understanding the other, and technologies in communication.

**Project Management and Collaboration Tools:** Several web-based tools are available to support the specific project-management processes of virtual project teams communicating over the internet. The following list provides a brief description of relevant web-based tools that can be used by virtual project teams:

- web-based forums enable team members to post messages to an online message board;
- web-based concurrent collaboration systems (such as wikis) are designed to help the project team involved in a common task (such as developing a requirements document) to achieve their goal;
- web-based task tracking systems are a specific type of issue-tracking system that manages and maintains a list of tasks as needed by the project team in developing a schedule for the tasks of a project, allocating the appropriate resources and calculating the critical path;
- web-based project planning supports the project team in developing a schedule for the tasks of a project, allocating the appropriate resources and calculating the critical path;
- web-based calendars help team members to schedule events, and automatically notify and remind the team members of these events;
- web-based time-sheet-management systems enable team members to report the time spent on project tasks, and are often combined with automated approval routing and messaging.
- web-based document sharing and storage facilities allow members of the project team to upload and download project documents (for example, protocols, deliverables, and project plans).

The challenge of sharing important information lies at the center of a virtual team. Since team...

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**TABLE II**

**Research Findings on the Performance Outcomes of Virtual Teams**

<table>
<thead>
<tr>
<th>Findings on Performance Outcomes</th>
<th>Researcher Group</th>
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<tbody>
<tr>
<td>Virtual team interaction increases the time required to accomplish a task.</td>
<td>(Straus, 1996)</td>
</tr>
<tr>
<td>Increased time required is partly caused by typing and use of computer-mediated communication technology.</td>
<td>(Hollingshead, 1996)</td>
</tr>
<tr>
<td>The cohesion of a team has been associated with better team performance.</td>
<td>(Straus &amp; McGrath, 1994)</td>
</tr>
<tr>
<td>The more that teams move away from the traditional form (regarding their degree of virtuality, team time worked together, member and distance virtuality), the more the traditional measures (member perceptions of performance and member satisfaction) of team effectiveness are negatively impacted.</td>
<td>(Chidambaram, 1996)</td>
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<tr>
<td>Deception has a negative impact on performance in virtual teams.</td>
<td>(Schweitzer &amp; Duxbury, 2010)</td>
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<tr>
<td>(Fuller, Marett, &amp; Twitchell, 2012)</td>
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members can be linked by a variety of information and communication technologies, information processing and sharing regulations are necessary to avoid the introduction of other socioemotional factors that might undermine project success. For example, unevenly distributed information is a common complaint of virtual teams [67].

**Theories on the Use of Selection of Tools and Technologies:** In selecting and classifying communication technologies for the use in virtual teams, one theory that is widely applied and cited is the Media Richness Theory [68]–[71]. Media Richness Theory is a theory that can be used to describe the ability of communication media to transfer information. It assumes that organizations process information to reduce uncertainty and equivocality [72]. Media Richness Theory suggests that media vary in the levels of richness they provide [19]. Media might differ in the number of cues they are able to convey, the timeliness of feedback, and the capacity for natural expression. The more a medium covers, the richer it is. Face to face can therefore be considered as the richest medium: it permits timeliness of feedback and it allows the simultaneous communication of multiple cues like body language, facial expression, and tone of voice. Further, face to face uses high-variety natural language and conveys emotion. Videoconferencing, phone, chat, email, short-messaging services (SMS), addressed written documents (such as, notes, memos, and letters), and unaddressed documents (such as bulletins and standard reports) vary with respect to in media richness in descending order. The Media Richness Theory further proposes that task performance will be improved when the requirements for task-information processing are matched to a medium's ability to provide that richness of information. In organizations, commonly used media work better for certain tasks than other media. Written media are preferred for unequivocovocal messages while face-to-face media are preferred for messages containing equivocality [73]. Even though Media Richness Theory is widely applied, there are some studies that do not support the Media Richness Theory regarding the media richness effect on the task performance and satisfaction [74], [75]. Alternatively, Dennis and Valacich have developed the Media Synchronicity Theory (MST) [76]. MST distinguishes the communication tasks in terms of whether they are conveyance tasks or convergence tasks [74], [76]. MST proposes that for conveyance communication processes, low media synchronicity will be more effective, and that for convergence communication processes, high media synchronicity is recommended. For most tasks, the use of one medium alone is not sufficient to achieve ideal communication performance [77]. This is the reason why many tasks require conveyance and convergence.

