An Organizational Framework for the Use of Web-Based Tools in "Virtual" Project Teams

By

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A thesis submitted in fulfilment of the requirements for the

Degree of Doctor of Philosophy in Information Systems

Department of Information Systems

Faculty of Commerce

University of Cape Town

August 2012

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"…we shall never understand the complex reality of organizations if we persist in studying them from a distance in large samples with gross, cross-sectional measures. We learn how birds fly by studying them one at a time, not by scanning them on radar screens."

(Henry Mintzberg)

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Acknowledgements

Firstly, I wish to thank Professor Irwin Brown for his supervision and valued support.

My special thanks go to Michael Pollock and Elsje Scott for helping me collect the data from the UCT project teams, discussing with me the first results, and then writing our first joint articles on this topic. Thanks, too, to Frank Kschonsak, co-lecturer of the BHT teams in Germany, for his help in assessing those teams.

I feel a deep sense of obligation to Professor Dewald Roode: he was generous with his supportive guidance and valuable advice in the first phase of my thesis and agreed to be my co-supervisor; sadly, he passed away far too soon.

I am grateful to Professor Ojelanki Ngwenyama for his inspiring lectures and for his helpful comments on methodology during our discussions. Professor Mike Hart and Dr. Eric Cloete also merit my thanks for their friendship and intellectual support, as do all other members of the University of Cape Town's Information Systems Department for their continuing support and encouragement.

This project could not have been completed without the willingness of the students who were interviewed to give generously of their input and their time. Thank you, to all of you.

Last but not least: completing a thesis makes demands not only of the candidate but also of his family: my thanks to you, Edda, Lea and Julian. Your lasting patience, understanding, back-up, and advice have been my mainstay.

SHORT ABSTRACT

The project management of virtual teams differs from that of traditional ones. Traditional project risks like 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. Numerous researchers have investigated the factors influencing the success of virtual teams, but little research has been done to understand how to align technology with team and project tasks. When investigating virtual team technology, mediation should be considered as a central theme, while new web-based project management tools are likely to affect project management processes, particularly for virtual teams.

This thesis investigates how virtual project teams should select and use Internet/web-based tools to improve the team's performance and the satisfaction of its members. In the last three years I have observed, questioned, and interviewed 28 project teams with 167 team members in Germany and South Africa. The sampling and analyses of these teams were approached using grounded theory and aimed at developing a resultant theory.

The major theoretical contribution of my research is a holistic framework relating the effects on virtual project teams of Internet/web-based tools. The goal of my research was to develop a theory to explain the selection and use of web-based tools by virtual teams operating in different contexts, and to explain and illustrate the consequences of the use of different tool combinations.

My results contribute to practice by providing a number of guidelines for 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: limited Internet availability and bandwidth; lack of training for certain tools; the wrong selection and use of tools that are either not integrated/do not support adequate sharing among team members/do not help to manage the tasks and promote transparency about progress made. Definite areas emerged where tool selection and use, or lack of use of appropriate tools, affected performance. My theory also emphasises that besides the project and team context the personal preferences and distance from work of each member are important when selecting and using web-based tools in a distributed work setting. While communication is the heart of project teams, sharing is the soul of project teams that are virtual and use web-based tools. Task awareness is a key influencing the team members' satisfaction.

LONG ABSTRACT

Within the last few years globalization, shorter development cycles and scarce human expert resources have placed additional pressure on project teams. To meet these challenges distributed teams have been set up to work together across space, time and even organizational boundaries to increase the availability of scarce skills, reduce travel costs, and enhance worker job satisfaction due to fewer relocations. This has been made possible through the development of technologies that support the work of distributed teams, including tools in the categories of groupware, video-conferencing, mobile phones and the Internet. The project management of virtual teams differs significantly from that of traditional ones. Traditional project risks like complexity, the uncertainty of factors influencing the project as well as the high interdependency of project tasks must be managed together with changed temporal, geographical and cultural dimensions: this makes the management of a virtual project a complex undertaking with a high probability of failure. Furthermore, some researchers argue that diminished media richness decreases the efficiency of communication and can lead to a decrease in trust and commitment in the group. This, in turn, increases both transaction costs and the time to complete a project, and may lead to reduced quality of deliverables as well as diminished satisfaction of the team members involved. In recent years numerous researchers have investigated the factors influencing the success of virtual teams, but little research has been done to understand how to align technology with team and project tasks. When investigating virtual team technology, mediation is a central theme that has not been sufficiently considered in research. The lack of sufficient attention paid to technology in the research of virtual teams is a symptom of a general weakness in IS research. In addition, new web-based project management tools emerging onto the market are likely to have a strong impact on project management processes, especially for virtual project teams.

This PhD thesis presents a research study that investigates how virtual project teams should be selecting and using Internet/web-based tools in the project-management processes to improve the team's performance as well as the team member's satisfaction. In the last three years I have observed, questioned and interviewed a total of 28 project teams with 167 team members in Germany and South Africa. The sampling and analyses of these teams followed the grounded theory approach and aimed at the development of a resultant theory. My research provides as its major theoretical contribution a holistic framework relating the effects on virtual project teams of Internet/web-based tools. The goal of my research was to develop a theory that will help to explain the selection and use of web-based tools by virtual teams operating in different contexts, and to

illustrate the consequences of the use of different tool combinations to support their project management activities. In addition, this research is expected to make a methodological contribution to the debate concerning the use of grounded theory in the analysis of virtual project teams when using the Straussian process paradigm to investigate both individual and organizational issues.

My research results contribute to practice by providing a number of guidelines for the management of virtual teams as well as the initial knowledge required for companies that want to launch projects with virtual teams. Differing performances of teams can in many cases be attributed to a set of conditions: limited Internet availability and bandwidth, lack of training for certain tools as well as the wrong selection and use of tools that are not integrated or are not supporting adequate sharing among team members and, finally, are not helping to manage the tasks and to promote transparency about the 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. While communication is the heart of project teams, sharing is the soul of project teams that are virtual and that are using web-based tools. My theory elucidates the different roles played by trust in the selection, use and change of tools to assist virtual teams. It summarizes and endorses research findings on single aspects of trust in virtual teams. Task awareness is a key issue that influences the team members' satisfaction. If a tool supports task management by making the task progress transparent to every team member then the task awareness is enhanced within a virtual team setting. Trust is, in reality, an antecedent to working in such a setting. Sharing of information using a tool, on the other hand, does not merely increase the team's effectiveness but also helps to build up trust within the virtual team. Furthermore, my theory emphasises that besides the project and team context the individual preferences and personal distance from work of each team member play an important role in the selection and use of web-based tools in a distributed work setting.

Keywords: virtual teams, web-based technology, technological alignment, project management, grounded theory, trust, media selection theories, culture, individual preferences

Peter Weimann, Cape Town, August 2012

Table of Contents

1. INTRODUCTION 22

1.1 Background to the Research Problem 22

1.2 Purpose of the Research 23

1.3 Research Objectives 24

1.4 Importance of the Research 24

1.5 Research Context 25

1.6 Definition of Terms 26

1.7 Organization of the Thesis 27

2. LITERATURE REVIEW 29

2.1 Project Management 31

2.1.1 Project Teams 31

2.1.2 Project Management Tasks 37

2.1.3 Project Teams in an Educational Environment 38

2.2 CSCW, CMC and GSS to Support Teams 39

2.2.1 Computer Supported Cooperative Work 39

2.2.2 Computer Mediated Communication 40

2.2.3 Group Support Systems 41

2.2.4 Categorization of Groupware 42

2.3 Virtual Project Teams 45

2.3.1 Advantages and Disadvantages of Virtual Teams 47

2.3.2 Technology to Support Communication, Cooperation, and Project Management 48

2.3.3 Web-based Tools and Usability 53

2.4 Virtual Teams, Culture and Diversity 54

2.5 Factors and Relationships influencing Virtual Project Teams 60

2.6 Conclusions from the Literature Review 66

3. RESEARCH QUESTIONS 69

3.1 Problem Statement 69

3.2 Research Question 70

4. RESEARCH DESIGN 73

4.1 Research Paradigm 74

4.1.1 Positivist Research 74

4.1.2 Interpretative Research 75

4.1.3 Critical Research 76

4.1.4 Qualitative Approach versus Quantitative Approach 77

4.1.5 Triangulation 77

4.1.6 Empirical versus non-Empirical research 78

4.2 Research Method 79

4.2.1 Theory in Research 79

4.2.2 Grounded Theory 82

4.3 Data Collection 92

4.4 Data Analysis 97

4.5 Summary of Research Methodology 99

4.6 Research tools 100

4.7 Access, Privacy, Confidentiality and Ethics 100

5. ANALYSES AND CODING OF UCT AND BHT TEAMS 102

5.1 High Level Map of Data Sampling and Collection 102

5.2 Analyses of the UCT Teams 2008 108
5.2.1 Sampling, Data Collection and Data of the UCT Teams 2008 108
5.2.2 Results from the Open Coding 115
5.2.3 Results from the Axial Coding 118

5.3 Analyses of the UCT Teams 2009 125
5.3.1 Sampling, Data Collection and Data of the UCT Teams 2009 125
5.3.2 Integrating the UCT Teams 2009 into the Results 131

5.4 Analysis of the BHT Teams 2009 149
5.4.1 Sampling, Data Collection and Data of the BHT Teams 2009 149
5.4.2 Integrating the BHT Teams 2009 into the Results 155

5.5 Analysis of the BHT Teams 2010-O and 2010 171
5.5.1 Sampling and Data Collection of the BHT Teams 2010-O 171
5.5.2 Sampling and Data Collection of the BHT Teams 2010 172
5.5.3 Data of the BHT Teams 2010-O and the BHT Teams 2010 174
5.5.4 Integrating the BHT Teams 2010 into the Results 178

5.6 Selective Coding in the Research Study 187
5.6.1 Theoretical Saturation and Development of Theory 187
5.6.2 Summarized Main Categories 189
5.6.3 Matrices on Categories and Relationships in Theory building 193

6. THEORY ON THE SELECTION, USE AND CHANGE OF TOOLS IN VIRTUAL TEAMS 204

6.1 Selection of a Tool/Tool Combination 208
6.1.1 Description of the Phenomenon “Selection of a Tool/Tool Combination” 208
6.1.2 Causal Conditions and resulting Consequences/Actions for the Selection of Tool/Tool Combinations 209
6.1.3 Influence of the Project Context on the Selection of Tool/Tool Combination 212
6.1.4 Influence of the Team Context on the Selection of Tool/Tool Combination 213
6.1.5 Influence of the Team Members Context on Tool Selection 215
6.1.6 Interventions on the Selection of a Tool/Tool Combination 215

6.2 Use of a Tool/Tool Combination 217
6.2.1 Description of the Phenomenon "Use of a Tool/Tool Combination" 217
6.2.2 Causal Conditions and resulting Consequences/Actions for the Use of a Tool/Tool Combination 217
6.2.3 Influence of the Project Context on the Use of a Tool/Tool Combination 222
6.2.4 Influence of the Team Context on the Use of a Tool/Tool Combination 223
6.2.5 Influence of the Team Members Context on the Use of a Tool/Tool Combination 224
6.2.6 Interventions on the Use of a Tool/Tool Combination 224

6.3 Change of a Tool/Tool Combination 226
6.3.1 Description of the Phenomenon "Change of a Tool/Tool Combination" 226
6.3.2 Causal Conditions and resulting Consequences/Actions for the Change of a Tool/Tool Combination 227
6.3.3 Influence of the Project Context on the Change of the Tool/Tool Combination 228
6.3.4 Influence of the Team Context on the Change of the Tool/Tool Combination 228
6.3.5 Influence of the Team Member's Context on the Change of the Tool/Tool Combination 229

7. DISCUSSION 230

7.1 The Emergent Theory and ICT Inadequacy 231

7.2 The Emergent Theory and Vital Signs of Virtual Teams 232

7.3 The Emergent Theory and Media/Tool/Technology Selection Theories 233
7.3.1 Team Leaders Choice on Technology 233
7.3.2 Media Richness Theory 234
7.3.3 Task-Media Fit Theory 234
7.3.4 Media Synchronicity Theory 235
7.3.5 Media Naturalness Theory 236

7.4 The Emergent Theory and Diversity 236

7.5 The Emergent Theory and Usability/Task Awareness from the CSCW Research Field 237

7.6 Theoretical Integration of Key Issue in the Emergent Theory 239

8. CONCLUSIONS 241

8.1 Contributions of the Research to the field of IS 242

8.1.1 Practical Contributions 242

8.1.2 Theoretical Contributions 243

8.1.3 Methodological Contributions 244

8.2 Limitations of my Research 244

8.3 Suggestions for Future Research on the Emergent Theory 246

8.4 Evaluation of Contribution 246

8.4.1 Evaluation According to the Guidelines for Grounded Theory Studies in Information Systems 246

8.4.2 Whetten's Model for Determining what Constitutes a Theoretical Contribution 249

8.5 Concluding Remarks 254

9. REFERENCES 255

10. ATTACHMENTS 274

10.1 Ethics Committee Approval 274

10.2 Survey Questionnaire UCT 2008/2009 275

10.3 Survey Questionnaire BHT 2009/2010 276

List of Figures

Figure 1 - Model of Team Development based on Tuckman (1965) as well as Tuckman and Jensen (1977) 33

Figure 2 - Magical Triangle 35

Figure 3 - 3-by-3 Map to Categorize Groupware (Grundin, 1994) 41

Figure 4 - CSCW-Matrix (Johansen, 1988) 42

Figure 5 - Categorizing Groupware according to Different interaction modes (Sauter, Mühlherr, & Teufel, 1994) 43

Figure 6 - Groupware Grid (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996, p. 166) 44

Figure 7 - Configurations of Virtual Teams (Gillam & Oppenheim, 2006) 46

Figure 8 - Dimensions of Virtualness (Griffith, Sawyer, & Neale, 2003) 47

Figure 9 - Categorization of Web-based Tools to Support Project Management 49

Figure 10 - The Task Media Fit Matrix (Hollingshead, McGrath, & O'Connor, 1993) 51

Figure 11 - Schein's 3-Level-Model of Culture (adapted from Weislowski (2009)) 56

Figure 12 - The Dynamic of Top-down, Bottom-up Processes across Culture Levels (Erez & Gati, 2004) 58

Figure 13 - Research Framework Related to the Project Management Task, Processes and Phases 61

Figure 14 - Grounded Theory Approach adapted from Urquhart *et al.* (2010) 73

Figure 15 - Coding Paradigm and graphically adapted based on Pandit (1996) 88

Figure 16 - Phases and Steps of my Research Approach 93

Figure 17 - Data Sampling and Collection in my Research Study (adapted from Urquhart, *et al.* (2010)) 102

Figure 18 - Interview Sources related to the Concepts 116

Figure 19 - Relationships based on the analysis UCT 2008 Teams (from NVivo) 122

Figure 21 - Early Diagram on the Influence of the INTERNET on TEAMS 124

Figure 21 - Parent-Child-Relationships of the Sub-category Task Management 133

Figure 22 - Parent-Child-Relationships of the Sub-category Project Activity 134

Figure 23 - Early Diagram on the Work Setting in the Project 137

Figure 24 - Early Diagram on the Influence of Team Size and Work Setting on Task Planning 139

Figure 25 - Early Diagram on the Role of a Tool like Vula in a distributed Work Setting 140

Figure 26 - Early Diagram on the Relationship between Usability and Usage Frequency 141

Figure 27 - Early Diagram on Tool Usability – Integration – Team Effectiveness.....143

Figure 28 - Early Diagram on the Relationship of Project Phase, Tool Choice and Team Effectiveness 144

Figure 29 - Early Diagram on the Relationship of Private Geographical Distance and Tool Selection 145

Figure 30 - Early Diagram on the Tool Preferences in Task Management 146

Figure 31 - Early Diagram on the Influence of the Internet on Task Management 146

Figure 32 - Early Diagram on the Relationship of Trust Level on the Project Stage 147

Figure 33 - Early Diagram on Tool Usability - Team Size – Integration – Team Effectiveness 160

Figure 34 - Early Diagram on Project Phase, Tool Selection, and Team Effectiveness.....162

Figure 35 - Early Diagram on Face-To-Face Meetings in Long-term Projects.....163

Figure 36 - Early Diagram on Shared Document Handling and Team Effectiveness.....163

Figure 37 - Early Diagram on Shared Document Handling/Document Sharing and Team Effectiveness 164

Figure 38 - Early Diagram on Information Exchange/Task Tracking and Team's Trust Level 165

Figure 39 - Early Diagram on Central Platform and Team Effectiveness 166

Figure 40 - Early Diagram on the Influence of Usability and User friendliness on Usage Frequency 167

Figure 41 - Early Diagram - the Influence of Leadership Concept and Project Phase on Tool Selection and Face-to-Face Meeting Frequency.....168

Figure 42 - Early Diagram on the Influence of TASK TRANSPARENCY on TEAM MEMBER SATISFACTION 170

Figure 43 - Early Diagram on the Influence of the TOOLS SECURITY FEATURES 182

Figure 44 - Early Diagram shows the Possible Consequences of a SECURITY INCIDENT 183

Figure 45 - Early Diagram on the Influence of the TEAM MEMBER'S PREFERENCES on the TOOL SELECTION 184

Figure 46 - Early Diagram on the Influence of the TEAM MEMBERS' PREFERENCES on the USE of a TOOL 185

Figure 47 - The Selection-Use-Change Cycle for Internet-based Tool in Projects.....195

Figure 48 - Process of Selection-Use-Change of a Tool/Tool Combination 204

Figure 49 - Overview of the Main Categories with Concepts.....206

Figure 50 - Conditions, Context and Consequences in the Selection of a Tool/Tool Combination 209

Figure 51 - Conditions, Context and Consequences in the Use of a Tool/Tool Combination 217

Figure 52 - Conditions, Context and Consequences During the Change of a Tool/Tool Combination 226

List of Tables

Table 1 - Critical Project Success Factors (Pinto & Prescott, 1988) 36

Table 2 - Proposed Advantages and Disadvantages of Virtual Teams 48

Table 3 - Effects of Culture in Virtual Teams 59

Table 4 - Research Findings on the Team Affective Outcomes of Virtual Teams 66

Table 5 - Research Findings on the Performance Outcomes of Virtual Teams 66

Table 6 – Seven Principles for Interpretative Field Research (based on Klein and Myers (1999)) 75

Table 7 - Types of Triangulation 78

Table 8 - A Taxonomy of Theory Types in Information Systems Research (Gregor, 2006, p. 620) 79

Table 9 - Data Collection Methods 94

Table 10 - Summary of the Different Data Collection Methods in my Research Approach 97

Table 11 - Summary of Research Design 99

Table 12 - Teams at UCT and BHT 105

Table 13 - Theoretical Sampling Requirements between the Different Data Collection and Analysis Cycles 107

Table 14 - Team-specific Project Brief UCT 2008 108

Table 15 - Data Collection Protocol UCT-2008 109

Table 16 - Team and Work Characteristics UCT Teams 2008 110

Table 17 - Diversity of the UCT Teams 2008 111

Table 18 – Face-to-Face Meeting Frequency UCT Teams 2008 112

Table 19 - Use of Communication Technology UCT Teams 2008 113

Table 20 - Use of PM Software UCT Teams 2008 114

Table 21 - Performance Level UCT Teams 2008 115

Table 22 - Internet Availability and Internet Bandwidth UCT Teams 2008 115

Table 23 - Concepts, Sources and Number of References of the UCT Teams 2008 116

Table 24 - Concepts, Properties and Dimensions of the Category TEAM 119

Table 25 - Concepts, Properties and Dimensions of the Category PROJECT 120

Table 26 - Concepts, Properties and Dimensions of the Category TOOL 121

Table 27 - Properties and Dimensions of Specific TOOLS 122

Table 28 - Concepts, Properties and Dimensions of the Category INTERNET 122

Table 29 - Team-specific Project Brief UCT 2009 125

Table 30 - Data Collection Protocol UCT-2009 126

Table 31 - Performance Level UCT Teams 2009 126

Table 32 - Internet Availability and Internet Bandwidth UCT Teams 2009 127

Table 33 - Diversity of the UCT Teams 2009 127

Table 34 - Team and Work Characteristics UCT Teams 2009 128

Table 35 – Face-to-Face Meeting Frequency UCT Teams 2009 130

Table 36 - Use of Communication Technology UCT Teams 2009 130

Table 37 - Use of PM Software UCT Teams 2009 131

Table 38 - Additional Concepts/Properties in the Category TOOL 131

Table 39 - Additional Concepts/Properties in the Category TEAM 132

Table 40 - Additional Concepts/Properties in the Category PROJECT 132

Table 41 - Concepts, Properties and Dimensions of PROJECT ACTIVITY and TASK MANAGEMENT 134

Table 42 - Relationship between FRIENDSHIP and TRUST LEVEL in a TEAM 135

Table 43 - Team-specific Project Brief BHT 2009 149

Table 44 - Data Collection Protocol BHT-2009 151

Table 45 - Team and Work Characteristics BHT Teams 2009 151

Table 46 - Diversity of the BHT Teams 2009 151

Table 47 - Performance Level BHT Teams 2009 152

Table 48 – Face-to-Face Meeting Frequency BHT Teams 2009 153
Table 49 - Use of Communication Technology BHT Teams 2009....153
Table 50 - Use of PM Software BHT Teams 2009....155
Table 51 - Additional Concepts in the Category TOOL 156
Table 52 - Common Properties of the Different Specific TOOLS 157
Table 53 - Sub-category ACCEPTANCE....157
Table 54 - New Concepts in the Category TEAM 158
Table 55 - Additional Concepts in the Category PROJECT....158
Table 56 - TOOL Sub-categories PROJECT ACTIVITY and TASK MANAGEMENT....159
Table 57 - Team-specific Project Brief BHT 2010 online 171
Table 58 - Data Collection Protocol BHT-2010-Online 172
Table 59 - Team-specific Project Brief BHT 2010 173
Table 60 - Data Collection Protocol BHT-2010....173
Table 61 - Diversity of the BHT Teams 2010 174
Table 62 - Team and Work Characteristics BHT Teams 2010....174
Table 63 - Performance Level BHT Teams 2010....175
Table 64 – Face-to-Face Meeting Frequency BHT Teams 2010 176
Table 65 - Use of Communication Technology BHT Teams 2010-O and BHT Teams 2010....176
Table 66 - Use of PM Software BHT Teams 2010-O and BHT Teams 2010 177
Table 67 - Concepts in the Category TEAM 178
Table 68 - Concepts in the Sub-category MEMBER....179
Table 69 - Summarized Category PROJECT....189
Table 70 - Summarized Category TEAM and Sub-Category TEAM MEMBER....190
Table 71 - Summarized Category TOOL....191
Table 72 - Summarized Sub-Category SPECIFIC TOOL 193

Table 73 - Summarized Category INTERNET 193

Table 74 - Relationships over the three Interdependent Actions: Selection, Use and Change 194

Table 75 - Relationships influencing the Selection of a Tool/Tool Combination in Virtual Teams 196

Table 76 - Conditions and Consequences for the Use of a Tool/Tool Combination in Virtual Teams 199

Table 77 - Conditions and Consequences for the Change of a Tool/Tool Combination in Virtual Teams 203

Table 78 - Theoretical Integration of Key Issue of the Emergent Theory on the Selection, Use and Change of Tools in Virtual Teams 239

Table 79 - Applied Guidelines in my Grounded Theory Research Study.....247

List of Abbreviations

ADSL	Asymmetric Digital Subscriber Line
APA	American Psychological Association
BHT	Beuth Hochschule für Technik Berlin
CMC	Computer Mediated Communication
CSCW	Computer Supported Cooperative Work
CUA	Collaboration Usability Analysis
DSL	Digital Subscriber Line
GDSS	Group Decision Support Systems
GSS	Group Support Systems
GTM	Grounded Theory Method
ICT	Information and Communication Technology
IPMA	International Project Management Association
IS	Information Systems
IP	Internet Protocol
IPMA	International Project Management Association
ISO	International Standardization Organization
MRT	Media Richness Theory
MSN	The Microsoft Network
MST	Media Synchronicity Theory
MUD	Multi-User Dungeon
OGC	British Office of Government Commerce
PhD	Doctor of Philosophy
PM	Project Management

PMBOK	Project Management Book of Knowledge
PMI	Project Management Institute
PRINCE	Projects in Controlled Environments
RQ	Research Question
SMS	Short Message Service
TAM	Technology Acceptance Model
TIP	Task Interaction Performance
TTF-Model	Task Technology Fit Model
UCT	University of Cape Town
VSS	Visual Source Safe
VT	Virtual Team
WK	Wissenschaftliche Kommission

1. Introduction

1.1 Background to the Research Problem

Over the last few years globalization, shorter development cycles as well as scarce human expert resources have placed additional pressure on project teams. Distributed teams have, therefore, been set up to work together across space, time, and even organizational boundaries, to increase the availability of scarce skills, reduce travel costs, and enhance workers' job satisfaction due to fewer relocations. This has been made possible through the development of technologies that support the work of distributed teams, including tools in the categories of groupware, video-conferencing, mobile phones, and the Internet.

Many companies have applied these technologies to enable their distributed or so-called 'virtual' project teams to become more agile, to rapidly recruit scarce expert resources from all over the world, and hence to gain a competitive advantage on the global market (e.g., Bergiel, Bergiel, & Balsmeier (2008) and Wright & Drewery (2006)).

In times of mobile technology, globalization as well as the almost ubiquitous availability of high-bandwidth Internet access, the world is moving away from face-to-face human interaction. Computer-mediated communication plays an increasing role in everybody's life as more and more people socialize and shop in cyberspace (Townsend, DeMarie, & Hendrickson, 1998). According to Townsend *et al.* (1998), this may well transform the virtual team from being an innovative source of competitive advantage (Bergiel, Bergiel, & Balsmeier, 2008) into becoming the dominant organizational project form.

The project management of virtual teams differs from that of traditional ones. Traditional project risks like complexity, the uncertainty of factors influencing the project, and the high interdependency of project tasks must be managed together with changed temporal, geographical, and cultural dimensions, making the management of a virtual project a risky and complex undertaking with a high probability of failure (Reed & Knight, Project Risk Differences between Virtual and Co-Located Projects, 2010).

Furthermore, De Pillis and Furumo (2007) argue that diminished media richness decreases the efficiency of communication (Straus & McGrath, 1994) and can lead to reduced trust and commitment in the group (Watson-Manheim & Bélanger, 2002). This, in turn, increases both transaction costs and the time taken to complete a project, and it may lead to reduced quality of

deliverables as well as diminished satisfaction amongst the team members. In addition free-riding, which is a potential problem in any working group, may be easier in virtual teams where team member's actions are less visible (Chidambaram & Tung, 2006). This may influence the satisfaction of team members as well as the team's performance.

Several researchers (e.g. Bergiel, Bergiel, & Balsmeier (2008); de Pillis and Furumo (2006); Reed and Knight: "Project Risk Differences between Virtual and Co-Located Projects" (2010) and Schweitzer and Duxbury (2010)) point out the performance gap between virtual and face-to-face teams. This relates for example to a difficult and less effective communication and causes reduced effectiveness (de Pillis & Furumo, 2007) or insufficient knowledge transfer (Reed & Knight, 2010). Schweitzer and Duxbury (2010) even argue that the more teams move away from the face-to-face form, the more traditional measures of effectiveness are negatively impacted.

Technologies and tools are necessary for performing projects with virtual teams (Lipnack & Stamps, 1997), but, on the other hand, they are also adding risks to the success of the project (Thomas & Bostrom, 2010).

1.2 Purpose of the Research

In recent years numerous researchers have investigated the factors influencing the success of virtual teams (e.g., Espinosa, DeLone, & Lee (2006), Kankanhalli, Tan, & Wei (2007), Kayworth & Leidner (2000), and Maznevski & Chudoba (2000)), but little has been done to understand the alignment of technology with the specific project requirements and team characteristics to improve the team's effectiveness as well as the team members' satisfaction (Bjørn & Ngwenyama, 2010). In their five-trigger model for the team leader intervention in virtual teams, Thomas and Bostrom (2010) identify inadequate information and communication technology (ICT) as one trigger for intervention. Bjørn and Ngwenyama (2010) say that technology mediation is a central theme when investigating virtual teams and it is one that so far has not been sufficiently considered in research. The lack of attention towards technology in the research of virtual teams is a symptom of a general weakness in Information Systems (IS) research, as has already been pointed out by Orlikowski and Iacono (2001). 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.

The purpose of this study is thus, firstly, to explore the selection and use of web-based/Internet tools in the underlying project management processes of virtual teams, and, secondly, to understand their impact on team effectiveness and performance, project success, as

well as team member's satisfaction. This is reflected in the core research question of how Internet/web-based tools should be employed in the project management processes of virtual project teams by increasing the effectiveness of the processes, and improving the project outcome as well as the team affective outcome. The investigation of these issues will provide the basis for developing a framework that integrates the relevant concepts and their relationships, and for proposing guidelines as to how organizations can improve the project management processes for distributed and virtual project teams. This will hopefully shed more light on how best to use web-based/Internet technology in a distributed environment, where continuous face-to-face interaction is missing or reduced.

1.3 Research Objectives

The research objectives are therefore as follows:

- To evaluate the impact of web-based/Internet technology on the processes of virtual project teams.
- To understand how the use of web-based/Internet technology influences communication, cooperation, and coordination of virtual teams and *vice versa*.
- To determine how web-based technology can be used to effectively support project management processes in virtual teams.
- To provide an initial set of guidelines for organizations and virtual teams that will facilitate the selection, use and change of web-based/Internet technology so as to increase the project performance outcome and the team affective outcomes (e.g., team member satisfaction) and thereby enhance the likelihood of project success.

1.4 Importance of the Research

This study will provide valuable insight into how the efficient use of web-based tools can reduce the gap between the performance of face-to-face and virtual project teams, based on a holistic view of the factors influencing both performance outcome and team affective outcome. The developed framework shall help organizations to understand how different team dynamics, socio-emotional factors, and project and team characteristics affect the selection and use of technology and in turn also affect the project outcome. Because communication technology plays an essential role in virtual teams, the task-technology fit and the media-richness of the different tools have a

significant impact on different factors affecting team and performance outcomes. The understanding of these relationships is essential in order to develop guidelines for virtual project teams.

1.5 Research Context

The research has been conducted among different undergraduate student project teams from Information Systems (IS) and Industrial Engineering in Cape Town (South Africa) and Berlin (Germany), 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 the team composition, task, and technology. While these teams are not spread across each country or the world[1], they provide typical 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 their literature review Martins, Gilson, and Maynard (2004) pointed out that only 13 out of 93 empirical studies used "real teams"; all other were case or lab studies mostly using "student teams". Some examples of empirical research studies with student teams are: Cramton (2001), Flammia, Cleary, and Slattery (2010), Gonzalez, Burke, Santuzzi, and Bradley (2003), Huang and Ocker (2006), Jarvenpaa and Leidner (1999), Lind (1999), Qureshi, Liu, and Vogel, (2005) as well as Sarker and Sahay (2002).

[1] According to Fiol and O'Connor (2005) and Kraut, Fussell, Brennan, and Siegel (2002) the effects of proximity among team members fall off rapidly with even very small distances. Therefore, even team members who reside near each other but who never meet may experience very similar dynamics to those who interact across large distances.

1.6 Definition of Terms

It is important to note the definition of the following terms, which are repeatedly used throughout this thesis and which are at the basis of the discussion:

- A ***project***[2] is "a temporary endeavour undertaken to create a unique product, service, or result" (Project Management Institute, 2004, p. 368).
- 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 (Cohen & Bailey, 1997).
- A ***project team*** is a team performing a project according to the PMI definition and thus it is assembled for a certain defined period of time.
- ***Virtual teams***[3] *are* teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task (Martins, Gilson, & Maynard, 2004).
- According to Martins *et al.* (2004*),* ***virtualness*** is a characteristic that can be assigned to every team and specifies the degree to which the team members are working across locational, temporal, and relational boundaries to accomplish an interdependent task.
- ***Team effectiveness*** can be determined by the enhanced productivity resulting from increased levels of interaction between team members, the degree to which team members enjoy the project experience, and the quality of the final results produced by the team in achieving the desired goal.
- Authors like Kerzner (2006) and Schwalbe (2008) have defined the factors *on time, within budget* and *to specification* as being measurements of the ***success of a project*** in terms of the project outcome. This is in line with the view of institutions like the British Office of Government

[2] The definitions of PMI have been selected for my research because the PMBOK is one of the major sources of project management knowledge and the selected undergraduate project teams from UCT and BHT Berlin have compulsory courses on PMBOK-based project management.

[3] Due to the growing literature on virtual teams there has been a proliferation of definitions. A closer look at these definitions indicates a considerable overlap in the core definition, which is well represented by the above definition, with small variations in the specifics, which are discussed briefly in the literature review.

Commerce (OGC), the Project Management Institute (PMI) and the International Project Management Association (IPMA).

- In the context of this research, ***Internet/web-based tools*** refer to a class of tools that support the project management processes of project teams working over the Internet. This includes the sharing of information, documents, and knowledge; communication and collaboration; and the specific management of project tasks.

1.7 Organization of the Thesis

In this chapter I describe the motivation for my research and my research objectives. In the following paragraphs I outline how my research study proceeded and what the purposes are of the different chapters. The thesis is organised into 7 chapters, excluding the reference list and appendices.

In Chapter 2, previous research work on teams, projects, virtual teams, web-based tools, project success, and critical success factors is reviewed, analysed, and finally major research findings and dependencies are presented, using the McGrath (1964) Input-Process-Output-Model. Related research regarding culture and diversity is described as well as the relevant research results from the fields of Computer Supported Cooperative Work (CSCW) and Computer Mediated Collaboration (CMC).

Chapter 3 details the problem statement and research questions.

Chapter 4 explains the methodology with reference to the research paradigm, method, and strategy; this section also discusses alternative research approaches with regard to virtual teams, and specifically outlines the grounded theory methods and the research procedure employed in this research study. In it I also discuss briefly the major strands in following a grounded theory approach.

Chapter 5 details the research results with corresponding analyses following a grounded theory approach aiming to develop an explaining theory (Gregor, 2006) addressing the research problem. The chapter is extended to address the different data slices and coding phases of my research design.

Chapter 6 describes the resultant theory on the selection, use and change of a tool/tool combination in a virtual project setting.

Chapter 7 discusses and compares my theory with other theories in this field, like for example the Media Richness Theory and the Media Synchronicity theory. Furthermore the research results are discussed in the context of recent research articles.

Chapter 8 summarizes the overall contribution of this thesis to the theory and practice of project teams as well as to research methodology, it also evaluates my approach according to the guidelines of Urquhart, Lehmann and Myers (2010) and it values my contributions according to Whetten's model for determining what constitutes a theoretical contribution (1989).

2. Literature Review

This chapter presents a review and critical discussion of the existing literature on virtual teams. Even though I am going to describe and justify my research approach, the grounded theory, in chapter 4, it is necessary to anticipate this decision.

One of the characteristics of the grounded theory method is that there are no pre-formulated hypotheses. Theory building and not theory verification is the main and only aim of grounded theory (Urquhart, Lehmann, & Myers, 2010). Arising from this goal, as pointed out by Suddaby (2006), some researchers have implied that the researcher should not review the existing literature prior to his empirical research. This would ensure that s/he does not impose ideas from literature in his data analysis (coding). Glaser and Strauss (1967, p. 4), however, point out in a footnote that prerequisite knowledge and orientation is necessary:

> Of course, the researcher does not approach reality as a tabula rasa. He must have a perspective that will help him to see data and abstract significant categories from his scrutiny of the data.

Discussing this issue, Dey (1999) accentuates the difference between "an open mind and an empty head" and believes that the founder of the grounded theory was inclined to favour the "open mind". Urquhart *et al.* (2010) agree with him and Urquhart (2007) sees the "preliminary literature review as orientation not defining framework" as one guideline for the application of grounded theory. Urquhart and Fernandez (2006, p. 461) suggest that a preliminary literature review is done

> on the understanding that it is the generated theory that will determine the relevance of the literature.

Further, she emphasizes that the literature should be revisited and even extended after the theory has been developed from the data (Urquhart, 2007). Based on these recommendations and guidelines, my literature review will serve as orientation for furthering my research work. I will extend the literature review by comparing my theory with other qualitative research results and with other theories, in chapter 7. While doing this I will follow the phasing of the literature as recommended by Martin (2006) as well as by Urquhart and Fernandez (2006).

Especially the weaving in the literature into the findings by not performing an extensive literature review upfront has been pursued by Strong and Volkoff (2010) and is pointed out in the subsequent quote:

> As our study leveraged grounded theory procedures, it does not start from the literature, but rather uses it later to compare the results revealed from data with existing theory (Urquhart and Fernandez 2006). Thus, we do not provide an extensive survey of literature on fit or on enterprise systems, but rather weave in the literature related to our findings and theoretical results later (Strong & Volkoff, 2010, p. 733).

As a starting point for my own literature review I used the following literature reviews for an overview of the existing state of the field and of the leading researchers in this field: Connaughton & Shuffler (2007), Gibbs, Nekrassova, Grushina, & Wahab (2008), Gillam & Oppenheim (2006), Ebrahim, Ahmed, & Taha (2009), Martins, Gilson, & Maynard (2004), Powell, Piccoli, & Ives (2004), and Schiller & Mandviwalla (2007). Based on these reviews I followed the literature that was referenced. In addition, the most frequently occurring journals were searched to make sure that all relevant literature and research findings had been identified.

As pointed out by Ngwenyama and Bjørn (2008), earlier 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 include Group Support Systems (GSS). Research issues in these fields that are relevant to virtual teams will be incorporated into my literature review.

The literature review has been constructed as follows. A general description is given of project team, project management, and project teams in general as well as in an educational environment. The above mentioned research in CSCW, CMC and GSS is described. This is followed by an overview of research in the field of virtual project teams. Diversity in team composition, including cultural background, is one of the key issues in the management of virtual teams and this topic is therefore addressed in a separate section. Further, the factors influencing the outcome and success of virtual project teams are described. Finally, the results of the review are summarized at the end of the chapter.

2.1 *Project Management*

Different national and international organizations such as the PMI, the OGC and the IPMA, have set up formalized bodies of project management methods for the planning, monitoring, and controlling of time, quality, cost, and results of projects. Furthermore, frameworks of guidelines such as the PMBOK[4] (Project Management Institute, 2004) and PRINCE/PRINCE2 (Office of Government Commerce, 2005) have been developed to support the various tasks in a project.

2.1.1 Project Teams

Since a project is "a temporary endeavour undertaken to create a unique product, service, or result" (Project Management Institute, 2004, p. 368) it is characterized by a definite beginning and a definite end, as well as by the uniqueness of the project deliverables.

A project team is created for the purpose of performing a project. Both a team and a group could be loosely defined as a collection of people at work, but a team is generally regarded as a group[5] that has a high level of interdependency and integration among its members as described by (Cohen & Bailey, 1997):

> 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 (for example business unit or the corporation), and who manage their relationships across organizational boundaries.

This stricter definition of a team is widely accepted and applies more appropriately to teams that are set up to conduct projects. I define a project team as a team performing a project according to the PMI definition: it is therefore a group assembled for a certain defined period of time.

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[4] In the literature review for my thesis I place emphasis on the PMBOK. The selected undergraduate project teams from UCT und BHT Berlin have compulsory courses on PMBOK-based project management.

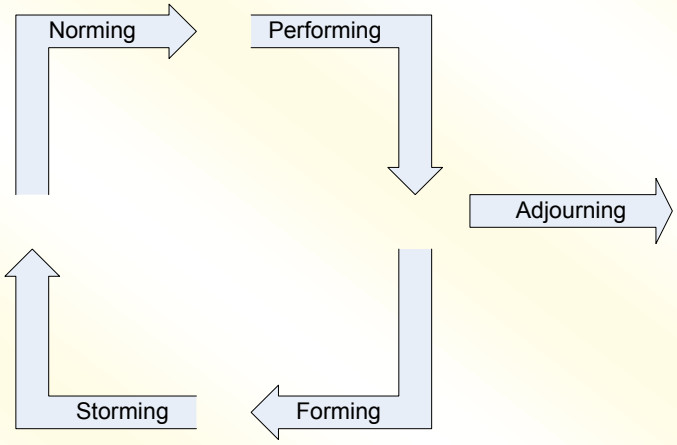
[5] As pointed out in Cohen and Bailey (1997) the academic literature tends to use the word "group" for specific phenomena like group cohesion, group dynamics and group effectiveness while management literature prefers to use the term "team". As my research places the emphasis on projects I am using the term "team", but when referring to specific phenomena from group research literature I will use the term from this literature.

Most software projects in industry are accomplished by teams of professionals rather than by individuals due to the size of these projects. Teams tend to perform better than individuals (Brown & Dobbie, 1999). Katzenbach and Smith (1992) support this view by stating that in teams the complementary skills of the individuals within the team speed up the time to delivery, provide a social framework, and create a pleasant working atmosphere. Taking these definitions into account, project teams are formed and disbanded. Furthermore, teams go through different phases. The team development model (see Figure 1) from Tuckman (1965) defines the following phases:

- **Forming:** The project team is initiated or at least new team members are introduced to an existing team. In this first phase normally little work is achieved.
- **Storming:** Team members often have different opinions of how the team in the project should operate. Hence, there are often conflicts in the project team during this phase, which follows the forming phase.
- **Norming:** In this phase the team develops common working rules. Subsequently, cooperation and collaboration replace the conflict and mistrust of the storming phase.
- **Performing:** The focus of the team is now set on the project tasks. The relationships in the team are settled and team members build loyalty to each other. The team can manage complex tasks and cope with changes.
- **Adjourning[6]:** This phase describes the break-up of the team after they have completed their project.

[6] The last phase was not originally part of Tuckman's 1965 model but was added to the model in 1977 in his article with Jensen (Tuckman & Jensen, 1977).