The task technology fit (TTF) model devised by Goodhue and Thompson [78] builds upon a model of IS success by DeLone and McLean [79]. They proposed that utilization and user attitudes about the technology lead to individual performance impacts. The TTF model goes beyond the DeLone and McLean model by exploring how technology impacts performance and by providing a stronger theoretical basis about a number of ICT-related issues related to performance, such as understanding the impact of user involvement or the impact of IS problems. The TTF model suggests that a technology has to take the utilization of the tasks into account and the good fit to have a positive impact on the user's individual performance [78].

The environment within which a project team functions is also a crucial element contributing to effective teamwork. The alignment of task, technology, and team is often neglected in the research of virtual teams [5]. Because communication and collaboration play a vital role in any project team, including traditional teams, they should be included when making such alignment. Thomas and Bostrom [9] developed a five-trigger model to diagnose, examine, and understand team technology adaptation contexts intended to support team leader training and evaluation of team technology adaptation in praxis as well as in research. Triggers taken into account were external constraints (such as, time schedule/scope change, and upper-management intervention), internal constraints (such as team size), information and communication technology inadequacy (such as not operating or a feature/tool missing), ICT knowledge, skills, and abilities inadequacy (such as lack of ICT knowledge), as well as trust and relationship (such as trust failure).

Not much literature was found on the effect of contextual conditions on the process of selecting and using web-based tools in virtual teams. Similarly, little was found on the causal conditions that influence the selection and use of web-based tools by virtual project teams. The intention of this study is to contribute to filling these knowledge gaps.
**METHODOLOGY**

This section describes how we applied the Grounded Theory approach [80] to investigate critical technology-related issues that influence effectiveness and team member satisfaction in virtual project teams. The section starts with an overview of our research methodology followed by the selection of the research site and the participants, the data collection, and methods of data analysis specific to our Grounded Theory approach.

**Choice of Research Methodology** Grounded Theory is a research method seeking to develop theory from data that has been systematically gathered and analyzed. The theory is thus grounded in the data of the research study. Glaser and Strauss, when emphasizing the process of generating the theory from data, say:

> Generating a theory from data means that most hypotheses and concepts not only come from data, but are systematically worked out in the relation to the data during the process of research. [80, p. 6]

A Grounded Theory is “one that is inductively derived from the study of the phenomenon it represents” [12, p. 23]. This quotation emphasizes the inductive nature of the Grounded Theory method. One major difference between Grounded Theory and other qualitative research methods is its specific approach to theory development [10]. Grounded Theory suggests that there should be a continuous interplay between data collection and analysis. A well-constructed grounded theory should meet the following criteria for judging whether the theory can be applied to a particular phenomenon: fit, understanding, generality, and control [12]. A Grounded Theory approach is appropriate for interpretive studies in IS because of the need to understand IS as they are used in organizational environments [81]. In addition, Grounded Theory has been successfully applied in virtual team research, such as in developing a process model for collaboration in virtual teams [82]; using symbolic interaction in Group Decision Support Systems (GDSSs) when studying global virtual team dynamics [40] and leadership-initiated relationship building within virtual teams [83].

The goal of this research is to develop a theory that helps us answer the main research question of “How do critical technology-related issues concerning the selection and use of web-based tools influence the performance and satisfaction of virtual project teams?” The development of a Grounded Theory focuses on incorporating the complexities of the social, technological, team, and organizational contexts into an understanding of the phenomenon. A theory can serve the purpose of providing better explanation about some phenomena [84] and the Grounded Theory approach is capable of generating such an explanatory theory [10].

**Selection of Research Site and Participants** In terms of sampling, we first selected two groups of teams, whose members were all final-year undergraduate students in the Department of Information Systems at UCT: the 2008 third-year project teams and the 2009 third-year project teams. Using student teams was a limitation compared to using organizational teams, but was adequate for the purpose of this study. Teams were similar in size, project duration, and project complexity but had different project sponsors, different cultural backgrounds, different technological skills, and different access to the internet and technology. They worked on campus, at home, partly distributed, or on the sponsors’ premises. The project teams were selected for this study for their similarities as well as for their differences. In their project work, the teams used a variety of traditional and internet-based communication, collaboration and project-management tools, such as email, SMS, phone, MS-Project (a server-based Project Management Tool, called Microsoft Project Server), Skype (Voice over IP-Tool), Version Control, and Vula. Vula is UCT’s web-based open-source learning, collaboration, and research content-management system. Vula offers a broad spectrum of features, including tools for administration, assessment, communication (such as chat), resource sharing, and collaborative learning.