Figure 1 - Model of Team Development based on Tuckman (1965) as well as Tuckman and Jensen (1977)



2.1.1.1 Project Team Effectiveness and Performance

A core element in evaluating and measuring teams is effectiveness. Effectiveness can be defined as the product of clear goals and objectives. A pleasing impression has been created through competent labour, and a minimization of the number of errors made during the course of completing an objective. Further, effectiveness can also be understood as the team's ability to perform. The performance of a project team is part of the team's overall effectiveness. Sundstrom, De Meuse and Futrell (1990) concur that one of the aspects of effectiveness is performance and therefore performance has a direct relationship to effectiveness (Katzenbach & Smith, 1992). When the effectiveness of a team is measured and evaluated, one of the outputs is the team's performance. According to Hackman (2002) 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 to help their personal needs be satisfied. (Hackman, 2002, p. 23;27;28)

Cohen and Bailey (1997) state that effectiveness also encompasses the quality of the final product and the degree of enjoyment the members had of the project experience. 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.

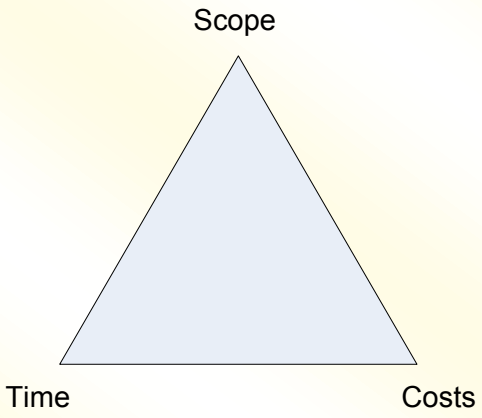
However, by knowing the distinguishing features of effective teams, this is not enough to achieve them: effective management is also needed (Hackman, 1987).

Thus, creating the correct environment for teams is crucial in providing an atmosphere in which effective teamwork is possible. A controlled and well-managed environment is necessary to create a safe space for creative development of project teams. A positive atmosphere is furthermore conducive to the productivity of teams, encourages enjoyment of the project experience, and motivates teams to commit to and achieve their goals.

2.1.1.2 Project Success

Due to the fact the many parties are involved in the project, defining and measuring the success of a project, especially in the field of Information Systems, is problematic (Chan, 2000). During the last decade a large number of empirical research studies have been conducted to identify factors that influence the success of traditional and virtual project teams. Many authors (e.g., Kerzner (2006), Project Management Institute (2004), and Schwalbe (2008)) have defined the factors that enable measurement of the success of a project in terms of the project outcome to be: delivering *on time, within budget and according to specification.* The relationship of these factors is often described as the supposed magical triangle (see Figure 2). For a successful project the project leader has to consider these factors and balance them, since they often compete with each other. This magical triangle illustrates the interdependency between these factors. To assess the performance of a project team one can take the project outcome and include the factors of scope/quality, budget and time.

Figure 2 - Magical Triangle



Even though Turner (1993) argues that these three factors primarily represent the view of the contractor of a project, empirical research reveals that they are also the highest ranked factors in different surveys (e.g., Wateridge (1998), and White & Fortune (2002)). However, they are not the only factors important when judging the outcome of a project. Also important:

- The fit between the project and the organization (White & Fortune, 2002).
- The consequences of the project for the performance of the business (White & Fortune, 2002).
- The quality levels met (Wateridge, 1998).
- The satisfaction of user and other stakeholders (Pinto & Slevin, 1988).

It has also been pointed out that the perceived success of a project is of equal importance to the eventual success of the project (Baker, Murphy, & Fisher, 1983). This implies that a project can still be successful even if it has not met the timescale and budget requirements. According to Wateridge (1998) the success of the project depends on the viewpoints of the different stakeholders. Furthermore, the success of a project may also be described in terms of how the project affected the team and its individual members with respect to level of stress, overtime, conflict, satisfaction, and level of motivation (Freeman & Beale, 1992).

As diverse as is the discussion on the different factors of success, **measuring** the success of a project has generated a long list of factors **influencing** the success of a project. The first useful coverage of these **critical factors in deciding on the success of a project** is given by Pinto and Prescott (1988) (See Table 1).

Table 1 - Critical Project Success Factors (Pinto & Prescott, 1988)

Critical Project Success Factor	Description
Project Mission	Initial clarity of goals and general directions.
Top Management Support	Willingness of top management to provide the necessary resources and authority/power for project success.
Project Plan	A detailed specification of the individual action steps required for project implementation.
Client Consultation	Communication, consultation, and action listening to all impacted parties.
Personnel	Recruitment, selection, and training of the necessary personnel for the project team.
Technical Tasks	Availability of the required technology and expertise to accomplish the specific technical action steps.
Client Acceptance	The act of "selling" the final project to its ultimate intended users.
Monitoring and Feedback	Timely provision of comprehensive control information at each stage in the implementation process.
Communication	The provision of an appropriate network and necessary data to all key actors in the project implementation.
Troubleshooting	Ability to handle unexpected crises and deviations from plan.

In the survey by White and Fortune (2002) the most frequently mentioned criteria are: clear goals; support from senior management; adequate funds and resources as well as realistic schedules. Other project success factors frequently mentioned are: end user commitment; clear communication channels; effective leadership/conflict resolution; effective monitoring and feedback; flexible approach to change; taking into account past experiences; recognizing complexity; recognition of external influences; effective team building/motivation and effective management of risk. These critical project success factors are in line with Pinto & Prescott (1988) and other researchers (e.g., Belassi & Tukel (1996), Magal, Carr, & Watson (1988), and Pinto & Slevin (1988)).

2.1.1.3 Team Performance 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 the transfer of knowledge and experience. Projects at an undergraduate level are most likely a first-time experience for team members of developing a comprehensive information system. Thus these projects might not be of a high enough standard to be implemented immediately in a business environment at the pre-determined hand-in date.

In some capstone courses, such as those partly investigated in my research, a comprehensive assessment strategy that implements various instruments to accomplish formal summative assessment, formal continuous assessment, and informal formative assessment can greatly enhance the quality of projects and their chances of successful implementation (Scott & van der Merwe, 2003). Teams achieving low marks are more likely to deliver a project failure, just as teams with high marks are more likely to deliver a project success. Procaccino, Verner and Lorenzet (2006) note that all project stakeholders, in particular project managers, must consider what developers deem to be important in terms of project success. Baker, Murphy and Fisher (1983) as well as Scott, Brown, Pearce and Weimann (2009) support this with their findings that perceived project success is of equal importance to the eventual success of the project.

2.1.2 Project Management Tasks

According to the PMBOK (Project Management Institute, 2004) specific methods need to be applied in the various phases of a project. A typical project runs through the following phases (e.g., Alpar, Alt, Bensberg, Grob, Weimann, & Winter (2011), Kerzner (2006), and Schwalbe (2008)):

- The **initiation phase** defines or authorizes processes at the beginning of a project or project phase.
- In the **planning phase** the processes are planned that are required to attain the objectives within the scope of the project.
- In the **execution phase** the resources are coordinated by carrying out the project plans and producing the deliverables of the project.
- The **monitoring and controlling phases** include the processes to regularly measure and monitor the progress towards achieving the project goals, to monitor deviations from the plans, and to take corrective actions.
- The **closing phase** includes the formal acceptance of the project deliverables and the completion of all activities related to the project's goal.

These phases partly overlap. The project team has to perform a large number of processes consisting of several tasks to manage costs, time, quality, communication, risks, people, integration, resources, and conflicts. These tasks will demand the application of specific project management methods. The PMBOK (Project Management Institute, 2004) addresses different related issues that are processed independently in specific knowledge areas, e.g., communication management, human resource management, or time management.

The effectiveness of the performance of these tasks can influence the effectiveness of the project team and the outcome of the project. For example, milestone planning and firm set deadlines have a positive influence on the team's performance and the assigning of roles to members and responsibilities for the deliverables produces a higher quality (see Soderlund (2002), and Gersick (1988)). Risk management is a critical success factor for information system development (Boehm, 1991). Frequent communication and information flow is necessary for maintaining commitment to the project goal and building trust in the project team (Jonsson, Novosel, Lillieskold, & Eriksson, 2001).

2.1.3 Project Teams in an Educational Environment

The importance of teamwork in industry demands that universities prepare students for projects in real life. One of the main benefits of team projects in tertiary education is to provide students with a unique experience of the multiple and diverse disciplines that are characteristic of the daily life of an Information Technology / Information Systems (IT/IS) specialist in industry (Scott, Brown, Pearce, & Weimann, 2009). In addition to technical skills, students also develop 'soft' skills, like mutual respect for other team members, presentation abilities, and communication skills (Brown & Dobbie, 1999). Team projects can be used as a learning experience to engage students in an Action Learning Cycle, thus promoting continuous planning, reflection, observation, and action amongst participants (Bunning, 1997). Team projects also nurture cognitive, affective, and psychomotor learning in a student-centred and student-directed manner which requires the command, analysis, and synthesis of knowledge and skills (Moore, 2005).

The following quotation of the words of an UCT alumnus confirms that a team project can expose students to many of the challenges they might encounter in future employment but it also shows that projects in an educational environment are often close to the reality in industry.

> 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.

In South Africa and Germany, student project teams show many characteristics typical for virtual teams of large organizations, because of their multi-cultural make up, their distributed working styles (at home, with the sponsor, in the labs), and their limited face-to-face meeting

opportunities due to travel costs, involvement in different courses, and part-time work (Van der Merwe, Weimann, & Scott, 2011).

2.2 *CSCW, CMC and GSS to Support Teams*

Previous research in team-based structures and groupware technology has attracted wide interest and led to the research fields of Computer Supported Cooperative Work (CSCW), Computer Mediated Communication (CMC), and Group Support Systems (GSS).

2.2.1 Computer Supported Cooperative Work

Research in the field of Computer Supported Cooperative Work (CSCW) focuses on issues that influence the work of people using technology; it is especially aiming to understand the characteristics of how people work together in a group or team and how systems should be designed to support mutually dependent team work. This research brings together scientists from different areas such as psychology, anthropology, economics, organizational theory, sociology and computer sciences (Grundin, 1994). Based on the research in CSCW a number of concepts have been identified as relevant for research in the field of virtual teams (Stahl & Hermann, 1999):

- **Awareness**[7] 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 (Schmidt, 2002). The understanding here is that for successful collaborative work the multiple participants are required to coordinate their activities (Heath, Svensson, Hindmarsh, Luff, & vom Lehn, 2002). In this context it is, according to Ngwenyama and Bjørn (2008), necessary to distinguish between activities demanding task-oriented awareness and those demanding social awareness. While the first addresses those activities performed in order to accomplish a specific, independent task, the second addresses awareness when the team members are present and engage socially with other team members regularly, and the activities of the team members in the collaborative work setting (Prinz, 1999).

[7] As pointed out by Schmidt (2002) 'awareness' is one of those English words that can be used to refer to many different things. "Depending on the context it may mean anything from consciousness or knowledge to attention or sentience, and from sensitivity or apperception to acquaintance or recollection." (Schmidt, 2002, p. 287)

- **Coordination** or **Articulation of work** describes the processes of aligning, scheduling, allocating as well as integrating of the single, 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 (Schmidt & Bannon, 1992).
- **Tailorability** covers the adaptation of the team and/or individuals of the used technology/tools to their particular work situation (Schmidt, 1991).
- **Negotiation** is necessary to find consensus in a team regarding cooperation, team goals, and work participation of the different team members (Stahl & Hermann, 1999).

Besides these issues, one of the most important aspects of CSCW research is the understanding that the social context plays an important role in the cooperative team work (compare Lyytinen & Ngwenyama (1992), and Schmidt & Bannon (1992)). This social context includes elements such as culture, beliefs and values as well as unarticulated background assumptions. This social context implicitly guides individual team members in the interpretation of collaborative events and gives meaning in concrete situations (see Ngwenyama & Bjørn (2008), and Orlikowski & Gash (1994)).

2.2.2 Computer Mediated Communication

Communication is at the heart of virtual team work. Therefore research in the field of Computer Mediated Communication (CMC) plays an important role for virtual teams. According to Hertel, Geister and Konradt (2005), research in the field of CMC compares the effects of different communication media in different groups (face-to-face, computer mediated).

Research in the field of CMC is, according to Baltes, Dickson, Sherman, Bauer and LaGanke (2002), related to the question on how CMC is affecting the outcome of collaborative team work with regard to, for example, team member satisfaction, team performance, 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 (Brewer, 2010).

2.2.3 Group Support Systems

According to Nunamaker, Briggs, Mittleman, Vogel and Balthazard (1996), Group Support Systems (GSS) are:

> interactive computer-based environments that support concerted and coordinated team effort toward completion of joint tasks. Besides supporting information access, GSS can radically change the dynamics of group interactions by improving communication, by structuring and focusing problem solving efforts, and by establishing and maintaining an alignment between personal and group goals.

Historically, GSS covers the "Same time-Same place" technology and is originated in the area of group decision making as supported by the so-called GDSS (Group Decision Support Systems) (Grundin, 1994). According to Grundin (1994) research in this field is closely related to the field of Information Systems, even though there is an overlapping with research in the CSCW and it originated in Business and Management Science.

Figure 3 - 3-by-3 Map to Categorize Groupware (Grundin, 1994)

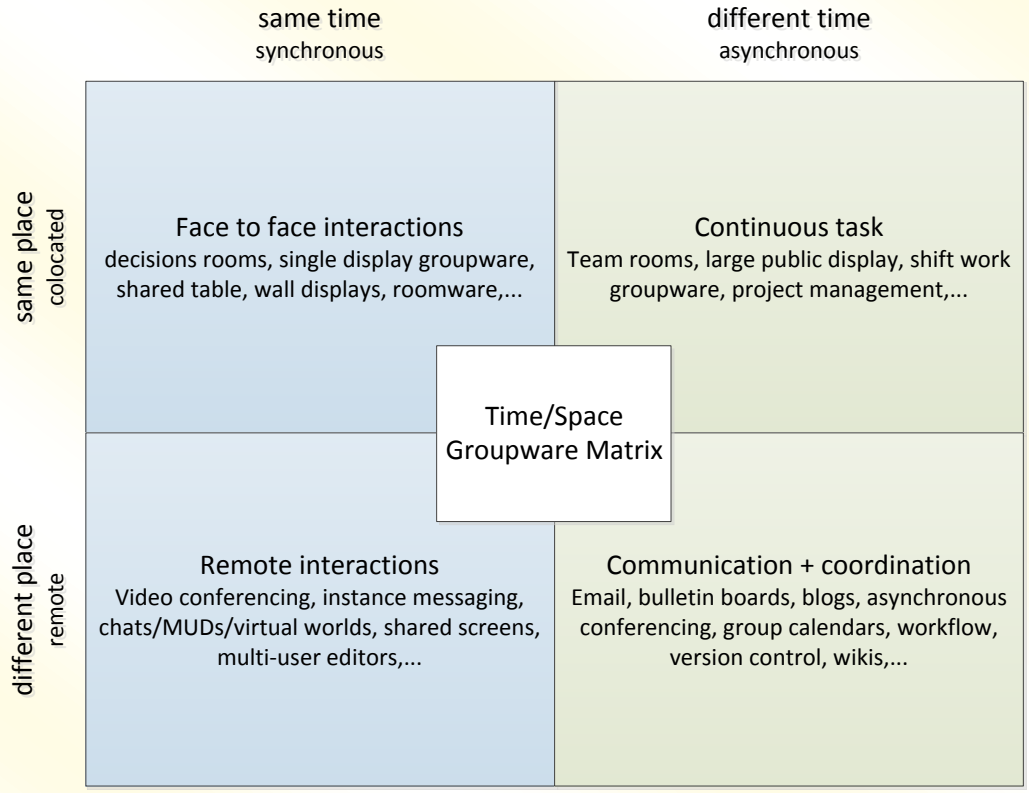
Place \ Time	Same	Different but predictable	Different and unpredictable
Same	Meeting facilitation	Work shifts	Team rooms
Different but predictable	Tele/video/dektop conferencing	Electronic mail	Collaborative writing
Different and unpredictable	Interactive Multicast seminars	Computer bulletin boards	Workflow

2.2.4 Categorization of Groupware

In all of the above research fields the term “groupware” plays an important role. But different authors have different kinds of applications in mind when using this term (Grundin, 1994). According to Krasner, Mclnroy and Walz (1991) groupware is a specific aspect of CSCW relating to the information technologies required to actively facilitate collaborating users. Groupware should enable groups that are geographically and temporally distributed to work together effectively.

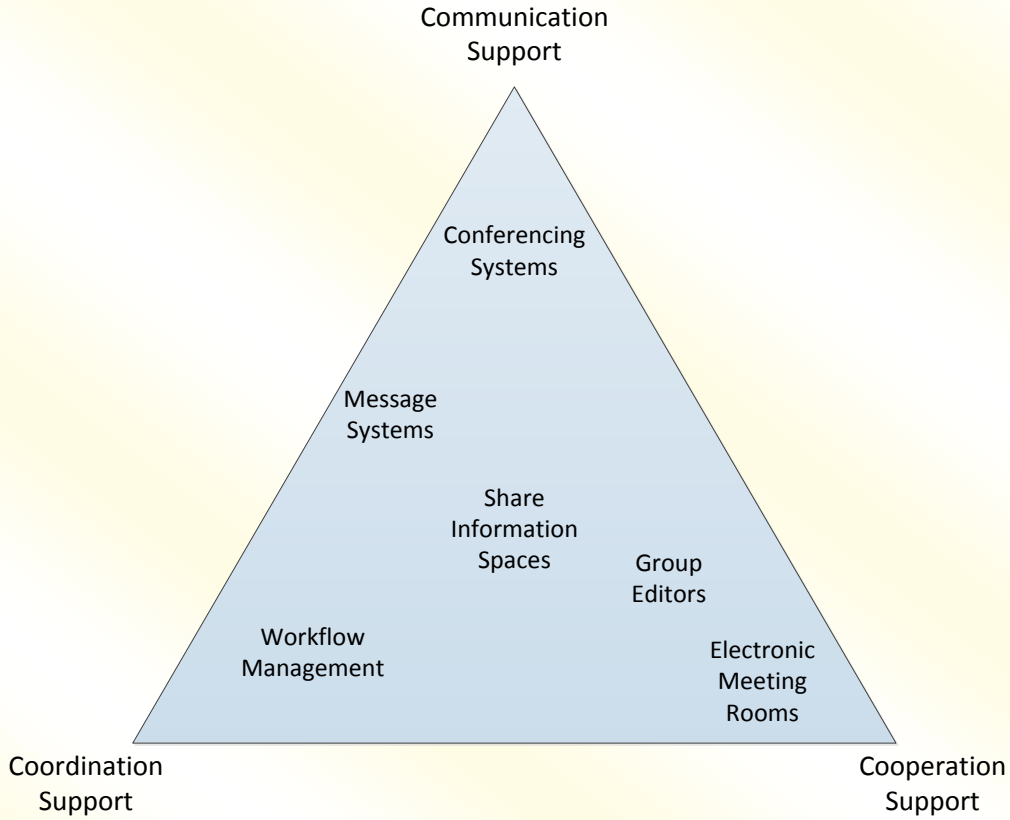
Grundin (1994) refers to a 3-by-3-map to categorize groupware software (see Figure 3) based on the space/time categorization of DeSanctis and Gallupe (1987). Hertel *et al.* (2005) state that groupware can be classified according to the necessary coordination efforts or their necessary interdependence, ranging from low--where only information exchange is supported--to high--where activities in the group are coordinated. Groupware applications in the field of CSCW are often classified according to the CSCW-Matrix first introduced by Johansen (1988) (see Figure 4).

Figure 4 - CSCW-Matrix (Johansen, 1988)



Taking the cooperation aspect into account, the triangle sourced from Sauter, Mühlherr and Teufel (1994) shows an alternative way to categorize groupware according to the main mode of how interaction in the group is supported (See Figure 5).

Figure 5 - Categorizing Groupware according to Different interaction modes (Sauter, Mühlherr, & Teufel, 1994)



Based on Briggs (1994), the team theory of group productivity (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996) proposes a three-by-three-Matrix (see Figure 6) for groupware categorization with a horizontal axis of communication, deliberation, and information access. According to Nunamaker *et al*. (1996, p. 165), **team theory**

> is a causal model for the productivity of a team. It asserts that team members divide their limited attention resources among three cognitive processes: communication, deliberation, and information access. Team Theory posits that these processes interfere with one another, limiting group productivity.

According to this theory communication addresses the attention that team members pay to choosing words, their behaviors, images, and artifacts, as well as presenting them through a medium to other team members. The term “deliberation” describes the cognitive effort made by team member’s when forming intentions towards accomplishing a goal. This includes the classic problem-solving activities. Finally, the information-access element refers to the demands of finding, storing,

processing, and retrieving the information needed to support deliberation (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996).

Based on **team theory,** the horizontal axis describes the potential of technology/groupware to reduce the cognitive costs or joint effort of the group to achieve a goal. Groups may become less productive if the attention demands for communication, deliberation, or information access are too high. Therefore, Groupware may improve productivity to the degree that it reduces the attention costs of these three processes.

Figure 6 - Groupware Grid (Nunamaker, Briggs, Mittleman, Vogel, & Balthazard, 1996, p. 166)

	Communication Support	Deliberation Support	Information Access Support
Concerted Work Level			
Coordinated Work Level			
Individual Work Level			

The vertical axis of their matrix (see Figure 6) consists of three group work levels:

- The individual level if the team member operates individually without requiring any coordination;
- At the level of coordinated group work the team needs to interact to coordinate (to sum up) their independent work results; and
- The concerted work level when teams must make a continuous concerted effort.

Groupware can support all three levels. Different groupware applications can be compared with each other.

In the following chapter I will pick up these issues as they are related to virtual teams and discuss them, including the factors that influence virtual project teams.

2.3 *Virtual Project Teams*

During the last decade there has been a proliferation of definitions of virtual teams caused by the growing literature[8] in the field. A close look at these definitions shows a considerable overlap in core areas and small variations in specific issues.

According to Hertel, Konradt and Orlikowski (2004), a virtual team is a group of geographically distributed and organizationally dispersed workers performing one or more tasks supported by information and communication technology. According to Powell *et al.* (2004, p. 7) distinctive features of a virtual team are

> their preponderant - and at times exclusive – reliance on information technology to communicate with each other, their flexible compositions, and their ability, if necessary, to traverse traditional organizational boundaries and time constraints.[9]

In DeSanctis and Monge (1999, p. 694) the definition of a virtual organization is different. They define a virtual organization as

> geographically distributed, functionally or culturally diverse, electronically linked, and connected via lateral relationships.

In their definition they explicitly mention *cultural diversity* or functional diversity as important attributes of a virtual organization.

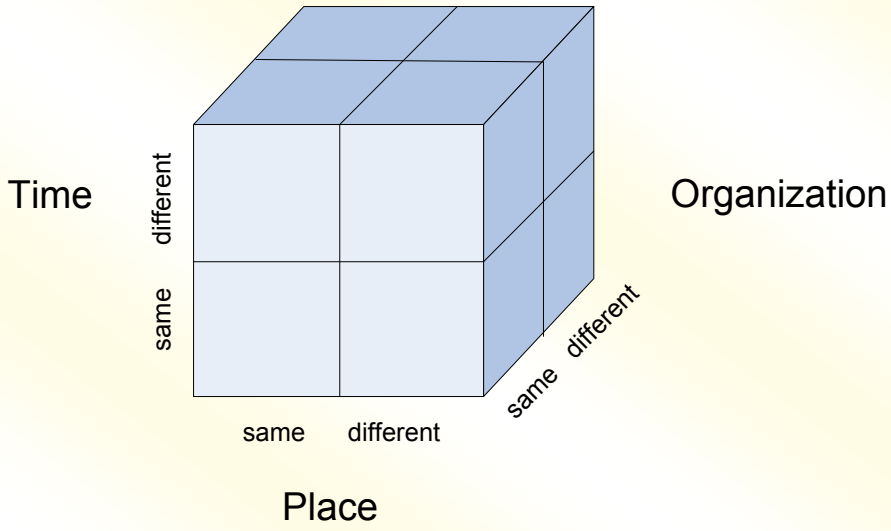
Instead of defining virtual teams as a type of team that contrasts with *traditional* or face-*to-face* teams, Martins *et al.* (2004) note that definitions are focussing on *virtualness* as a potential characteristic of all teams. Today the majority of definitions state that virtual teams are functioning

[8] The articles I reviewed varied in the use of terms to describe virtual teams. Most common was the term “global virtual teams”. Other terms researchers used were “cross cultural distributed teams”; “global teams”; “geographically distributed teams”; “virtual intercultural teams”; “multicultural distributed teams”; “geographically dispersed teams” or “computer-mediated distributed teams”.

[9] Applying this definition and the described features to virtual project teams I interpret the features of “flexible composition” and the necessity to “traverse traditional organizational boundaries” as project-specific elements and not necessarily as a distinct feature of a virtual team. These characteristics can occur in any project.

teams that rely on technology-based communication while crossing several different boundaries. According to Gillam and Oppenheim (2006) the coordinates of time, place, and organization can be used to highlight the different boundaries and define the characteristics of different virtual teams.

Figure 7 - Configurations of Virtual Teams (Gillam & Oppenheim, 2006)



The dimension *place* or geographical boundary has led some researchers to focus on *global* virtual teams only (Maznevski & Chudoba, 2000).

Other characteristics of virtual teams that have not universally been adopted are a more fluid membership (Kirkman, Rosen, Tesluk, & Gibson, 2004) and the shorter lifecycle of virtual teams compared to face-to-face teams (Jarvenpaa & Leidner, 1999). Taking into account that in real life purely face-to-face teams are as rare as are virtual teams that communicate and interact exclusively through electronic media, recent definitions of virtual teams focus on a team's *extent of virtualness* (see Bell & Kozlowski (2002), Griffith & Neale (2001), and Kirkman, Rosen, Tesluk, & Gibson (2004)). Schweitzer and Duxbury (2010, p. 267) define the degree of virtuality according to three dimensions:

> the proportion of work time that the VT [virtual team] members spend working apart (team time worked virtually), the proportion of the team's members who work virtually (member virtuality) and the degree of separation of the team's members (distance virtuality).

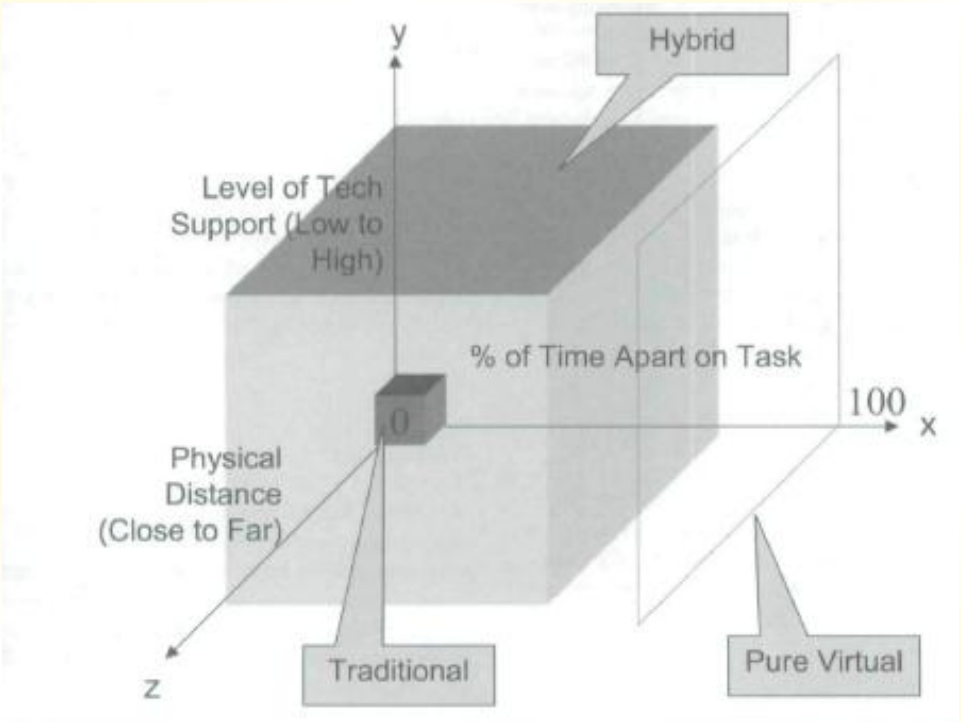
According to Espinosa, DeLone and Lee (2006) global team members need to bridge boundaries such as geographic distance, time separation as well as organizational, functional, and cultural borders. Lu, Watson-Manheim, Chudoba, and Wynn (2006) state that as more of these boundaries are present the "virtuality" of the team increases.

In line with these aspects I use in my research work the definition for virtual teams of Martins *et al.* (2004). They define virtual teams as

> teams whose members use technology to varying degrees in working across locational, temporal, and relational boundaries to accomplish an interdependent task. (Martins, Gilson, & Maynard, 2004, p. 808)

Griffith, Sawyer and Neale (2003) illustrate in the following figure the varying degree of the dimensions **Level of Technological Support**, **Time Apart on Task** and **Physical Distance** in defining **Traditional**, **Hybrid** and **Pure Virtual** teams.

Figure 8 - Dimensions of Virtualness (Griffith, Sawyer, & Neale, 2003)



2.3.1 Advantages and Disadvantages of Virtual Teams

In the literature (e.g., Bergiel, Bergiel, & Balsmeier (2008), and Lipnack & Stamps (1997)) many advantages and disadvantages of virtual teams are proposed and partly (see, e.g., De Pillis & Furumo (2007)) discussed critically. The following table summarizes and briefly describes the main advantages and disadvantages.

Table 2 - Proposed Advantages and Disadvantages of Virtual Teams

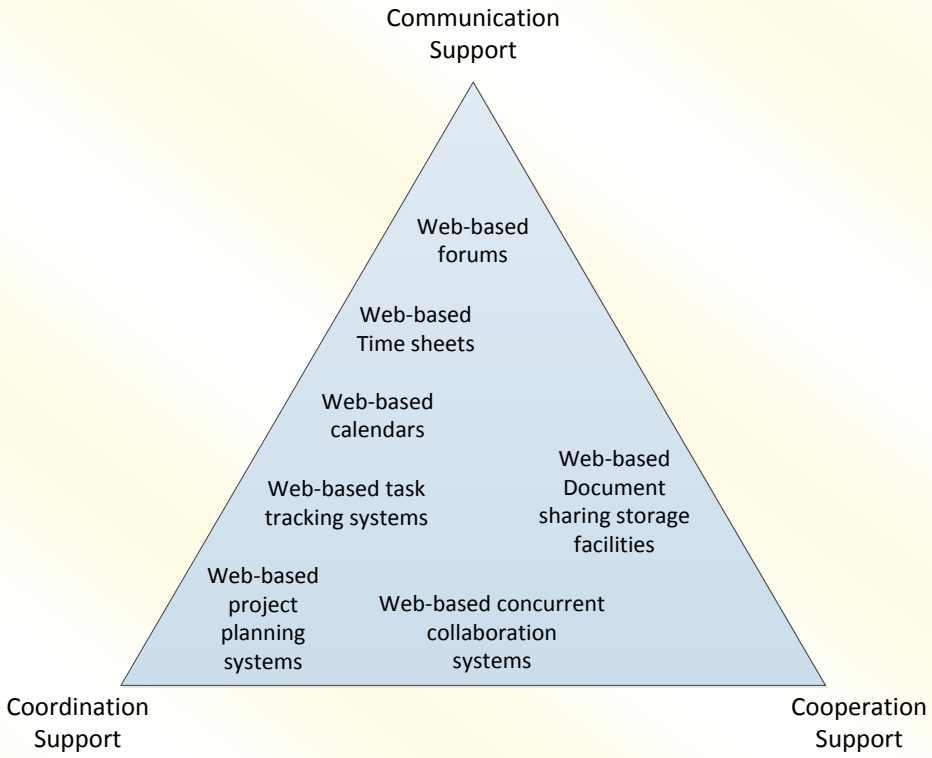
Advantages	Disadvantages
Potential decrease in travel time and costs (Gillam & Oppenheim, 2006); (Bergiel, Bergiel, & Balsmeier, 2008); (Kayworth & Leidner, 2000)	The virtual structure may not fit into the operational environment (Gillam & Oppenheim, 2006)
Diversity forces creativity (Bergiel, Bergiel, & Balsmeier, 2008)	Lack of expertise in technological application related to teaming among some mature senior manager (Gillam & Oppenheim, 2006)
Responsiveness (Bergiel, Bergiel, & Balsmeier, 2008)	Not an option for every type of employee because of an employee's psychological make-up and other predispositions (Gillam & Oppenheim, 2006)
Higher flexibility (Bergiel, Bergiel, & Balsmeier, 2008), flexibility in balancing personal and professional life (Gillam & Oppenheim, 2006)	Potential decrease in efficiency due to free-riding (de Pillis & Furumo, 2007); (de Pillis & Furumo, 2006)
Reduces discrimination (Bergiel, Bergiel, & Balsmeier, 2008); opportunities for physically challenged people to work in a non-traditional environment (Gillam & Oppenheim, 2006)	Extremely difficult and less effective communication and therefore reduced efficiency (Kayworth & Leidner, 2000); (de Pillis & Furumo, 2007); (McGrath & Hollingshead, 1994)
Teams of expert's and best competencies – Maximize the expertise without having physically to relocate individuals (Bergiel, Bergiel, & Balsmeier, 2008); (Gillam & Oppenheim, 2006); (Kayworth & Leidner, 2000); Useful for projects that require cross-functional or cross-boundary skilled inputs (Lee-Kelley & Sankey, 2008)	More project risk due to insufficient knowledge transfer (Reed & Knight, 2010)
Cost saving in central office space (Gillam & Oppenheim, 2006)	Negative, often unintended and unanticipated effects on innovation (Gibson & Gibbs, 2006)
Team members' ability to be at two places at the same time (Majchrzak, Malhotra, Lipnack, & Stamps, 2004)	

2.3.2 Technology to Support Communication, Cooperation, and Project Management

Technology is an essential channel for the communication in the virtual teams and builds the basis for every collaboration and coordination activity. In CSCW Research and GSS research different matrixes have been proposed to classify groupware according to time, place, and predictability. Similar classifications can be found in virtual team literature (e.g., Jude-York, Davis, & Wise (2000) and Shen & Dewan (1992)). Alternatively groupware, especially Internet and web-based tools, can be categorized according to their interaction modes: collaboration, coordination and coordination as proposed by Sauter *et al.* (1994). Several web-based tools are available to support the project

management processes of virtual project teams over the Internet. A categorization of these tools into the 3C-Modell from Sauter *et al.* (1994) is shown in the following Figure 9.

Figure 9 - Categorization of Web-based Tools to Support Project Management



The following list gives a brief description of relevant web-based tools that can be used by virtual project teams (see Gillam & Oppenheim (2006), Shen & Dewan (1992), and Townsend, DeMarie, & Hendrickson (1998)):

- **Web-based forums** enable team members to post messages to an online message board.
- **Web-based concurrent collaboration systems** (e.g., 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. They manage and maintain a list of tasks as needed by the project, a list often initiated during project planning.
- **Web-based project planning** supports the project team in developing a schedule for the tasks involved in 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 (e.g., protocols, deliverables, project plans).

The challenge of sharing important information lies at the heart of a virtual team (Jude-York, Davis, & Wise, 2000). Since team members can be connected by a variety of information and communication technologies, regulations for processing and sharing information are necessary to avoid the introduction of other socio-emotional factors that might undermine project success**.** For example, unevenly distributed information is a common complaint of virtual teams (Cramton, 2001).

In selecting and classifying communication technologies for the use in virtual teams one theory that is widely applied and cited (e.g., Burke, Aytes, & Chidambaram (2001), (D'Ambra, Rice, & O'Connor, 1998), Lee A. S. (1994), and Ngwenyama & Lee (1997)) is the **Media Richness Theory** (MRT). Sometimes it is also referred to as Information Richness Theory. This theory is based on the work of Daft and Lengel (1984 and 1986) as well as Daft, Lengel and Trevino (1987). MRT 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 (Daft & Lengel, 1986).

According to Schiller and Mandviwalla (2007), MRT suggests that media vary in the levels of richness they provide. 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, SMS, addressed written documents (e.g., notes, memos and letters), and unaddressed documents (e.g., bulletins and standard reports) follow in media richness in a descending order. The MRT 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. Daft and Lengel (1984) found out that commonly used media in organizations work better for certain tasks than other media. They specifically concluded that written media are preferred for unequivocal messages while face-to-face media are preferred for messages containing equivocality. Further, Daft *et al*. (1987) found out that high performing managers are more sensitive to the relationship between message ambiguity and media richness than low performing managers.

Even though this theory is widely applied there are some studies that do not support the media richness theory regarding its effect on the task performance and satisfaction (e.g., Dennis & Kinney (1998), and Suh (1999)).

McGrath and Hollingshead have suggested the task-media fit theory as an improvement to MRT. In a four-by-four they describe matrix media and characteristics and task types as well as the effect of their fit on performance (See Figure 10 - The Task Media Fit Matrix).

Figure 10 - The Task Media Fit Matrix (Hollingshead, McGrath, & O'Connor, 1993)

			Communication Media			
			Increasing potential richness of information →			
			Computer Text Systems	Audio Systems	Video Systems	Face-to-Face Communications
Task type(s)	Increasing potential richness required for task success ↓	Generating ideas & plans	Good fit	Marginal Fit Info too rich	Poor Fit Info too rich	Poor Fit Info too rich
		Choosing correct answer: intellective tasks	Marginal Fit Medium too constrained	Good fit	Good fit	Poor Fit Info too rich
		Choosing preferred answer: judgement tasks	Poor Fit Medium too constrained	Good fit	Good fit	Marginal Fit Info too rich
		Negotiating conflicts of interest	Poor Fit Medium too constrained	Poor Fit Medium too constrained	Marginal Fit Info too lean	Good fit

Hollingshead *et al.* (1993) argue that the best fits between media and tasks lie near the main diagonal of this matrix. Task/media combinations northeast of the diagonal tend to be inefficient, because the media may be too rich for the task and cause the distraction from effective communication. On the other hand, task/media combinations southwest of the diagonal tend to be ineffective because the media might be too lean for the task and therefore not capable of giving enough information.

Alternatively, Dennis and Valacich (1999) have developed the **Media Synchronicity Theory** (MST) which is, according to Schiller and Mandviwalla (2007), based on the MRT (Daft & Lengel, 1984) and Task Interaction Performance (TIP) theories (McGrath, 1991). According to Dennis and Valacich (1999), media synchronicity is defined as based on five media characteristics: immediacy of feedback, symbol variety, parallelism, rehear ability, and reprocess ability. Media synchronicity itself is defined as

> the extent to which individuals work together on the same activity at the same time; i.e., have a shared focus (Dennis & Valacich, 1999, p. 5).

Further, MST differentiates the communication tasks according to whether they are conveyance or convergence. 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. Based on MST a better match of media synchronicity with the teams communication processes will lead to an improved performance of the team members (Schiller & Mandviwalla, 2007). According to Dennis, Fuller and Valacich (2008), for most tasks the use of one medium alone is not sufficient to achieve an ideal communication performance. The reason is that many tasks require both conveyance and convergence. This is further explained by the following quotation:

> 'Richer' is not 'better.' The use of multiple media, either concurrently or consecutively, will lead to better communication performance, because no one medium provides the ideal combination of capabilities for both conveyance and convergence (Dennis, Fuller, & Valacich, 2008, p. 595).

The **Task Technology Fit (TTF) Model** devised by Goodhue and Thompson (1995) builds upon a model by DeLone and McLean (1992). They proposed that utilization and user attitudes about the technology lead to individual performance impacts. The TTF Model goes beyond their model both by exploring how technology impacts performance and by providing a stronger theoretical basis about a number of IT related issues on performance like understanding the impact of user involvement or the impact of Information Systems problems. Goodhue and Thompson (1995) suggest in their TTF model that a technology has to take into account the utilization for the tasks and the good fit to have a positive impact on the user's individual performance.

Kock (2004) developed the **Media Naturalness Theory** to understand the user's behaviour towards communication media. This theory provides a psychological model and can be considered,

according to Kock (2004), as a Darwinian theory of behaviour regarding different types of communication media. He argues that the evolutionary process of the last thousands of years has led to a development of our brain that is designed for face-to-face communication. Other forms of communication are too recent to have had an impact on the development of our brain. Using electronic communication tools that suppress key elements in face-to-face communication creates cognitive obstacles in the communication. This is especially important for complex tasks, as they demand more intensive communication than simple tasks.

2.3.3 Web-based Tools and Usability

For technology in general but especially for virtual teams selecting and using web-based tools, **usability** is an important issue and, according to Mayhew (1999), can be defined as a measurable component of a product's interface. Usability is the most traditional concept in human computer interface research. One of the more frequently used definitions of usability is that of ISO 9241. The ISO 9241 Standard, titled *Ergonomics of Human System Interaction*, defines usability as

> the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use (ISO, 2010).

According to Green and Pearson (2011), usability has been applied in many different ways and to different kinds of application and, according to Quesenbery (2003), even the ISO 9241 does not provide broad enough coverage to describe human interaction in the world of the Web. There are several attempts to fully understand website usability (e.g., Hall & Hanna (2004), Cappel & Huang (2007), and Palmer (2002)). Lee and Kozar (2011) identified 10 website usability factors: consistency, navigability, supportability, learnability, simplicity, interactivity, telepresence, content relevance, credibility, and readability.

Usability research on tools, especially web-based tools that support virtual teams, is mainly located in the CSCW and groupware fields (e.g., Gutwin, Roseman, & Greenberg (1996), Gutwin & Greenberg (1999), Romano, Nunamaker, & Briggs (1997), and Olaniran (1996)).

Several researchers have evaluated the acceptance of technology and tools in IS using approaches like the Technology Acceptance Model (TAM) (e.g., Vreede, Jones, & Mgaya (1999)) or the Collaboration Usability Analysis (CUA) (e.g., Pinelle, Gutwin, & Greenberg (2003)).