At UCT, a systems development team project is one of the major deliverables of the capstone course of the IS undergraduate curriculum. The duration of this team project is one year. The course has been shaped according to guidelines provided by international curriculum standards as specified in the IS Model Curriculum [85] and the Computing Curricula 2005 [86]. The practical component of the course involves the application and implementation of theoretical concepts while following the full life cycle of a project using a team-based IS project in a real-life setting. This real-life setting is provided by a sponsor in industry who donates their time and identifies a business problem for the project team to solve. The complex environment of teamwork
and effective communication and cooperation plays an important role in developing necessary life skills. At UCT, student teams work either in the computer labs, at their sponsors’ offices, or at home. Due to different courses and commitments, team members are often unable to work in the same physical location at the same time, and they rely on virtual team technologies to enhance their productivity and assist in the delivery of a quality product. The student project teams also show a high degree of cultural diversity, which is typical of the South African social and academic environment, and they therefore face many of the same challenges as are encountered by global project teams operating in different countries. The research approach and the data collection were approved by the Ethics in Research committee of UCT and the participants gave their informed consent. The participants, their companies (here the sponsors of the project teams), and the information and opinions expressed by them, remained completely anonymous. Thus, team names have been changed in order to refer only to the university and the academic year of the course. From the four people in the researcher team conducting this research, two people had no relationships to the students (they have not taught them nor were involved in any marking of their results) and always one of these two researchers was in the interview team. The other two members of the research team were course convenors of the student teams.

How Data Were Collected The process of developing a grounded theory (as outlined in [87] and critically discussed in [10]) includes:

- iterative data collection and analysis, with constant comparison of data incidents to data incidents, data incidents to concepts, and concepts to concepts;
- open coding of concepts and iterative conceptualization, such as assigning conceptual labels to data incidents;
- development of categories (grouping related concepts) and relating categories and concepts (axial coding);
- theoretical sampling (such as sampling driven by theory development); and
- development of a theory using the coding paradigm (as illustrated in Fig. 1).

The iterative data-collection process where there is instant analysis of data as they are collected, followed by constant comparison of new data with the results from previous cycles of analysis is an integral part of the Grounded Theory process. The focus in this section is on the data-collection phase, with further detail about data analysis provided thereafter.

The first set of data [88] for each group was collected through a variety of methods: semistructured and structured interviews, surveys, and course results for each team. The data collection, coding, and analysis process were more or less iterative. In the first phase of data collection, relating to the 2008 teams, data were collected by means of a survey questionnaire. The questionnaire was semistructured and contained closed- and open-ended questions. Each team was asked to return at least three questionnaires answered by individual team members. The questionnaires were treated anonymously. This phase was followed by semistructured interviews consisting of open-ended questions that guided respondents to explore issues of virtualization, the use of technology, and the availability and access to technology. Two students per project team participated in each interview, which had a typical duration of between 30 and 45 minutes.

The data collection for the 2009 teams was conducted in much the same way as the 2008 data-collection phase, except that only one questionnaire per team was requested, and we had refined the questionnaire to gather richer qualitative data related to our research question (as per the principle of theoretical sampling). The reason for only one questionnaire per team was so that a collective team perspective was acquired. This ensured that the team would be collectively involved in completing the questionnaire, which resulted in richer answers to the open-ended questions.

How Data Were Analyzed The Grounded Theory method recommends that analysis should begin immediately after the first interview or observation has been completed [12], [80]. Each interview (or even interview question) should be followed by analysis to allow the researcher to identify concepts and to come up with additional questions and conduct the interviews more sensitively in order to build theory along the way (theoretical sampling) [87]. However, in our research, it was not always possible to analyze information between the interviews, because the interviews had to take place in a limited time period after the team’s final project presentations. Fig. 2 shows how data collection proceeded in our research study and how
the different data-analysis steps according to the Grounded Theory approach were interwoven.

Data analysis (referred to as Coding), is at the heart of the Grounded Theory method. Coding is defined as “Extracting concepts from raw data and developing them in terms of their properties and dimensions” [87, p. 159]. During the initial stage of open coding, all of the data are examined and the emerging concepts are organized into recurring themes. These themes are the prime candidates for a set of stable and common categories.

Each category in a grounded theory is linked to a number of associated concepts, using a process known as axial coding [12]. This relies on a synthetic technique of making connections between subcategories in order to construct more comprehensive schemes. The goal is to determine the set of categories and concepts that covers as much data as possible. The two phases of open and axial coding are often intertwined as pointed out by Corbin and Strauss “...open coding and axial coding go hand in hand. The distinction between the two types of coding are ‘artificial’ and for explanatory purposes only...” [87, p. 198].