CUA is an evaluation method for shared-workspace groupware that focuses on the teamwork that is conducted in a group task. CUA permits variable paths through the execution of a specific group task, and allows alternative pathways and optional tasks to be modelled.

According to Pinelle *et al.* (2003, p. 281), CUA's main contribution "is to provide evaluators with a framework in which they can simulate the realistic use of a groupware system and identify usability problems that are caused by the groupware interface."

Related to the usability of a tool is acceptance on the part of the user. One way to assess the usability is the Technology Acceptance Model (TAM) developed from Davis (1989). The TAM is an Information Systems theory modelling how the user accepts and uses a specific technology.

This model proposes that when users are presented with a new technology or tool, several issues effect their decision about how and when they will use the tool or technology:

> **Perceived usefulness** – "is defined as the prospective user's subjective probability that using a specific application system will increase his or her job performance within an organizational context". (Davis, Bagozzi, & Warshaw, 1989, p. 985)
>
> **Perceived ease-of-use** - "refers to the degree to which the prospective user expects the target system to be free of effort". (Davis, Bagozzi, & Warshaw, 1989, p. 985)

The TAM model has been thoroughly studied and expanded in different versions (for more detail see (Venkatesh, Morris, Davis, & Davis, 2003) and (Venkatesh & Bala, 2008)).

Despite being one of the most influential theories in Information Systems, TAM is criticized for diverting the researchers' attention directly or indirectly away from other important research issues through their focus on TAM-based explanations in their field of studies (e.g., Benbasat & Barki (2007) and Straub Jr. & Burton-Jones (2007)). Further, the attempt of the researcher to adapt TAM to the constantly changing IT environment has created a number of different theories and confusion over which version of TAM is the commonly accepted one (Benbasat & Barki, 2007).

2.4 Virtual Teams, Culture and Diversity

Examining diversity in team composition means looking at a number of factors including varying backgrounds, skills, unit affiliations, sex, and last and but not least, cultural backgrounds (Paul, Samarah, Seetharaman, & Myktyn, 2005). The cultural background (or culture) has been described as one of the key issues in the management of teams and project (e.g., Leidner & Kayworth

(2006)) and is especially significant for virtual teams (e.g., Baba, Gluesing, Ratner, & Wagner (2004), Connaughton & Shuffler (2007), Espinosa, DeLone, & Lee (2006), Fisher & Fisher (1998), and Shachaf (2008)). The definitions of virtual teams highlight the different cultural background of members as one characteristic of these teams. Connaughton and Shuffler (2007) provide numerous examples and references for the growing prevalence of virtual teams with a so-called multi-cultural background. Therefore, it is important to analyse the literature as to how culture is constructed, to discuss its role in virtual teams, and to look into the existing empirical research on culture in virtual teams.

According to Hall and Hall (1989), in anthropology--where the concept of culture is traditionally studied-- there is no consensus on its meaning. There are a large number of perceptions on the matter and culture has been defined in numerous ways even in recent academic research (e.g., Jenks (1993), Stohl (2001), and Ting-Toomey (1999)).

The first known definition of culture dates back to 1871 when Sir Edward Burnett Tylor defined culture as

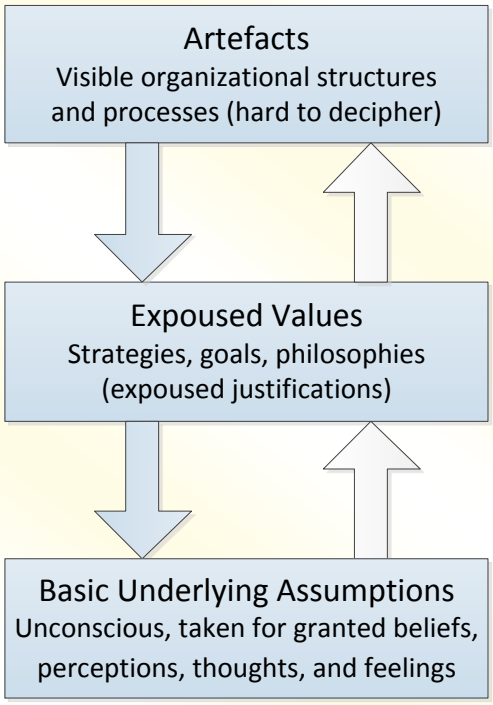
> that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society (Tylor, 1871, p. 1).

A well-known definition of culture is that of Kroeber and Kluckhohn (1952), who also relate the notion of culture to behaviour. They identify culture as patterns of ideas and values that shape one's behaviour.

Schein's three level model of culture (1985) goes further, dividing culture into three levels including the observable aspects:

- On the highest level are the visible **behaviours** and physical artefacts and creations, such as technology, art, visible and audible behaviours.
- **Values** are on the second level and they answer the question why individuals behave as they do**.** They represent a visible manifestation of culture that shows the beliefs of what is important to a specific cultural group.
- The underlying **basic assumptions,** placed on the third level, are the core part of a culture and represent the individual's belief system regarding human behaviour, relationships, reality and truth. They are invisible and non-debatable.

Figure 11 - Schein's 3-Level-Model of Culture (adapted from Weislowski (2009))



According to Schein (1985, 1990), the cultural artefacts, on the highest level, are the most observable, but are also the hardest to interpret regarding their cultural meaning. Several researchers (e.g., Coombs, Knights, & Willmott (1992), Feldman & March (1981), and Robey & Markus (1984)) have pointed out that certain artefacts, including information technology, are not culturally neutral. They may symbolize a number of different values driven by underlying basis assumptions. Schein (1985, 1990) points out that values are easier to study then basic assumption and cultural artefacts.

It is not surprising, as is highlighted by Leidner and Kayworth (2006), that many of the theories that conceptualize in the area of culture use a reference group value orientation, use the work of Hofstede's Cultural Dimensions (1980) or Hall's high and low context (1976) when focussing on a national level, Quinn and Rohrbaugh's competing values framework (compare (1981) and (1983)) or Kotter and Heskett's for work on organizational cultures (1992)[10].

[10] In their review of culture in information system research Leidner and Kayworth (2006) classify the theories according to whether they address culture on the National, Organization or Sub-Unit Level. In my thesis I will use their classification when addressing the specific cultural theories.

Schein's 3-Level-Model on Culture (see Figure 11) shows that there is a link between 'values' and 'behaviour'. Accordingly, say Posner and Munson (1979), 'values' can be seen as a set of social norms that define the rules of social interaction (action and communication), having an impact on the subsequent behaviours of a group or organization, and setting the expectations and boundaries of appropriate behaviour for its members (O'Reilly & Chatman, 1996).

Leidner and Kayworth (2006, p. 359) conclude:

> Thus, the study of organizational values may be of particularly useful in explaining certain behaviours with respect to how social groups interact with and apply IT in organizational context.

In current research on virtual teams Hofstede's cultural dimensions are often applied to assess the consequences on team process and outcomes of multi-cultural composition (such as Sarker (2005), Paul, Samarah, Seetharaman, & Myktyn (2005), Vogel, Van Genuchten, Lou, Verveen, Van Eekout, & Adams (2001), and Workman (2005)).

Hofstede suggests that culture is not inherited but learned, as it is derived from "one's social environment". Hofstede's work from the 1970s explored the notion of national culture. Four independent dimensions of national culture that could be measured relative to other cultures were proposed (Hofstede, 1980). After replication of his studies a fifth cultural variable was added. A country's position on these dimensions allows us to predict how its society operates. The five cultural dimensions identified are (Hofstede, 1991):

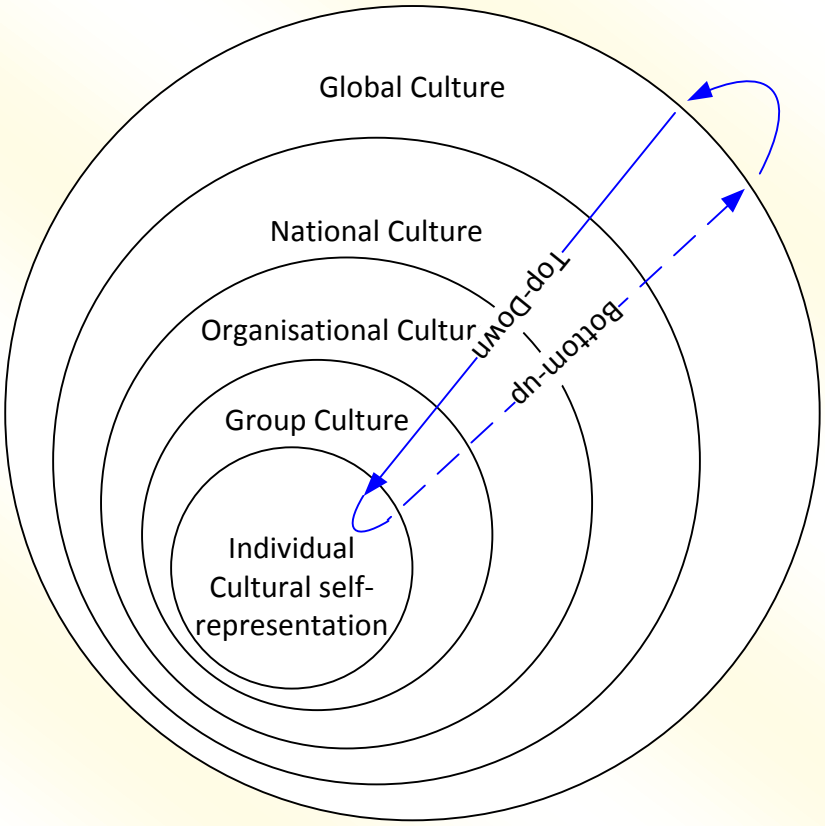
- *Power distance*: Degree of inequality among people that is considered as normal (from small to large);
- *Uncertainty avoidance*: Degree to which people prefer structured over unstructured situations (from weak to strong);
- I*ndividualism versus collectivism*: Degree to which people prefer to act as individuals rather than as members of groups;
- *Masculinity versus feminity*: Degree to which tough values prevail over tender values;
- L*ong-term* orientation as opposed to short term orientation: Degree to which people's efforts are focused towards the future rather than the present.

These five dimensions can be used to study cultural differences between people from different nations. Among Hostede's dimensions that of individualism-collectivism is particularly useful in understanding multi-cultural team processes, even if it does not account for the fluid and

dynamic aspects of culture (Ancona, 1987). Further, Ancona (1987) points out that even when team member belong to a specific national culture they are influenced by the context (the team or organization) in which they are living or working.

Culture itself is not static. Even though there are forces that resist change, change is constant. Erez and Gati (2004) propose a dynamic model of the different levels of culture as displayed in Figure 12.

Figure 12 - The Dynamic of Top-down, Bottom-up Processes across Culture Levels (Erez & Gati, 2004)



The general sources that influence change and resistance are, among others, the forces at work within a society and contact between societies. Also relevant within the field of virtual team work, are the findings of Anawati and Graig (2006) that team members who had training on the differences among national cultures adapted their behaviour more readily compared to team members without such training. Lee and Barnett (1997) as well as Lindsey (1999) showed, furthermore, in their studies that the national culture is influential and affects the organizational culture as well as team related issues. The following table provides an overview of the findings of several researchers regarding the effects of cultures on virtual teams.

Table 3 - Effects of Culture in Virtual Teams

Effects of culture on team outcome and processes	**Researchers/Research Groups**
Members of multi-cultural teams adapt to each other in written and oral communication.	(Anawati & Craig, 2006)
Language is one of the primary cause of miscommunication	(Brewer, 2010)
Information distortion and various instances of miscommunication, e.g. cultural differences intensify communications problems; the language barrier caused loss of information; cultural differences affected ability to communicate ideas and coordinate the project; cultural differences affected the timing and the ability to meet deadlines.	(Kayworth & Leidner, 2000)
More collaborative conflict management and decision-making in multi-cultural virtual teams.	(Paul, Samarah, Seetharaman, & Myktyn, 2005)
A number of problems attributable to place--limited human connection; lack of agreed upon norms of virtual presence and turn-taking; invisibility of remote team-members' physical actions; mismatch in practices (e.g., language, communicative styles, working styles, festivals--and time--mismatches in psychological and social clocks of team members; complexities in accounting for time zones; negative interpretations of time lapses, and difficulty in comprehending temporally disordered sequences of chat and threaded messages--separation specific to different cultures.	(Sarker & Sahay, 2004)
Hofstede's cultural dimension "individualistic versus collectivistic" was found to have a significant effect on knowledge transfer in that members of individualistic cultures shared/transferred more knowledge.	(Sarker, 2005)
Differences in virtual team members (coming from different cultural background) perception of time influence the team's dynamics and performance.	(Saunders, Van Slyke, & Vogel, 2004)
Information and communication technologies mitigate the negative impact of intercultural miscommunication in virtual teams.	(Shachaf, 2008)
The cultural diversity of team members influences the selection of information and communication media. A combination of channels was one way in which Information and communication technology could operate better than in face-to-face meetings.	(Shachaf, 2008)

Connaughton and Shuffler (2007) also pointed out in their review that some research results implied that culture and diversity in virtual teams does not always have consequences with regard to processes and output:

- Baba, Gluesing, Ratner and Wagner (2004) argue that there is affective knowledge sharing of the team member who understands the other nationalities' beliefs.

- Jarvenpaa, Knoll and Leidner (1998) stated that in a situation where swift trust[11] has developed, culture is less relevant for the team's effectiveness.

In many studies nationality is the index used to determine the composition in multi-cultural teams. A different focus in the multi-cultural teams could be the visible marker (Paul, Samarah, Seetharaman, & Myktyn, 2005) or the so-called demographic tile (Chao & Moon, 2005). Consequently, researchers are focussing on heterogeneity or diversity of team composition and its effect on processes and outcomes in virtual teams. An example is the research of Paul *et al*. (2005) where, in addition to diversity, the influence of varying backgrounds and skills have been taken into account.

2.5 *Factors and Relationships influencing Virtual Project Teams*

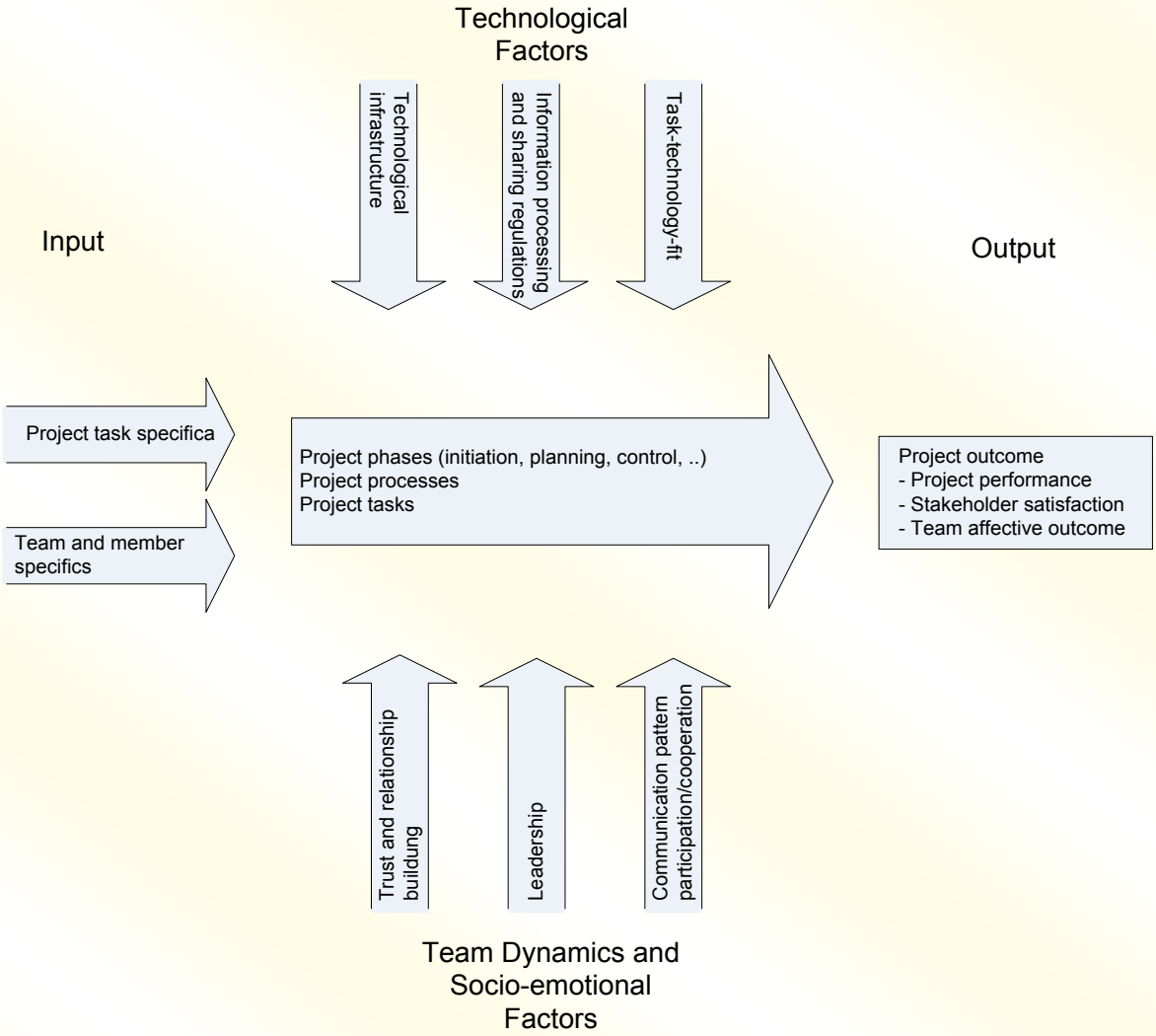
Over the last decade a large number of empirical research studies have been conducted to identify factors that influence the success of virtual teams. As with other kinds of project teams, virtual teams are composed of a group of people interacting through interdependent tasks, who are guided by common project goals. Unlike traditional face-to-face teams they use technology to varying degrees in working across space, time, and organizational boundaries. Therefore virtual teams have, according to Katzenbach and Smith (2001), many of the best practices that influence critical project success in common with traditional teams.

A number of literature reviews (e.g., Gillam & Oppenheim (2006), Hertel, Konradt, & Orlikowski (2004), Martins, Gilson, & Maynard (2004), and Powell, Piccoli, & Ives, (2004)), discuss research frameworks, identify areas of research interest, and describe critical success factors that influence the success or failure of virtual projects. I have adapted their frameworks to structure my research interests in this literature review. More specifically, I have considered the integration of project management processes and tasks as well as Internet technology to support virtual project teams. The input-process output-model (I-P-O-model) from McGrath (1964) is a dominant framework used in studying traditional teams (e.g., Hackman & Morris (1975) and McGrath & Hollingshead

[11] According to Mayer, Davis and Schoorman (1995) the concept of "swift trust" was developed to explain behaviours in temporary face-to-face teams, when the team did not have the opportunity to develop trust in a natural, cumulative way. Instead, teams act as if trust is already established. In Jarvenpaa, Knoll & Leidner's (1998) model of trust in global virtual teams, the concept of swift trust is released from the interpersonal dimensions and based initially on broad categorical social structures then, later, on actions.

(1994)), and virtual teams (e.g., Espinosa, DeLone, & Lee (2006), Hollingshead, McGrath, & O'Connor (1993), Martins, Gilson, & Maynard (2004), and Thomas & Bostrom (2010)) in terms of task technology and performance behaviour.[12] It provides a sound basis for the structure of the literature on the factors influencing virtual teams.

Figure 13 - Research Framework Related to the Project Management Task, Processes and Phases



[12] Alternatively a kind of team development model (see Tuckman (1965) and Tuckman & Jensen (1977)) or a life cycle model (used by Hertel *et al*. (2005)) could have been used to organize the different topics relevant to virtual teams. A team development model or life cycle model would allow for identifying the differences of the technologies in the different cycles or phases of team development or teamwork (Hertel, Geister, & Konradt, 2005); but it would be less transparent regarding matters of input requirements and output effects.

Under the topic **input** I cover factors that influence the project before the project starts and the project team has been initiated. These factors comprise the **project characteristics,** including the project goal, project scope and the organizational context as well as the **team and team member characteristics** including their skills, abilities, cultural background and whether the team has received uniform training on relevant technological issues in advance.

Project characteristics such as complexity of the project task and the right scoping of the project influence the successful management of a project. These are success factors for traditional project teams (Pinto & Prescott, 1988), and, according to de Pillis *et al.* (2007), they are even more important for virtual project teams.

Project team characteristics such as the size of the team, members' experience with project work, and shared work have a strong influence on the team dynamics, project management processes, and the team's effectiveness in traditional teams (Kerzner, 2006) as well as in virtual teams. Virtual teams are often more diverse than traditional project teams. Team members not only have different technical skills but often come from diverse cultural, language, and organizational backgrounds (Fisher & Fisher, 1998). If a virtual team is, besides being distributed around a country but also comes from various countries, the communication and social behaviour between the virtual team members influences the project team coordination (e.g., Johansson, Dittrich, & Juustila (1999), Maznevski & Chudoba (2000), and Paré & Dubé (1999)) and effectiveness (e.g., Maznevski & Chudoba (2000), and Paré & Dubé (1999)).

According to the PMBOK (Project Management Institute, 2004) **project phases** describe the **phases, processes,** and **tasks** that occur in a project. Major issues in my research framework concern how different phases, processes, and tasks are influenced by the input parameters of virtual project teams, the technological as well as the socio-emotional factors, and the team dynamics.

The **technological factors** comprise the **technological infrastructure** that is available for the project team and controls how the teams can accomplish their project tasks. Further, it is important to evaluate the influence of the technology available and the tasks that the virtual project team has to accomplish. This is covered under the factor **task-technology-fit.** Research work by Hollingshead, McGrath, and O'Connor (1993) as well as Robey, Khoo, and Powers (2000) hypothesized that the team's choice of technology depends on their experience with the technology available, its ease of use, individual preferences, and the urgency of the task. Thomas and Bostrom (2010) found out that one of the vital signs for management intervention for virtual teams is the inadequacy of the ICT.

Virtual team members can be linked by a variety of information and communication technologies. For that reason, **information processing and sharing regulations** are necessary for team success, especially in relation to various other socio-emotional factors**.** For example, according to Cramton (2001), unevenly distributed information is a common complaint of virtual teams, and according to Jude-York *et al.* (2000), the challenge of sharing important information lies at the heart of a virtual team. Another important point is the transfer of knowledge within a project. According to Reed and Knight (2010), in virtual teams insufficient transfer of knowledge often takes place.

From the researcher's point of view the **socio-emotional factors** cover **relationship building, team cohesion, team motivation,** and **trust** as well as **leadership concepts**, **communication patterns,** and **participation/cooperation**. According to Alexander (2000), Lipnack and Stamps (2000), as well as Solomon (2001) these socio-emotional factors are related to team effectiveness and virtual teams usually experience severe difficulties in achieving them.

In comparison with traditional teams, virtual teams show weaker relational links with their team colleagues. In addition, virtual teams tend to be more task-oriented and have less social focus (e.g., Walther (1995) and Walther & Burgeon (1992)). If relationship building is supported in the early phases of a project, e.g., via face-to-face meetings, success is fostered by improved performance and enhanced learning (e.g., Maznevski & Chudoba (2000), and Robey, Khoo, & Powers (2000)).

Research results on virtual teams suggest that trust[13] is necessary for preventing distances between the team members from becoming a problem area (Lipnack & Stamps, 2000) and (Jarvenpaa & Leidner, 1999). Experimental research studies (e.g., Bos, Olson, Gergle, Olson, & Wright (2002), and Jensen, Farnham, Drucker, & Kollock (2000)) have shown that electronic communication leads to decreased trust in virtual teams. Face-to-face meetings, e.g., in the team forming phase, and direct leadership seem to enhance virtual team trust (Duarte & Snyder, 2001). The **cohesion of a team** has been associated with better team performance (Maznevski & Chudoba, 2000) and greater team satisfaction (Chidambaram, 1996); it is therefore a significant factor.

[13] According to Cummings and Bromley (1996, p. 302) trust in virtual teams is defined as the belief that an "individual or group (a) makes good-faith efforts to behave in accordance with any commitments both explicit and implicit, (b) is honest in whatever negotiations preceded such commitment and (c) does not take excessive advantage of another even when the opportunity is available".

Working across distances and organizations places increased demands not only on the team members but also on the team leader, because face-to-face contact and direct influence is restricted. Hence, according to Duarte and Snyder (2001), leaders have to utilize more indirect and structural forms of **leadership**. Hertel *et al.* (2004) as well as Konradt, Hertel and Schmook (2003) propose management by objectives as the adequate leadership concept for remote work situations. A number of research studies have focused on self-managed/self-directed virtual teams. They are defined as

> groups of independent individuals that can self-regulate their behaviour on relatively whole tasks (see Cohen & Ledford (1994), and Goodman, Devadas, & Hughson (1988)).

The assumption is that virtual team members will be able to organize and manage optimally their processes by themselves. The influence of managerial control mechanisms like progress reports, work assignments, and periodic project meetings has been ignored.

The communication process is crucial to the achievement of success of any virtual team. Research results of Jarvenpaa *et al.* (1998) as well as Jarvenpaa and Leidner (1998) demonstrate that successful virtual teams have extended and predictable **communication patterns**. Virtual teams also communicate more frequently with each other than do traditional project teams (Galegher & Kraut, 1994). As pointed out by Connaughton and Shuffler (2007) the two aspects of communication, namely, frequency and face-to-face communication emerge consistently in research related to virtual teams. According to Hinds and Mortensen (2005) frequent communication enhances shared team identity and moderates distance conflict relationships. Research from Jarvenpaa, *et al.* (1998) as well as Jarvenpaa and Leidner (1999) revealed that frequent communication increases the trust in the teams. Further findings are that predictable communication with regular feedback has been associated with improved team performance (see Jarvenpaa & Leidner (1999), Jarvenpaa, Knoll, & Leidner (1998), Kayworth & Leidner (2000), and Maznevski & Chudoba (2000)). Some research considers face-to-face communication as necessary to foster trust (Oertig & Buegri, 2006), reduce task conflict (Hinds & Mortensen, 2005), enhance team dynamics and in turn increase team effectiveness (compare Maznevski & Chudoba (2000) and Grosse (2002)). Face-to-face meetings, for instance, in the team forming phase, seem to enhance virtual team trust (Duarte & Snyder, 2001) and are, according to Grosse (2002), perceived as critical early on in a team's development.

Even though frequency and face-to-face communication are relevant aspects of communication they alone do not cover the complexity of communication. According to Suchman (1987) and

Weick (1993), teamwork is dependent on how well the team members are socialised into the organizational context. According to some Information Systems researchers all actions, such as communicative actions, are socially oriented and performed within a defined social context (e.g., Lyytinen & Ngwenyama (1992), Ngwenyama & Lee (1997), and Ngwenyama (1998)). For Ngwenyama and Lee (1997) the organizational context is a foundational element for the development of shared meaning for all organizational actors.

Communication is at the heart of project teams in a distributed environment. Many virtual team issues such as conflict management, trust or team cohesion are rooted in team communication behaviours and processes. The communicative action is therefore an essential element of virtual teamwork and many researchers (e.g., Bjørn & Hertzum (2006), Cramton (2001), Olson & Olson (2000), and Weimann, Hinz, Scott, & Pollock (2010)) have found that successful communication depends on the process of establishing common ground and a shared meaning context. A failure to establish and maintain this common ground and shared meaning context might, according to Cramton (2001), result in breakdowns in the teamwork. New virtual teams especially have an increased risk of communication breakdowns (Hinds & Mortensen, 2005).

When summarizing the results on the links between technology and communication, the findings of Ngwenyama and Lee (1997) must be pointed out. They found that communicative activities are highly influenced by the collaboration technology and the organizational context. Further, one of the key findings of Ngwenyama and Bjørn (2008) is the importance of social steering processes for the management of the distributed work processes.

Research areas related to the **output** of virtual teams that are conducting projects also address **team affective outcomes,** such as team members' satisfaction and **performance outcomes** such as effectiveness, speed of decision, creativity and decision quality. Several researchers (e.g. Schweitzer and Duxbury (2010); de Pillis and Furumo (2006); and Reed and Knight: "Project Risk Differences between Virtual and Co-Located Projects" (2010)) highlight the performance gap between virtual and face-to-face teams. Research results from Schweitzer and Duxbury (2010, p. 267) for example suggest "that the more that teams move away from the proximate form, the more the traditional measures of team effectiveness are negatively impacted."

Researchers have tried, with mixed results, to examine the different factors that influence the team affective and/or performance outcome. According to Martins *et al.* (2004), differences among results are partly attributable to the nature of the project/task and the type of virtual team

(e.g., undergraduate student team, global team, hybrid team). The following tables show some of the researcher's findings in the area of team affective outcome (see Table 4) and performance outcome (see Table 5).

Table 4 - Research Findings on the Team Affective Outcomes of Virtual Teams

Finding on Team Affective Outcomes	Researcher Group
In general lower level of satisfaction in virtual teams than in face-to-face teams.	(Thompson & Coovert, 2002) (Straus, 1996)
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.	(Lind, 1999) (Savicki, Kelley, & Lingenfelter, 1996)
The cohesion of a team has been associated with greater team satisfaction.	(Maznevski & Chudoba, 2000)
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.	(Schweitzer & Duxbury, 2010)

Table 5 - Research Findings on the Performance Outcomes of Virtual Teams

Finding on Performance Outcomes	Researcher Group
Virtual team interaction increases the time required to accomplish a task.	(Straus, 1996) (Hollingshead, 1996)
Increased time required is partly caused by typing and use of computer-mediated communication technology.	(Straus & McGrath, 1994)
The cohesion of a team has been associated with better team performance.	(Chidambaram, 1996)
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.	(Schweitzer & Duxbury, 2010)

2.6 *Conclusions from the Literature Review*

In this section I summarize some of the main findings in the literature and demonstrate the opportunities to make contributions in my research study. In my literature review I did not attempt to give an all-inclusive understanding of project teams in a virtual environment and the factors influencing project outcome and team affective outcome. The intent was to show the clash of the

request for high performance of project teams on the one hand, with the decreased project outcome in virtual teams on the other hand.

Projects are still failing (e.g., Keil, Mann, & Rai (2000)) and there is an on-going discussion aimed at identifying and addressing the critical success factors (e.g., Westerveld (2003)). Different researchers (e.g., Chan (2000)) aim at identifying what creates the success of a project. Organizations like PMI, OCG, and IPMA have set up formalized bodies of knowledge (e.g., Project Management Institute (2004) and Office of Government Commerce (2005)) to help organizations to conduct successful projects. Authors like Cicmil, Williams, Thomas, and Hodgson (2006), however, doubt that these formalized bodies of knowledge are sufficient to create proficient performer or expert teams.

Further, in setting up virtual projects, organizations wish to address globalization and scarce expert resources, so gaining a competitive advantage (Bergiel, Bergiel, & Balsmeier, 2008). The fact that projects are becoming increasingly virtual adds more risk to the project (e.g., Beise (2004) and Casey & Richardson (2006)). Many authors doubt that virtual teams can reach a level of performance similar to that of face-to-face teams due to communication deficiencies and non-visibility of team members. According to de Pillis & Furumo (2007) virtual teams are often less efficient and therefore have increased transaction costs and require increased time to complete their projects.

Diversity and different cultural backgrounds of team members is characteristic for virtual teams. There exist many different views on culture. Culture as a concept has been defined in numerous ways, even in recent academic research (Jenks, 1993). Schein's three level model of culture explains why cultural artefacts are so difficult to decipher and values are so much easier to study (Schein, 1985). Therefore, research studying culture in virtual teams should use as a reference group value orientation, the most prominent among Hofstede's cultural dimensions (Leidner & Kayworth, 2006). In addition, value reference systems are useful in understanding multi-cultural team processes, even if they do not account for the fluid and dynamic aspects of culture (Ancona, 1987). Further, Ancona (1987) points out that even when team members share a specific national culture they are influenced by the context in which they are living or working. Culture itself is not static even though there are forces that resist change; there is constant change (Erez & Gati, 2004). Research results highlight various effects of diversity and culture on processes and outcome of virtual teams (Connaughton & Shuffler, 2007).

In addition, during the last decade a large number of research studies have been conducted to analyse and understand the different single aspects of virtual teams and their influence on

affective and performance outputs, according to Martins *et al.* (2004)--with differing and mixed results.

Also to be taken into account is the fact that, a new generation of web-based tools is coming onto the market providing, on the one hand, more media richness and, on the other, specific functionality to support project management in teams.

Research on CSWS, CSS and GSS gives important insight into the use of groupware systems that can be relevant in understanding the usage and selection of web-based systems in a virtual environment. The social context of distributed team work, features of collaborative work such as awareness, coordination and tailorability, as well as research on groupware technology are main aspects from these fields that are, according to Ngwenyama and Bjørn (2008), important in the research field of virtual teams.

Finally, computer-mediated communication plays an increasing role in everybody's life and this may well transform the virtual team into the dominant organizational project form (Townsend, DeMarie, & Hendrickson, 1998).

In conclusion, the review uncovers gaps in the research of factors that influence project outcome (de Pillis & Furumo, 2007) and team affective outcome (Schweitzer & Duxbury, 2010) of virtual teams in the light of a new generation of tools. It reveals the need for more research in the selection, the use and alignment of technology with teams and processes (Bjørn & Ngwenyama, 2010) to better understand single aspects of their effectiveness in a virtual work setting as well as to provide a holistic view.

3. Research Questions

This chapter will detail the research questions for the proposed research study. The problem statement is first presented, followed by the research questions.

3.1 *Problem Statement*

Unfortunately projects are still failing. The magical triangle meant to deliver a required product on time, within budget, and with a certain quality is still putting a lot of stress on project teams. In addition, often the customer's expectations are not met and the perceived project outcome is unsatisfactory.

Globalization, with the necessity of travelling, interacting within different cultures, multiple languages, and different time zones puts additional pressure on teams. In addition, the development cycles for products are becoming shorter. Not only in South Africa, but everywhere companies are battling with the problem of not having enough experts available to complete their projects. Given these challenges, virtual teams are becoming more and more important. Those companies that successfully implement virtual teams might gain a competitive advantage (Bergiel, Bergiel, & Balsmeier, 2008).

On the other hand, virtual teams tend to develop mistrust, show communication deficiencies, and may support free-riding; they are consequently less efficient than face-to-face teams (de Pillis & Furumo, 2007).

Bjørn and Ngwenyama (2010) say that technology mediation is a central theme when investigating virtual teams and it is one that so far has not been sufficiently considered in research. The lack of attention towards technology in the research of virtual teams is a symptom of a general weakness in IS research, as has already been pointed out by Orlikowski and Iacono (2001). In addition, new web-based project management tools coming onto the market may have a strong impact on project management processes, especially in virtual teams. By understanding the roles played by established technologies (e.g., email, chat, and phone) and by new web-based technologies (e.g., web-calendar, web-based task tracking, and web-based videoconferencing) in the processes of project management, and their influence on team cohesion, trust-building, and leadership it may be possible to improve processes and increase team effectiveness, project outcome, and team member satisfaction.

3.2 Research Question

Driven by the gaps in the relevant literature and based on the problem statement, this research study focuses on exposing the structure of the problem: effective selection and use of tools. I wish to break down the meaning of the underlying concepts and ideas of virtual project teams. The **core research** question is:

> **How should Internet/web-based tools be employed in the project management processes of virtual project teams so as to increase the effectiveness of the processes, and improve the project outcome as well as the team affective outcomes (e.g., member satisfaction)?**

In order to expose how web-based technology influences project management processes and in turn project outcome, a number of secondary research questions shall be used, as given below.

> **SECONDARY RESEARCH QUESTION 1: How and when are web-based tools used in the different project management tasks?**

RQ 1.1. What is the reason for a specific tool supporting a specific task better than another tool?

RQ 1.2. What is the reason for a team member not applying/using a certain tool?

RQ 1.3. Why is a certain tool not used (for a specific task or in general)?

RQ 1.4. What are the reasons that some project management tasks cannot be supported by any tool?

RQ 1.5. Why are team members not contributing to the project outcome? Can they be better integrated by means of a certain tool?

RQ 1.6. How should web-based tools be used so as to align them with the project management tasks?

RQ 1.7. How does access and available bandwidth influence the selection of a specific tool?

RQ 1.8. How does gender and cultural background influence the use of web-based tools?

RQ 1.9. How does the team size influence the use of web-based tools?

SECONDARY RESEARCH QUESTION 2: How does the task-technology fit influence team performance and team affective outcome?

RQ 2.1. How should the workload of the team members be planned with regard to the virtuality of the team? What is the role of the different tools in this process?

RQ 2.2. What are the problems arising during the use of tools and how can these problems been handled? What is the effect of these problems on the performance and team affective outcome?

RQ 2.3. 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?

RQ 2.4. How should conflict that arises in virtual teams be solved? Has the conflict been caused by the use of a web-based tool? Has the conflict been escalated due to the use of a tool?

RQ 2.5. How does training in the use of tools influence their use?

RQ 2.6. What is the effect of the task complexity on the use of specific tools?

RQ 2.7. How does the use a specific tool contribute to the team's affective outcomes, such as satisfaction and motivation?

RQ 2.8. Which tools have been used for which project management tasks? How does the use of the tool contribute to the performance of the team?

RQ 2.9. Has the media richness influenced the choice of the tool for a specific task?

SECONDARY RESEARCH QUESTION 3: How does the use of a certain tool influence team dynamics and socio-emotional factors?

RQ 3.1. How does media richness influence the team dynamics and the socio-emotional factors?

RQ 3.2. What is the effect of the new web-based tools on communication and cooperation in teams?

RQ 3.3. How did the use of a tool support managerial control mechanisms? Do the use of tools and their virtuality support the team becoming self-managing?

RQ 3.4. Does a certain tool also support the cohesion of the team? Which features of the tool were especially helpful with regard to team cohesion and team cooperation?

SECONDARY RESEARCH QUESTION 4: How do team dynamics and socio-emotional factors influence the team performance and the team affective outcome?

RQ 4.1. What is the influence of trust in the team on its performance and affective outcome?

RQ 4.2. What is the effect of web-based cooperation and communication on the team performance and affective outcome?

RQ 4.3. What is the influence of conflict in virtual teams on the performance of the teams?

RQ 4.4. How does the leadership concept influence the performance and affective outcome of the team?

RQ 4.5. Why is the performance of one team better than the performance of others?

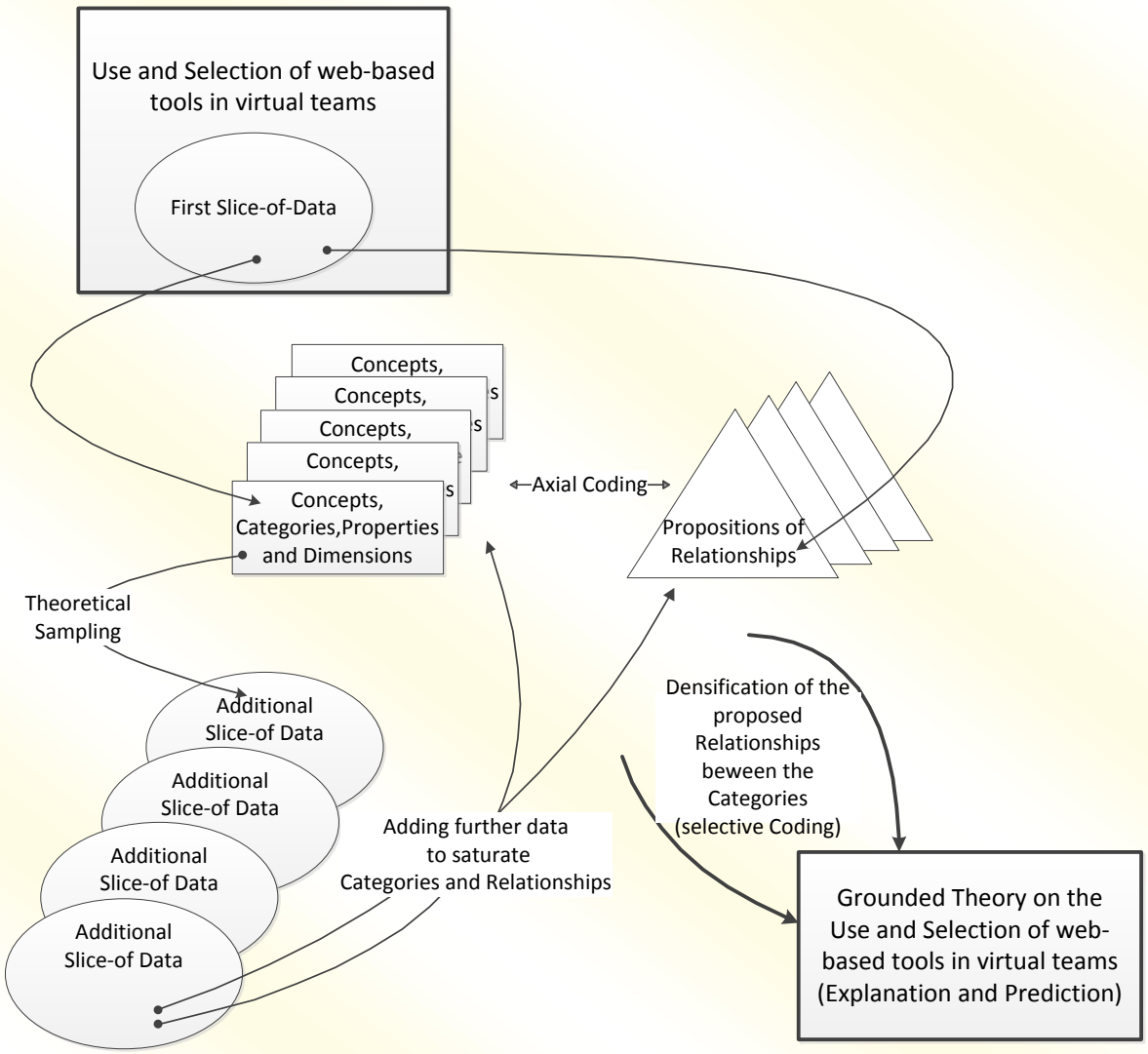
The next chapter specifies the methodology employed in order to investigate and answer the research questions described above. The methodology that has been devised is based on the nature of the topic being investigated and the format of the questions being posed.