The method of constant comparison is the major strategy used in discovering a grounded theory [80]. It is defined as: “The analytic process of comparing different pieces of data for similarities and differences” [87, p. 65]. It is mainly this procedure that is used for identifying conceptual categories and their properties that may be embedded in the analyzed data.

Selective coding is the process of integrating and refining the theory [12]. This can be done by identifying a core category and linking the other categories to this category following the paradigm model that consists of conditions, context, strategies, and consequences [87]. (See Fig. 1.)

Ensuring Credibility and Trustworthiness Data were collected through a variety of methods: semistructured and structured interviews, surveys, and course results for each team offer multiple perspectives on the same issue and provide more information on emerging concepts in the coding [80], [89]. In addition, two interviewers were always participating in each interview during data collection and discuss the findings in the coding of the data.

RESULTS

This section describes the results of our investigation into the selection and use of tools within virtual project teams and their impact on...
performance and team member satisfaction. Before delving into conceptual detail, we describe the student teams who participated in the study. Then, we present the themes in the data identified and close with the Emergent Theory.

Who Participated in the Study

At UCT in 2008, 39 undergraduate students formed eight teams of four to five students each, with each team finding their own industrial sponsor to supply a business problem. The duration of this project was one year. (See Table III.) In 2009 at UCT, 32 undergraduate students formed seven teams of three to five students each, with each team finding their own industrial sponsor to supply a business problem. The duration of this team project was again one year. All teams had five team members, except UCT-Team-2009-7, which formed a team of three students. (See Table IV.) Due to the size of the class taking the course, there were no more students available. All teams had regular meetings with the sponsors, the project manager, and among themselves (team meetings). All teams signed a team contract at the beginning of the course. All teams also followed the protocols set out by the course.

Themes in the Data

The interviews were coded into a qualitative data-analysis software tool called InVivo version 9. Applying the open coding technique to data yielded about 130 concepts through different iterative coding cycles. In the axial coding phases, the interviews were analyzed again, taking into account previous memos, team characteristics (such as size, skills, work, and social characteristics), the frequency with which teams used the different communication, collaboration and project-management tools, and how often teams met face to face, as well as the team results.

The goal was to organize the concepts into recurring themes and to identify stable categories covering as much of the data as possible. To achieve this, each category was linked to a number of associated concepts. Some of the results, like the identification of properties—characteristics of categories and their dimensionality—such as variability of the categories, already occurred in the open coding phase.

In the axial coding process, the codes were grouped into four main categories: (1) Team, (2) Project, (3) Tools, and (4) Internet. These concepts and subcategories were related to the main categories used to answer questions such as who, where, why, when, and how about the specific category. For these main categories, the concepts/properties were organized and appropriate dimensions assigned. Fig. 3 gives an overview of the resulting categories, subcategories, and concepts identified.

In the interviews, the memos, and the survey data, the category Team emerged as a strong category, incorporating many emerging concepts such as Team Building, Friendship Between Team Members, Trust Level in the teams and team Cohesion. These concepts are encapsulated in the following quotation:

We know each other from the beginning of our studies. We are all friends and worked partly together in previous assignments. We are friends that wanted to be together and therefore build this team. (UCT-Team-2009-1)

In the category Project, many interviewees mentioned the importance of the different project activities including task management. For example, the relationship between Task Complexity and Face-To-Face-Meetings was demonstrated by
the following quotation from UCT-Team-2009-2: “[Question: What is the effect of the task complexity on the use of specific tools?] If it gets too complex you need face to face meetings.”

**Task Management and Different Activities** represent subcategories in the main category **Project**. Most of these concepts relate also to the main category **Tool** since they represent activities executed using different tools. The **Tool** category specifies and explains tool specifics, use and usage frequencies, as well as the different functionalities that were needed by the teams for different project activities. Even though only a few concepts were included in the category **Internet**, there were many references within this category that showed relationships to concepts in other categories, as shown in the following quotation: “Also the limited internet access and bandwidth on campus prohibited the use of task tracking/planning tools.” (UCT-Team-2009-5)

As the themes and concepts emerged from the data, they aided the structuring of supporting arguments to address the research questions.