4. Research Design

This section describes the methodology being applied in the research study. The chosen research paradigm, method, and strategy are explained and critically discussed. The proposed data collection and data analysis techniques are described and justified. In the last section the expected contributions to the field of Information Systems are specified. Furthermore the issues of access, privacy, confidentiality, and ethics are addressed.

For the purpose of this series of prospective studies, an **interpretative and empirical** research approach was followed. Qualitative and quantitative methods were also used and if necessary triangulation was applied.

Figure 14 - Grounded Theory Approach adapted from Urquhart *et al.* (2010)



The grounded theory approach was applied to develop a theory that addresses the research questions and helps to explain the selection and use of web-based tools in virtual teams. The data was collected through questionnaires, structured interviews (individuals and groups), and observations. Besides, course results were taken into account. The analysis was guided through the grounded theory approach. It is the goal of my research approach to develop a holistic model 'to answer' the research questions (see Figure 14).

The choice of this research approach will be justified in the following sections. Finally the developed theory will be discussed along with other theories in this field.

4.1 Research Paradigm

Quantitative and qualitative research approaches are based on underlying assumptions about what constitutes valid research and whether appropriate methods are being applied. Epistemological theory (Becker & Niehaves, 2007) guides the researcher in the choice of his or her approach, laying the basis for understanding how knowledge is produced and how it can be obtained (Orlikowski & Baroudi, 1991). Myers (1997) distinguishes between three underlying philosophical assumptions of research in IS: it can be positivist, interpretative or critical. These three different paradigms exist since, just as the beliefs and values of people differ, the ways of understanding what research is also differ (Myers, 1997).

4.1.1 Positivist Research

According to Myers (1997), **positivist researchers** generally assume that reality is objectively given and can be described by measurable properties which are independent of the researcher and his or her instruments (Myers, 1997). Positivist research studies often attempt to test predictive theory so as to increase the understanding of phenomena. According to Orlikowski and Baroudi (1991), IS research can often be classified as positivistic if there is evidence of formal propositions, quantifiable measures of variables, hypotheses testing, and the drawing of inferences about a phenomenon from the sample to a stated population (Orlikowski & Baroudi, 1991).

4.1.2 Interpretative Research

Interpretative research studies attempt to understand phenomena through the meanings that people assign to them. Interpretative methods of research in IS are

> aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by the context (Walsham, 1993, pp. 4-5).

Interpretative research does not predefine dependent and independent variables, but focuses on the full complexity of human sense-making as the situation emerges (Kaplan & Maxwell, 1994). The researcher thus assumes that access to reality (whether given or socially constructed) is only through constructions such as language, consciousness, and shared meaning (Myers & Avison, 2002). Klein and Myers (1999) set up the following principles of interpretative field research (see Table 6).

Table 6 – Seven Principles for Interpretative Field Research (based on Klein and Myers (1999))

Principle of	Description
Hermeneutic Cycle	All human understanding is achieved by interacting and considering the independent meaning of parts and the whole that they form.
Contextualisation	Critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
Interaction between the researcher and the subject	Critical reflection on how the research materials were socially constructed through the interaction between the researcher and participants.
Abstraction and Generalisation	Relating the idiographic details revealed by the data interpretation to theoretical, general concepts that describe the nature of human understanding and social action.
Dialogical Reasoning	Sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings, with subsequent cycles of revision.
Multiple Interpretations	Sensitivity to possible differences in interpretations among the participants as they are typically expressed in multiple narratives or stories of the same sequence of events under study.
Suspicion	Sensitivity to possible “biases” and systematic “distortions” in the narratives collected from the participants.

Especially fundamental to all other principles for interpretative field research is the principle of the hermeneutic circle (Klein & Myers, 1999) and it is also important for the grounded theory approach in my research work. Therefore it will be discussed in more detail in section 4.4.

As my research is directed towards the future role of web-based technology in virtual teams and towards an organizational framework to ensure project success, increased project outcome, and team affective outcomes (e.g., team member satisfaction) the application of my research methods is aimed at the understanding of the context of the web-based technology as well as the influence of this technology on the processes within the virtual teams and *vice versa*. Consequently **interpretative research** seems to be the appropriate approach.

Developing the research framework in the context of student groups frees my research from certain power relations within the typical hierarchical structure of companies. For their project work, the teams will be provided with a selection of tools. It is left to the teams to select those tools that will help them to accomplish their project task. The technology does not determine the way in which the teams do their project work; instead, the teams decide on the technology that will support them in their projects. Besides its advantages, this approach prohibits adapting a critical research stance (see section 4.1.3).

4.1.3 Critical Research

The third form of philosophical stance, according to Myers (1997), is that of **critical research**. Based on the Frankfurt School, particularly the work of Jürgen Habermas (Doolin & Lowe, 2002), critical research aims at focusing more explicitly on the dynamics of power, knowledge, and ideology that surround social practices. Critical researchers assume that social reality is historically constituted and that it is produced and reproduced by people. According to Myers (1997), the main task of critical research is one of social critique, whereby the restrictive and alienating conditions of the status quo should be brought to light.

Critical research focuses on the oppositions, conflicts, and contradictions in contemporary society, and seeks to be emancipatory, that is, to help eliminate the causes of alienation and domination. Myers and Klein (2011) propose a set of principles for conducting critical research based on the three elements of insight, critique and transformative redefinition. Even though McGrath (2005) suggests that the principles of interpretative research are useful for critical research as well, Myers and Klein (2011) point out that they are not sufficient and that in particular the element of critique requires that the researchers adopt a more critical stance than interpretivists.

4.1.4 Qualitative Approach versus Quantitative Approach

Quantitative research is a form of research involving large representative samples and structured collection procedures to study natural phenomena through survey methods, laboratory experiments, formal methods, and numerical methods such as mathematical modelling (Myers & Avison, 2002). A primary task in this kind of research is to test hypotheses. A hypothesis is a statement regarding the relationship between two or more phenomena (variables). Various authors (such as Cook & Campbell (1979), Manicas & Secord (1983), and Maxwell, Bashook, & Sandlow (1986)) argue that the study of social sciences in a natural setting involves several uncontrolled variables, of which the imprecise measurement or omission might produce misleading, or unusable results (Myers & Avison, 2002).

Qualitative research methods have been chosen for this study as they are said to yield a better understanding of the real world setting (Kaplan & Duchon, 1988). Such methods refer to the kind of research that produces findings not obtained through statistics or other means of quantification. Qualitative research attempts to broaden and deepen our understanding of how things came to be the way they are in our social world. It is thus suited to studying organizations, groups, and individuals (Strauss & Corbin, 1990). One major characteristic of qualitative research is the focus on interpretation rather than quantification. Qualitative research is concerned with developing explanations of social phenomena. That is to say, it aims to help us to understand the social world in which we live and why things are the way they are. These characteristics may be considered as advantages when conducting research and they justify the choice of qualitative methods for my research project. Further, qualitative methods emphasise subjectivity rather than objectivity, flexibility in the process of conducting research, an orientation towards process rather than outcome, a concern with context, and an explicit recognition of the impact of the research process on the research situation (Cassell & Symon, 1997).

4.1.5 Triangulation

Triangulation is the application and combination of several research methodologies or data sources in the study of the same phenomenon. According to Patton (1987), there are four types of triangulation available to evaluate the evidence of research findings (see Table 7).

Table 7 - Types of Triangulation

Type of Triangulation	Description
Data triangulation	Collection of data from multiple sources but aimed at corroborating the same fact or phenomenon.
Investigator triangulation	Different investigators collect data from the same sources applying the same research methods.
Theory triangulation	Using more than one theoretical scheme in the interpretation of the phenomenon.
Methodological triangulation	The use of qualitative data to illustrate or clarify quantitatively derived findings; or the use of quantitative data to validate qualitative findings.

According to Eisenhardt (1989) and Yin (2003), triangulation by multiple data collection methods provides a stronger substantiation of constructs and hypotheses. Qualitative and quantitative methods in the form of a triangulation can be applied to provide additional insight and modes of analysis while such information is unlikely to be revealed if only one method is used (compare Kaplan & Duchon (1988) and Pather & Remenyi (2004)). Triangulation through multiple investigators has the two key advantages of providing complementary insights and strengthening confidence in the findings (Eisenhardt, 1989). These three forms of triangulation will be applied within my research study where necessary.

4.1.6 Empirical versus non-Empirical research

Empirical research is any research that bases its findings on direct or indirect observation (e.g., Kling (1991), and Schwandt (1997)). Non-empirical research focuses on ideas, frameworks, and speculations rather than observations (Alavi, Brooke, & Carlson, 1990). According to Järvinen (2004), empirical research can be subdivided into theory-testing and theory-creating research. Theory-testing studies involve laboratory experiments, surveys, field studies, or field experiments. The respective theories, models, or frameworks are either taken from the literature, or developed, or refined for purposes of specific studies. The opposite holds for theory-creating studies, which make use of case-studies, ethnographic methods, grounded theory, contextualism, discourse analysis, longitudinal studies, phenomenological studies, and hermeneutics, among others (Järvinen, 2004) to develop a theory. According to these definitions my research study follows a theory-creating empirical approach.

4.2 *Research Method*

4.2.1 Theory in Research

Before discussing in more detail the grounded theory approach, it is necessary to clarify understanding of the term "theory", the different types of theory, and the purpose of developing a theory. A definition of theory that is widely accepted is one provided by Kerlinger (1979, p. 64). He says a theory is

> a set of interrelated constructs (variables), definitions, and propositions that presents a systematic view of phenomena by specifying relations among variables, with the purpose of explaining natural phenomena (Kerlinger, 1979).

Providing a more general definition of theory, Strauss and Corbin (1998) add the "prediction of phenomena". They define a theory as

> A set of well-developed concepts related through statements of relationship, which together constitute an integrated framework that can be used to explain or predict phenomena (Strauss & Corbin, 1998, p. 15).

In her article on the nature of theory in Information Systems, Gregor (2006) provides a taxonomy to classify Information Systems theories depending on how they address the four central goals: analysis, explanation, prediction, and prescription. She distinguishes five interrelated types of theories in Information Systems research.

Table 8 - A Taxonomy of Theory Types in Information Systems Research (Gregor, 2006, p. 620)

Theory Type	Distinguishing Attributes
I. Analysis	Says what it is. The theory does not extend beyond analyses and description. No causal relationships are specified and no predictions are made.
II. Explanation	Says what it is, how why, when, and where. The theory provides explanation but does not aim to predict with any precision. There are no testable propositions.
III. Prediction	Says what it is and what will be. The theory provides predictions and has testable propositions but does not have well-developed justificatory causal explanations.
IV. Explanation and Prediction	Says what is, how, why when, where, and what will be. Provides predictions and has both testable propositions and causal explanations.
V. Design and action	Says how to do something. The theory gives explicit prescriptions (e.g., methods, techniques, principles of form and function) for constructing an artefact.

Gregor (2006) also points out that the different theories are interrelated. Comprehensive and well-developed theories could include components for all of the above types of theory. As structural components that are common to all theories, Gregor (2006) highlights the following elements:

- *Means of representation*: The theory must be represented physically, e.g., in words, diagrams, mathematical terms or symbolic logic.
- *Constructs*: The primary constructs of the theory should be well defined.
- *Statements of relationship:* The theory should include statements of relationship. Their nature might be associative, compositional, unidirectional, bidirectional, conditional or causal.
- *Scope:* The scope of the theory should be specified by the degree of generality of the statements of relationships. In addition, boundary statements should show the limits of generalisations.

Other components are contingent on the purpose of the theory. Gregor (2006) lists and defines the following elements:

- The theory might provide **causal explanations** in the form of statements of relationship among the phenomena that show causal reasoning.
- The theory might state relationships between constructs in such a form that they can be tested empirically (**testable hypotheses**).
- **Prescriptive statements** in the theory might specify how people can accomplish something in practice.

In her introduction Gregor (2006), further emphasizes the relevance of a good theory for the practice of research. She states

> Theories are practical because they allow knowledge to be accumulated in a systematic manner and this accumulated knowledge enlightens professional practice (Gregor, 2006, p. 613).

Further, Creswell (2009) examines the placement of the theory. While in most[14] quantitative research studies the theory is derived **deductively** and therefore is placed at the beginning of the

[14] Osei-Bryson and Ngwenyama (2011), for example, propose a data mining approach to abducting and evaluating hypotheses based on Peirce's theory of abduction.

research work, in the majority of qualitative research work the theory often becomes the end point, because it is developed in an **inductive** approach.

A further way of distinguishing types of theory is discussed by Godfrey–Smith, who makes the distinction between *normative* and *descriptive* theories:

> A descriptive theory is an attempt to describe what actually goes on, or what something is like, without making value judgements. A normative theory does make value judgements; it talks about what should go on, or what things should be like (2003, p. 6).

Further, theories generated may be **formal** (conceptual) or **substantive**. Glaser and Strauss (1967) view a formal theory as the goal of a sociologist. For them a formal theory is valid if it is developed on the basis of concrete social actions. A substantive theory is developed before the formal theory. It is closely related to the domain of empirical practice.

Glaser and Strauss distinguish the two types of theory as follows:

> By substantive theory we mean that developed for a substantive, or empirical, area of sociological inquiry, such as patient care, race relations, professional education, delinquency, or research organizations. By formal theory, we mean that developed for a formal, or conceptual, area of sociological inquiry, such as a stigma, deviant behaviour, formal organization, socialization (1967, p. 32).

Locke (2001) points out that in Glaser and Strauss's view substantive and formal theory are closely related and a substantive theory can provide a link to more formal theory.

4.2.2 Grounded Theory

4.2.2.1 Traditional Grounded Theory

Grounded theory[15] is a research method seeking to develop theory from data that have been systematically gathered and analysed. The theory is thus *grounded* in the data of the research study. Glaser & Strauss, when emphasizing the process of generating the theory from data, say:

> Generating a theory from data means that most hypothesis and concepts not only come from data, but are systematically worked out in the relation to the data during the process of research (1967, p. 6).

According to Strauss and Corbin (1990, p. 23), a grounded theory is "one that is inductively derived from the study of the phenomenon it represents". This quotation emphasises the inductive nature of the grounded theory method.

According to Urquhart *et al.* (2010), one major difference between grounded theory and other qualitative research methods is its specific approach to theory development. 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 (Strauss & Corbin, 1990).

As pointed out by Urquhart (2002) and Bryant (2002), there is some confusion regarding the distinction between the method and the theory. A grounded theory is the possible outcome of using the grounded theory method. One might use the method without producing a grounded theory.

The principles, elements, and techniques of the grounded theory and grounded theory methods are mainly based on the work of Glaser and Strauss (1967). Strauss and Corbin (1990) as well as Glaser (1992) show a development in two different directions guided by the two founders. According to Locke (2001, p. 64), the differences between the two researchers are that Glaser inclines towards “more openness, flexibility, and more parsimony in the elaboration of necessary

[15] This research method originated with the work of Glaser and Strauss (1967) on the interactions between health care professionals and dying patients.

analytical steps"; Strauss, on the other hand, tends towards "increased prescription and formal elaboration of operational procedures" (Locke, 2001, p. 64).

In my research study, the Strauss version of grounded theory methodology, as described in Corbin and Strauss (2008), was the main approach. The reason for this selection was the clear prescriptions and guidelines that were provided. Hughes and Jones (2003) point out that such prescriptions and guidelines are useful for researchers who are new to the method of grounded theory.

The three basic element groups of the grounded theory are **concepts, categories,** and **propositions.** Further, the theory embodies an integrated **framework** and the **explanation or storyline** of phenomena.

Concepts are the basic units of analysis. As Corbin and Strauss (2008, p. 51ff) state:

> Concepts are derived from data. They represent the analyst's impressionistic understanding of what is being described in the experiences, spoken words, actions, interactions, problems, and issues expressed by the participants. The use of concepts provides a way of grouping/organizing the data a researcher is working with.

The second element group of the grounded theory are **categories**. They are defined by Corbin and Strauss (2008, p. 159) thus:

> High-level concepts under which analysts group lower-level concepts according to shared properties. Categories are sometimes referred to as themes. They represent relevant phenomena and enable the analyst to reduce and combine data.

In many research areas, there may be a large number of concepts identified and therefore it is necessary to aggregate lower concepts. **Sub-categories** are related to a main category, and answer questions such as who, where, why, when, and how about that category (Strauss & Corbin, 1998).

The third element group of grounded theory are propositions. **Propositions** are generalized relationships between a category and its concepts or between discrete categories. Corbin and Straus (2008, p. 159) define them as "Characteristics that define and describe concepts". For the visualisation of these propositions Corbin and Strauss (2008) recommend the use of diagrams. Miles and Huberman (1994, p. 22) say about diagrams:

> Conceptual frameworks are best done graphically, rather than in text. Having to get the entire framework on a single page obliges you to specify the bins that hold the

> discrete phenomena, to map likely relationships, to divide the variables that are conceptually or functionally distinct, and to work with all of the information at once.

Further relevant elements in the work of Glaser and Strauss (1967) as well as Strauss and Corbin (1998) include core categories, the phenomenon, properties, and dimensions. The **phenomenon** is the central idea or event in the data that is related to the research area (Strauss & Corbin, 1998). It is often interchangeably used with the term **core category** (Pandit, 1996). Categories may have several characteristics. They are called **properties** of the category.

A **category** can be aggregated from several lower order concepts. It is possible that these lower order conceptual elements may ultimately constitute the properties of a category and may therefore vary in their range - see Strauss & Corbin (1998) and Locke (2001). According to Corbin and Strauss (2008), the variations within properties along a range are defined as the **dimension** of a property.

The **explanation or story line** is related to the phenomenon in the theoretical framework. According to Strauss & Corbin (1998, p. 124) the storyline,

> tells a story about the relations among things or people and events. To tell a complex story, one must designate objects and events, state or imply some of their dimensions and properties…, provide some context for these, indicate a condition or two for whatever action/interaction is selected to be central to the story, and point to, or imply, one or more consequences.

In order to develop a grounded theory containing all these elements, a number of principles, procedures and techniques have been suggested (Corbin & Strauss, 2008). They are discussed in section 4.2.2.3.

4.2.2.2 Two approaches to the development of a grounded theory

In 1967 the two sociologists Barney Glaser and Anselm Strauss published their book entitled *The Discovery of Grounded Theory: Strategies for Qualitative Research* (Glaser & Strauss, 1967). Their book described a new research methodology that would develop systematically theories of human behaviour from empirical data. According to Dey (1999), this book was opposed to the 'armchair' functionalist theories in sociology.

In 1987 Strauss published *Qualitative Analysis for Social Scientists* (Strauss, 1987) and revealed a disagreement between himself and Glaser as to how grounded theory development

should be conducted. After Strauss published, in 1990, *Basics of Qualitative Research: Grounded Theory Procedures and Techniques,* with Juliet Corbin (Strauss & Corbin, 1990), Glaser highlighted in his book, published in 1992, with the title *Basics of Grounded Theory Analysis. Emergence vs Forcing* (Glaser, 1992), that the differences in what he argued was that the original grounded theory approach of Strauss and Corbin (1990) was not the 'intended form' of grounded theory development. The disagreement between Glaser and Strauss on how to develop a grounded theory finally resulted in a split in the theory between the so-called "Straussian" and "Glaserian" approaches. Glaser's criticism of the Strauss and Corbin approach is summarized in the following quotation:

> If you torture the data long enough, it will give up! This is the underlying approach in the forcing preconceptions of full conceptual descriptions. The data is not allowed to speak for itself, as in grounded theory, and to be heard from, infrequently it has to scream. Forcing by preconception constantly derails it from relevance (Glaser, 1992, p. 123).

According to Urquhart *et al.* (2010), Glaser disagrees with Strauss and Corbin's book on two fundamental points:

- Breaking down the coding process into four prescriptive steps (open, axial, selective, and coding for process) instead of Glaser's three forms of coding: open, selective, and theoretical.
- Use of the coding paradigm and the conditional matrix, provided as tools for the conceptualization process.

The last point especially is, according to Kelle (2007), a main source of disagreement in the controversy between Glaser and Strauss. It raises the question whether the researcher should use a well-defined 'coding paradigm' as prescribed by Strauss and Corbin (1990), whereas, alternatively, s/he could employ theoretical codes as they emerge, in the same way as substantive codes emerge, but drawing them from a large fund of 'coding families' as recommended by Glaser (1992). Kelle (2007, p. 203) points out that

> At a first glance, Strauss and Corbin's 'Coding paradigm' represents a more user friendly concept, since it describes the construction of a theoretical framework for the development of empirically grounded theories in an explicit manner. By drawing on this concept researchers with limited experience in the application of theoretical

knowledge can use grounded theory methodology without taking the risk of being flooded with the data.