**Answers to the Research Questions** Our first research question was related to how the selection and use of tools influence a virtual team’s performance in a project. Based on our findings, the selection and use of tools for communication, collaboration, and project management in a project is strongly influenced by the different contexts of team, project and notably, team member. The selection and use of tools, in turn, influence the virtual team’s performance. Hence, we highlight the important role of context, including the role of individual preference. This finding is in line with the TTF model [78], which proposes that for a technology to have a positive impact on a user’s individual performance, its suitability for the task and context must be taken into account. Research from Sivunen and Valo has focused on the team leaders’ choice of technology and explained the choice in terms of accessibility, social distance, idea sharing, and informing [90]. Our findings lend support to this explanation.

The second research question asked how the selection and use of tools influence a virtual team’s and team member’s satisfaction in a project? A number of research studies have focused on self-managed/self-directed virtual teams, which have been defined as groups of ‘independent individuals that can self-regulate their behavior on relatively whole tasks’ [21], [91]. Our research results emphasize the role of individual context within a team setting, and how individual team members influence tool selection and use, which ultimately has an impact on team and team member satisfaction.

The third and fourth research questions relate to how critical technical issues influence the selection and use of tools, and how these issues affect team performance and satisfaction? Our findings underpin the importance of ICT adequacy and trust in project teams [9] and explain how certain critical technical issues influence performance and team member satisfaction. These issues include limited access to the internet, which reduces the availability of media richness and has a negative impact on communication processes. As a result, virtual project teams with limited internet access generally perform at a lower level than other teams. We suggest that restrictions in the internet access of even a single team member limits the virtual team’s technological choices and, thus, affects team performance and team satisfaction.

The final research question relates to how the context of project, team, and team member in the selection and use of tools influence team performance and team and team members’ satisfaction. Based on our results, the following specific issues influence performance and team member satisfaction: activities in the beginning phase of a project, individual tool preferences, transparency of the work progress, trust, and the task-tool alignment. Each will be discussed in turn.

The **beginning phase** of a project is when project management, collaboration, and communication tools are selected and introduced, which will influence the team’s effectiveness and, therefore, its performance. Virtual teams are more fragile and vulnerable to breakdowns than face-to-face teams [58]. The beginning of a project is a crucial phase [59], [92] and it is important to select the right tools during this phase to avoid discontinuities in project work. Discontinuities can be gaps or a lack of coherence in work due to task, culture, technologies, or working rules [93].

Flammia, Cleary, and Slattery [94] point out that the use of **lean** media, such as chat, has a strong influence on team cohesion, trust, and member satisfaction. Our research has revealed that an even more important factor affecting team member satisfaction and team performance is the degree of alignment between the team’s choice of tools and the team members’ **individual needs and preferences**.
One of the concepts that strongly influenced team member satisfaction was the transparency of the work progress in the task management. Transparency of the work progress in task management is closely related to a key research issue in the CSCW field, that of awareness. Awareness describes the need of team members to monitor and support the mutually dependent team activities that enable the work progress [51]. Ngwenyama and Bjørn [95] distinguish between task-oriented awareness and social awareness activities. The first addresses activities that are performed to accomplish a specific independent task and is related to the task transparency in task management; the second provides information about the presence and activities of the team members in the collaborative work setting [96].

While the team members' satisfaction caused by task awareness in virtual teams is supported by different researchers [97], the antecedent of a certain trust level to achieve this satisfaction, needs to be emphasized. Trust plays an essential role in the virtual team, as pointed out by many researchers [59], [98], [99]. There are some activities supported by tools, such as sharing knowledge and information that help to build up trust [100]. There are other activities, like task awareness facilitated by tools, where trust is needed beforehand. Our findings elucidate the different roles of trust in the selection and use of tools to assist virtual teams, and integrate and validate research findings on various aspects of trust in virtual teams.

According to DeLuca and Valacich [101], media with high synchronicity (such as face to face or phone) are preferred for complex problem-solving tasks in virtual teams in order to ensure convergence on a shared meaning. In our research, the complexity of the project task is an important matter for teams working in distributed settings. The MST does not consider how the different media are used in tools, while our findings support the idea that the integration of functionality (different media) also increases the team’s effectiveness.

Based on MST (MST), a better match of media synchronicity with the team’s communication processes will lead to improved performance of the team members [19]. For most tasks, the use of one medium alone is not sufficient to achieve ideal communication performance [77]. Many tasks require conveyance and convergence. MST suggests the use of multiple communication media to accomplish a task. This is supported by our research results, in that teams select different media/tools in their work on a project task (tool-task alignment). MST, however, does not take into account the fact that team members’ personal preferences may also influence the use and selection of tools and that the team member’s satisfaction will then be improved. Our theory, as described in the next subsection, addresses this shortcoming.

Emerging Theory During the open and axial coding, we identified a number of relationships that served as input into subsequent sampling and interviews in order to help build the theory (theoretical sampling). We did not initially classify these relationships according to the paradigm model of Fig. 1 (such as whether they were causal, contextual, or intervening conditions) because they were only based on the first slices of data, and needed to be confirmed through subsequent slices of data. In addition to writing memos related to the various concepts that had been identified, we drew figures describing the relationships between them and wrote explanatory memos underpinned by supporting quotations from the interviews. Informed by about 30 such relationships and related memos, we again analyzed our data (interviews, survey data, observations, and course results) and reorganized the concepts following the paradigm model, in order to come up with a theory as shown in Fig. 4.

The following subsections elaborate on this theory, and demonstrate the extent to which it is able to explain the selection and use of tools in different project contexts and to suggest the consequences of their use. We also develop an understanding of when, why, and for what purpose a specific tool is selected and used (or why it has not been used) and when it is preferable or more appropriate for team members to meet face to face.

Causal Conditions for the Selection and Use of Tools: The conditions that exert the greatest influence on the selection and use of tools relate to Internet Access and Availability, Tool Training, Usability Tool Integration, and Task Management as shown in Fig. 4. Each of these will be discussed in turn.

Internet Access and Availability: The role of the internet as a causal factor is most apparent where internet access is limited. Teams choose and use specific tool combinations in order to overcome limited internet availability and bandwidth. This restricted internet availability is likely to reduce the effectiveness of certain project activities. This restriction especially seems to prohibit the use of
Fig. 3. Overview of the main categories with concepts.

Fig. 4. Conditions, context, and consequences in the selection and use of a tool/tool combination.
task/tracking and task planning tools, as stated by UCT-Team-2009-5: “Also the limited internet access and bandwidth on campus prohibited the use of task tracking/planning tools.”

It also restricts tool use and selection for communication purposes: “An increased bandwidth would allow for more possibilities with regards to technical communication.” (UCT-Team-2008-3)

In addition, teams that have limited internet access and bandwidth encounter obstacles in accessing information that will help them learn how to use new tools and technology. An example is this quotation from UCT-Team-2009-2:

...The internet is too slow during the day. It is understandable, that the internet has to be limited but if you want to download something that you need for your project or for any academic research the current situation is not sufficient.

Consequently, limited Internet Availability and Bandwidth contribute to reduced Effectiveness and a lower Performance Level amongst virtual teams.

Tool Training: Some tools have a low usage frequency because the teams feel that they need more Tool Training to use them effectively. For instance, many teams complained that they did not use MS Project because they did not know how to use it. A quotation from UCT-Team-2009-3 is illustrative of this: “The whole use of MS Project was also very poorly communicated. I do not think that I am ever going to use MS Project again. We haven’t been trained on it.”

Usability: When students mention MS Project, they are not referring only to the Gantt chart done in MS Project, but rather to the Microsoft Project Server as the technology platform for workgroup environments when used with MS Project. Through its web-access interface, MS Project Server is intended to make it easy for team members and stakeholders to collaborate and access project information using only a web browser. The teams, however, found this collaborative project-management tool complicated and very difficult to use. UCT-Team-2009-2 notes:

It [the use of MS Project] was a waste of time, but we also didn’t really know how to use it. We did not understand the concept and it wasn’t really easy to use. We would have needed more training.

This issue is related to the Usability of MS Project as illustrated by the following quotation: “The paper based task planning dominated because of the clumsiness of the tools, especially MS Project.” (UCT-Team-2009-5)

Tool Integration: Tool usage is related to the integration of functionality within the tool [Tool Integration], which increases the teams’ effectiveness. This relationship between tool integration and tool selection/usage emerged from complaints about the difficulty of maintaining data in MS-Project and the need to change to another tool. The following quotation underpins the relationship:

Time estimation is a problem and it is therefore difficult to use task management with project server that you have to update the Gantt charts all the time. And it also takes time to do the updates. It is a bit of hassle to do those things with MS Project. It would be fine to have it all in Vula. We spent so much time with Vula and it would be fine to have it there and no need to change the system. Two systems made it difficult and are producing too much overhead. (UCT-Team-2009-2)

The integration of the different tools was often raised as an issue in the interviews with the UCT Teams 2008 and 2009:

We used Version Control and Vula for our tasks management. Version Control of System used to see who was doing what tasks—code classes checked out when a person was working on it. It would be nice to have Version control software combined with task management into Vula. (UCT-Team-2009-3)

UCT-Team-2009-3 even proposed the integration of all three tools (Vula, Version Control, and MS Project):

I would really consider using a technology that combines Version control, Vula chat room and MS Project. We met a lot but I am sorry to say but most of meetings were useless. They were really a waste of time. We came there often waited for everybody to show up and sitting there for an hour for no reason at all. Towards the end the Version control and Vula chat room was very effective the way we did it. What would have been doing it like that right from the beginning? Instead of waiting for hours and having long discussions.
Task Management/Transparency: In the different phases of Task Management, different tools are preferred by the teams. Teams with good task management are more likely to deliver good project results. None of the teams with poor task management showed a high performance level. For good task management, it is essential to make the task progress transparent, for instance, by means of a tool. Tools that support Task Transparency in the Task Management increase the Team Members’ Satisfaction. For team members, it was important to know the status of the tasks assigned to each of the team members, especially while working in a distributed work setting. Tools that supported task management by means of making transparent the actual status of tasks increased the team members’ satisfaction. This is underpinned by the following quotation:

[Question: How should team members be motivated to finish in time with the required quality? What is the role of the different tools in this process?] We did nag each other on Vula. Checked Vula often and also were often online. We said: ‘There is a deadline, we are waiting for you.’ We could check which tasks were allocated to whom. We could see the uploads and check the quality of the others easily. (UCT-Team-2009-2)

Influence of the Project Context on Tool Selection and Use: The team’s effectiveness is strongly influenced by the tool selection that takes place at the beginning of the project (Project Phase) to support the different Project Activities. These relationships suggest that the teams’ effectiveness depends on an early selection of appropriate tools to support the different tasks in a project. This is supported by the following quotation:

[Question: What would you recommend to a team starting a similar project?] I would recommend the same things that an honors student recommended to us. Get source control, get some place online to manage your documents effectively and … assign tasks—we started too vaguely. (UCT Team-2009-3)

In the different phases of Task Management, different tools are preferred by the teams. The following quotations underpin the role of different tools in different project phases:

The paper based task planning dominated because of the clumsiness of the tools, especially MS Project. (UCT-Team-2009-5)

A wiki for the task management [task tracking] but mostly paper based list with the items that need to be done visual view of progress and what needs to be done. (UCT-Team-2009-5)

[Question: How should team members be motivated to finish in time with the required quality? What is the role of the different tools in this process?] We did nag each other on Vula. Checked Vula often and also were often online. We said: ‘There is a deadline, we are waiting for you.’ We could check which tasks are allocated to whom. We could see the uploads and check the quality of the others easily. (UCT-Team-2009-2)

Influence of the Team Members’ Context on Tool Selection and Use: Tool selection is influenced by the team’s social Cohesion and geographical distance (Work Setting). This relationship is well illustrated by the specific situation of UCT-Team-2009-4 as revealed by the following quotations:

We didn’t use Virtual Server. We didn’t need it. We are living a few minutes from each other. Take a flash drive and that’s it.

Face to face meetings; motivated each other and socialized very well in the team.

We didn’t work too much via the internet. We worked at my house or at Cathy’s house. We had 2 3G Cards and ADSL was available. It’s not that all five of us needed the internet the same time. It was that one or two need to do something via the internet.

Influence of the Team Members’ Context on Tool Selection and Use: The selection and use of a tool is influenced by the team member’s Work Preference or need to work from home and his/her distance to work (Geographical Distance to Work). The team member’s work and tool preferences have a strong impact on team satisfaction and effectiveness. This is underpinned by the following quotation:

No, we had low trust level at the beginning and in the middle and then trust did increase when VSS (version control) was used towards the end (last five weeks), because also Walter was working from home. We did a lot of work not being together. (UCT-Team-2009-3)

This quotation also demonstrates the importance of the team’s trust level as a factor influencing tool selection and tool use.

The following quotation endorses the role of the team members’ Technological Skills:
Improvement will be apparent if every individual in the team is equipped with the necessary skills to utilize the technological tools available efficiently and effectively.

(UCT-Team-2008-3)

**Interventions on the Selection and Use of Tools:**

Low levels of trust in a team and a critical Project Stage or a deadline require face-to-face working in a project. This is underpinned by the following quotations from UCT-Team-2009-6, a team with a low trust level at the beginning of the project:

Email and Vula are fine but it is easier to get work done if you are working together face to face. Then you know that the work is done for the next deadline.

I prefer working all together face to face. Then I know what everybody is doing. If someone needs help you can immediately give him or her support.

We would have had less trust if we were working distributed, only after some time after the person proved that he/she is reliable then I maybe would trust the person the next time.

**Consequences of Selection and Use of Tools:** There emerged clear areas where tool selection and use, or lack thereof, affected the performance of the teams. For instance, selection and usage of tools was constrained by limited internet access and bandwidth, lack of training for certain tools, and the context of small and culturally diverse teams with differing levels of trust. This, in turn, gave rise to differing team performance and satisfaction.

**Conclusions, Limitations, and Suggestions for Future Research**

Based on the Emergent Theory developed in our research study, we discuss the implications for the practice and theory of virtual teams. After the conclusions, we critically explain the limitations of our research approach and thereafter give some suggestions for future research activities.

**Conclusions** Our research results contribute to practice by providing a number of guidelines for the management of virtual teams as well as knowledge required by companies intending to launch projects with virtual teams. From the six general leadership practices for virtual teams recommended by Malhotra, Majchrzak, and Rosen [102], our findings support and elaborate on the following four guidelines:

First, the establishment and maintenance of trust in the team through the use of communication technology is essential. Transparency in task management via a tool that supports task awareness is a key issue that influences the team member’s satisfaction within a virtual team setting. Trust is, in reality, an antecedent to using such a setting. Sharing of information via a tool, on the other hand, does not merely increase the team’s effectiveness but also helps to build up trust in the team.

Second, to monitor team progress using technology, it is important to have a technical infrastructure that works well. In many cases, differing performances of teams can be attributed to technical restrictions, such as limited internet availability and bandwidth or the wrong selection of communication and collaboration tools. Further, it is especially important in the beginning phase of a project to ensure the right selection and use of tools to avoid discontinuities in the project work.

Third, to enhance visibility of virtual members within the team and outside the organization, the technology should help to manage the tasks and to promote transparency about the work progress of the project. Clear areas emerged where tool selection and use or the lack of use of appropriate tools, impacted the performance of the teams. Here again, transparency of the work progress as supported by the tools plays a major role.

Finally, the virtual team setting should enable individual members of the virtual team to benefit from the team. Our theory emphasizes that besides the project and team contexts, the individual preferences and personal distance from work of each team member play an important role in the selection and the use of web-based tools in a distributed work setting. It implies that the team’s choice of tools and the team member’s individual needs have to be aligned to ensure team member satisfaction and team performance.

Theories, such as the TTF model [78], the Media Synchronicity model [74], as well as Thomas and Bostroms’ [9] Five Trigger model describe single aspects of the role of technology to support virtual teams. Our theory gives a holistic explanation of how these single aspects contribute to the team’s performance and team member’s satisfaction in a virtual work setting when selecting and using internet/web-based tools.

**Limitations** Our research has been conducted among different undergraduate student project
teams from IS in Cape Town, South Africa, working on diverse project tasks primarily given to them by industrial sponsors. This research context provides a rich world of different scenarios, technological infrastructure, and cultural background, and, therefore, makes it possible to investigate and understand the different issues influencing the application of technologies and the outcome of the project. At the same time, the educational setting allows the control of aspects, such as team composition, task, and technology. While these teams are not spread across each country or the world, they provide similar characteristics to virtual teams in major organizations because of their diverse team composition, the necessity of working at different places (at home, with the sponsor, in the university labs), and the limited face-to-face meeting opportunities due to travel expenses, involvement in different courses, and employment while studying. In addition, the effects of proximity among team members fall off rapidly with even very small distances [103], [104]. Therefore, even team members who reside close to each other but who never meet may experience very similar dynamics to those who interact across large distances. All of these factors help to ensure a realistic setting for virtual teams, which is not unlike that found in major organizations. In their literature review, Martins, Gilson, and Maynard [17] pointed out that only 13 out of 93 empirical studies used “real teams”. Case or lab studies mostly using “student teams” were the others [38], [59], [67], [94].

**Suggestions for Future Research**

Many limitations of our research relate to the fact that teams were set up in an educational environment. Therefore, future research on the Emergent Theory should be about testing its applicability in “real world” projects. For example, researchers have to consider the fact that in “real world” project teams, the selection of a tool/tool combination might be determined or limited by organizational standards or policies [105]. The environment within which a project team functions is a crucial element contributing to effective teamwork. As pointed out by Bjørn and Ngwenyama [5], the alignment of task, technology, and team is often neglected when researching virtual teams. Because communication and collaboration play an increasing role in any project team, including traditional teams, they must be encompassed in this alignment. In addition, web-based technology offers new ways of collaboration and has an important role in the workplace of the individual team members.

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