Kelle (2007) further explains how Strauss and Corbin's 'Coding paradigm' is linked to micro-sociology[16]. Even though Glaser's coding families rarely include macro-sociological approaches, Kelle (2007) argues that a researcher with a strong background in macro-sociology and systems theory may easily develop such a coding family and apply it to his research into, for example, a certain organization.

Urquhart (2001) discusses the use of the coding paradigm critically and points out its various limitations in developing a theory compared to the more flexible coding families proposed by Glaser (1978).

Having the pros and cons of both strands (see also (van Niekerk & Roode, 2009)) in mind, I decided to follow the Straussian approach, because

- my research is located on the micro-sociological level and the coding paradigm seemed to better meet the requirements of my phenomena under investigation;
- the Strauss and Corbin (1990) approach has been successfully applied to similar problems in related areas, such as,
    - Helping to understand Information Systems as they are used in their organizational environments (Orlikowski, 1993);
    - Developing a process model for collaboration in virtual teams (Sarker, Lau, & Sahay, 2000);
    - Using symbolic interaction in Group Decision Support Systems (GDSSs) when studying global virtual team dynamics (Maznevski & Chudoba, 2000); and
    - Focusing on leadership-initiated relationship building within virtual teams (Pauleen, 2003).
- Strauss and Corbin were also less rigorous in their evaluation of the necessity for doing a literature review prior to research.

[16] While **micro-sociology** is one of the main branches of sociology that is concerned with the nature of everyday human social interactions and agency on a small scale, **macro-sociology** emphasises social systems and population on a large scale.

4.2.2.3 Grounded Theory Key Concepts

Corbin and Strauss (2008, p. 159) define coding as "Extracting concepts from raw data and developing them in terms of their properties and dimensions". Charmaz (2006, pp. 186-187) describes **coding** as

> . . the process defining what the data are about. Unlike quantitative researchers, who apply preconceived categories or codes to the data, a grounded theorist creates qualitative codes by defining what he or she sees in the data. Thus the codes are emergent – they develop as the researcher studies his or her data. The coding process may take the researcher to unforeseen areas and research questions . . ..

Open coding uses a form of content analysis where the data are read and categorised into concepts. Open coding relies on analytic techniques for identifying possible categories as well as their properties and dimensions. Having examined all the data, the researcher organises the concepts into recurring themes. These themes are the prime candidates for a set of stable and common categories. Corbin and Strauss point out that coding also means to think in the abstract. The researcher has to look for the words to describe best what he or she thinks is indicated by the raw data. Coding does not involve taking a phrase from the data and using it as a label. The following quotation from Corbin and Strauss (2008, p. 160) highlights the intellectual task of the researcher:

> The greatest tools researchers have to work with are their minds and intuition. The best approach to coding is to relax and let your mind and intuition work for you.

Each category will therefore link to a number of associated concepts. This is known as **axial coding** (Strauss & Corbin, 1990). The method relies on a synthetic technique of making connections between sub-categories in order to construct more comprehensive schemes. The goal is to determine the set of categories and concepts that covers as much of the data as possible.

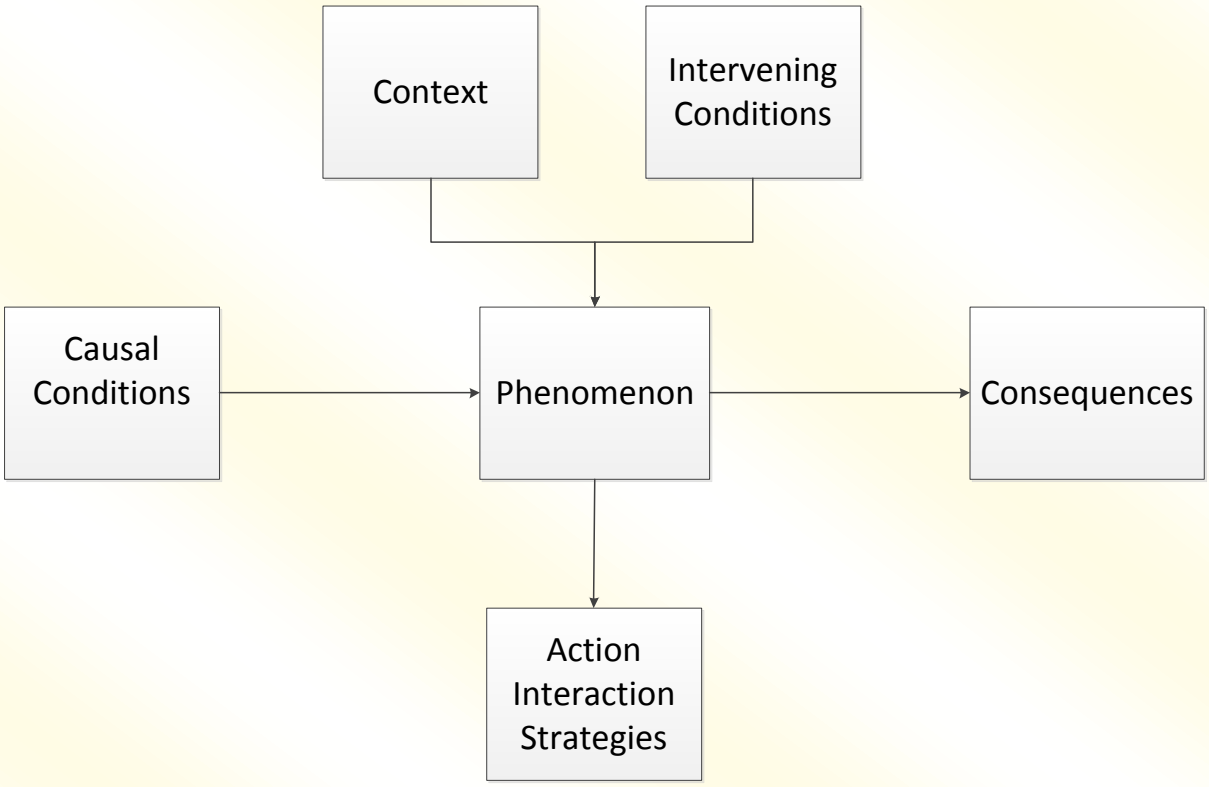
Selective coding is the process of "integrating and refining the theory" (Strauss & Corbin, 1990). As part of the selective coding process, a central category is identified. This process takes the form of what is termed "Trimming the Theory" (Strauss & Corbin, 1990), in order to reduce the amount of data. In line with Strauss and Corbin (1990), then, the conceptual schema will be reviewed for internal validity and logic; poorly developed categories will be filled in; excess categories will be trimmed; the schema will be validated through a high level comparative analysis of the data.

Central to the selective coding, according to Strauss and Corbin (1990), is their **Paradigm Model** or **Coding Paradigm**. The basis of this paradigm is the core category representing the central phenomenon of the research study. Around this core category all other categories are systematically grouped according to the schema as displayed in Figure 15.

The **causal conditions** form necessary requirements of a phenomenon or, as Pandit (1996) writes, "lead to the development of the phenomenon". The **context** describes a set of environmental conditions under which the phenomenon can be set, observed or couched. The **intervening conditions** describe interventions that have a strong impact on the phenomenon.

The **action and interaction** strategies, according to Pandit (1996), refer to responses that take place in consequence of the phenomenon. The **consequences** themselves are the intended and unintended responses to the action as well as the interaction or the outcome of the phenomenon itself.

Figure 15 - Coding Paradigm and graphically adapted based on Pandit (1996)



According to Hughes and Jones (2003), there are three main concepts from grounded theory that have significance for interpretative research and that give grounded theory its intuitive appeal:

- Theory (explained at the beginning of Section 4.2.2.1);

- Constant comparative analysis; and
- Theoretical sampling.

Glaser and Strauss (1967) emphasise the method of **constant comparison** as the major strategy to be used in discovering a grounded theory, while Urquhart *et al.* (2010) also highlight constant comparison as one major guideline in applying the grounded theory approach. Corbin and Strauss (2008, p. 65) define it as:

> The analytic process of comparing different pieces of data for similarities and differences.

It is the main procedure used for identifying the conceptual categories and their properties that may be embedded in the analysed data. One incident (element of data) is compared with another to assess accuracy of evidence. Even if some evidence has inaccuracies, this is not a major obstacle, as, in generating theory

> it is not the fact upon which we stand, but the conceptual category (or a conceptual property) that was generated from it (Glaser & Strauss, 1967, p. 23).

Glaser and Strauss (1967) pointed out the following uses of constant comparison:

- Establishing limits of empirical generalization,
- Specification of concepts,
- Determination of the accuracy of data,
- Verification of theory, and
- Generation of theory.

For the **verification of a theory,** constant comparative analysis can be used to look for other cases that confirm the existence of categories and propositions (Glaser & Strauss, 1967). According to Corbin and Strauss (2008, pp. 77-78), the following points summarize the usefulness of constant comparison. It

- Helps analysts obtain a grasp on the meaning of events that otherwise seem obscure.
- Helps sensitize researchers to possible properties and dimensions that are in the data but remain obscure due to a lack of sensitivity on the part of the researcher.
- Suggests further interview questions or observations based on evolving theoretical analysis.

- Helps analysts move more quickly from the level of description to one of abstraction.
- Counters the tendency to focus on a single case by immediately bringing analysis up to a more abstract level.
- Forces researchers to examine their own basic assumptions, their biases, perspectives, and those of participants.
- Forces examination of findings, sometimes resulting in the qualification of altering of the initial interpretations.
- Makes it more likely that analysts will discover variation as well as general patterns.
- Ensures the likelihood of a more fluid and creative stance towards data analysis.
- Facilitates the linking and densification of categories.

Theoretical sampling is the third of the three main concepts from grounded theory that have significance for qualitative research: it forms part of the process of data collection which is important in the development of a grounded theory. Corbin and Strauss (2008, p. 143) define theoretical sampling as

> A method of data collection based on concepts/themes derived from data. The purpose of theoretical sampling is to collect data from places, people, and events that will maximize opportunities to develop concepts in terms of their properties and dimensions, uncover variations and identify relationships between concepts.

In addition, Goulding (2002) notes that theoretical sampling is sampling directed by the inductive theory, as opposed to purely purposeful sampling, which is typically predetermined before the start of the research study. Further, Glaser (1992) points out that theoretical sampling guides the decision as to where and when to sample. The size of the sample is determined by the emerging theory, and should continue until each category identified in the theory is saturated.

In their book *The Discovery of Grounded Theory* Glaser and Strauss (1967) specifically emphasize the difference between theoretical sampling and statistical sampling:

> It is important to contrast theoretical sampling based on the saturation of categories with statistical (random) sampling. Their differences should be kept clearly in mind for both designing research and judging its credibility. Theoretical sampling is done in order to discover categories and their properties and to suggest the inter-

> relationships into a theory. Statistical sampling is done to obtain accurate evidence on distributions of people among categories to be used in descriptions or verifications. Thus in each type of research the 'adequate sample' that we should look for (as researchers and readers of research) is very different (Glaser & Strauss, 1967, pp. 62-63).

Theoretical saturation is the point at which incremental learning is minimal and previously observed phenomena are again encountered or seen. At this point, enough categories and associated concepts will have been defined to explain what is being observed in all project teams. Furthermore, no additional data will add to the set of categories (Glaser & Strauss, 1967).

The key characteristics of the grounded theory methods can be summarized as follows (Creswell, 1998):

- The aim of grounded theory is to generate a theory.
- The researcher has to set aside any other theory to allow a *"substantive"* theory to emerge.
- Theory focuses on how individuals interact in relation to the phenomenon under study.
- Theory asserts a plausible relation between concepts and sets of concepts.
- Theory is derived from data acquired through fieldwork interviews, observations, and documents.
- Data analysis is systematic and begins as soon as data is available.
- Data analysis proceeds through identifying categories and connecting them.
- Further data collection (or sampling) is based on emerging concepts.
- These concepts are developed through constant comparison with additional data.
- Data collection can stop when no new conceptualizations emerge.
- Data analysis proceeds from "open" coding (identifying categories, properties, and dimensions), through "axial" coding (examining conditions, strategies, and consequences), to "selective" coding around an emerging storyline.
- The resulting theory can be reported in a narrative framework or as a set of propositions.

4.2.2.4 Appropriateness of the Grounded Theory Approach in my Research

Grounded Theory approaches are becoming more and more common in interpretative and critical IT studies. They are highly congruent with the need to understand Information Systems as they are used in their organizational environments (Orlikowski, 1993). There are different

methodologies available for inductive theory building such as interpretative case study, ethnography, and grounded theory. I chose the grounded theory methodology for the following reasons:

- It allows for developing a theory out of a rich world of empirical data of a concrete social situation.
- It emphasizes, as much or more than all other inductive methodologies, the need for the researcher to be immersed in data, and the need to consciously guard against imposing a theory in a related substantive area that does not actually match the patterns in the data (e.g., Glaser & Strauss (1967), and Urquhart (1997)).
- It does not require the researchers to suspend or ignore all pre-existing theoretical knowledge, but, instead, according to Glaser (1978), it encourages the enrichment of grounded theories by drawing upon broad theoretical approaches that are not in the same substantive area.

Further, Locke (2001) sees the field of virtual organizations as a field to develop a substantive theory. She states

> Today, substantive theories might be developed for issues associated with working in virtual organizations or managing contingent workers (Locke, 2001, p. 35).

In addition, grounded theory has been successfully applied in related areas, such as:

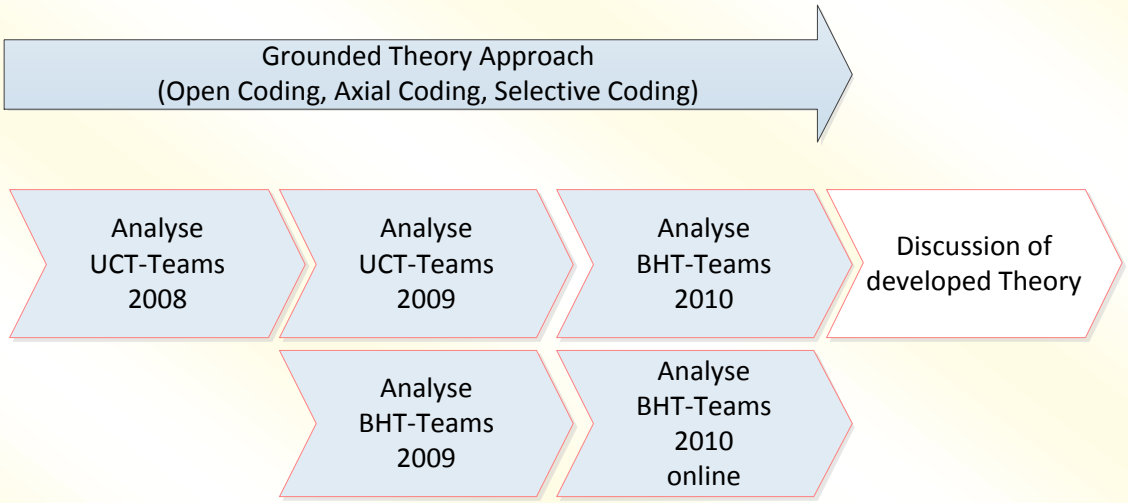
- the development of a process model for collaboration in virtual teams (Sarker, Lau, & Sahay, 2000);
- the analysis of the distributed electronic work environment of virtual teams regarding coordination, communication, and adaptation (Qureshi, Liu, & Vogel, 2005);
- GDSS used symbolic interaction; to study global virtual team dynamics (Maznevski & Chudoba, 2000);
- Media Use in Workplace Virtual Teams (Zhang & Poole, 2007);
- Effects of cultural diversity and ICT on team effectiveness (Shachaf, 2008); and
- Leadership initiated relationship building with virtual teams (Pauleen, 2003).

4.3 Data Collection

The data in my research study was collected iteratively and was guided by the results of the analysis of each data slice (see Figure 16) through several methods (quantitative and qualitative), namely semi-structured interviews, questionnaires, direct observation, and documentation. When

profiling grounded theory approaches Matavire & Brown (2011) discuss the "types of data" in the grounded theory method and point out that qualitative analysis techniques can be applied to any type of data whether qualitative or quantitative. According to van Niekerk & Roode (2009), Glaser differentiates between qualitative research and qualitative analysis, while the latter is any type of analysis, as in the grounded theory method, that results in findings without the use of statistical methods.

Figure 16 - Phases and Steps of my Research Approach



This approach will provide a wider scope of coverage and a fuller picture of the phenomena under study (compare Bonoma (1985), Eisenhardt (1989), and Strauss & Corbin (1990)). Triangulation across various techniques of data collection is particularly beneficial in theory generation as it provides multiple perspectives on an issue, supplies more information on emerging concepts, allows for cross-checking, and leads to a stronger substantiation of constructs (e.g., Eisenhardt (1989), Glaser & Strauss (1967), and Pettigrew (1989)). It will be applied where necessary.

Table 9 below is based on Yin (2003) and specifies the strengths and weaknesses of the chosen sources of evidence.

Table 9 - Data Collection Methods

Sources of Evidence	Strengths	Weaknesses
Documentation	Stable – can be reviewed repeatedly Unobtrusive – not created as a result of the case study Exact – contains exact names, references, and details of an event Broad coverage – long span of time, many events and many settings	Retrievability – can be low Biased selectivity – if collection is incomplete Reporting bias – reflects (unknown) bias of author Access- may be deliberately blocked
Focused Interviews	Insightful – provides perceived causal inferences	Bias – due to poorly constructed questions Response bias Inaccuracies – due to poor recall Reflexivity – interviewee gives what interviewer wants to hear
Structured Questions as part of a Survey	Targeted – Focuses directly on case study topic Efficient way of collecting information	Bias – due to poorly constructed questions Quality and quantity of data depends on the ability and willingness of the respondents
Direct Observation	Reality – covers events in real time Contextual – covers context of event	Time consuming Selectivity – unless broad coverage Reflexivity – event may proceed differently because it is being observed

The interview is an important data gathering technique involving verbal communication between the researcher and the participant. There is a range of approaches to interviewing, from the completely unstructured, in which the participant is allowed to talk freely about whatever they wish, to highly structured, in which the participant's responses are limited to answering direct questions (Fox, 2006). Group interviews, sometimes known as *focus groups*, are only really appropriate for qualitative approaches, and can be used where there is some benefit in getting a group story about a setting or incident (Morgan, 1998).

Semi-structured interviews of individuals and small groups were the primary source of data of my research study. These allow the researcher to access the participants' interpretation regarding the actions and events which have or are taking place (Walsham, 2002). Interviews remained open-ended and assumed a conversational manner. In the context of virtual project teams it also seems appropriate to investigate certain issues in a focus group interview.

Each respondent or group of respondents was interviewed for not longer than 1 hour and care was taken to keep the balance between excessive passivity and over-direction. By avoiding over-direction, the data obtained will retain a richness that will be exploited when the data are analysed and interpreted. Furthermore, by not being excessively passive, the researcher will demonstrate an interest in each respondent's answers (Walsham, 2002). Special care was taken to elicit the

respondent's views and experiences in his or her own terms, rather than to collect data that are simply a choice among pre-established response categories (Kaplan & Maxwell, 1994). In the preparation of the interview the subject matter and the purpose of the interview was carefully analysed to avoid unnecessary and long interview transcripts (Kvale, 1996).

In case study based research, a maximum variation sampling strategy is often recommended, which requires that the investigator obtains a broad range of data and perspectives on the subject of study (e.g., Guba & Lincoln (1989) and Eisenhardt (1989)). By looking at this broad range of perspectives, preconceived (and developing) understanding of the phenomenon under study is purposefully challenged (Paré, 2004). This is only partly in line with the **theoretical sampling** that is recommended as the main principle in the grounded theory approach (see Corbin & Strauss (2008) and Glaser (1978)). In theoretical sampling the participants are selected according to the needs of the emerging concepts and categories in the analysis of the data so far collected (see Charmaz (2006)).

Other types of sampling methods in grounded theory as described by Morse (2007) are:

- Convenience sampling: the selection is done on the basis of accessibility.
- Purposeful sampling: as indicated in the initial analysis of the interviews, participants are selected depending on how they partition themselves according to the emerging phenomena.
- Theoretical group interviews: these group interviews are used to expand and to verify the emerging theory. Participants in these interviews are exposed to the preliminary findings and asked to discuss them. The analysis of the discussion is used to modify and saturate the emerging theory.

During my research I started with convenience sampling as this method is often used at the beginning of a research study (Morse, 2007). After the analysis of my first interviews, I pursued the principle of theoretical sampling with regard to concepts that seemed relevant to the problem and came up during the previous interviews (e.g. team size, tool restrictions, Internet access, security, experience in virtual team work, project type, and project sponsor). The boundaries of my theoretical sampling go in line with the limitations of my research (e.g. student teams, organisational restrictions of the universities, team and project experience, and degree of virtuality). Regarding the advantages of theoretical sampling Corbin & Strauss (2008, p. 145) point out:

> Theoretical sampling is concept driven. It enables researchers to discover the concepts that are relevant to this problem and population, and allows researchers to explore the concepts in depth. Theoretical sampling is especially important when studying new or unchartered areas because it allows for discovery.

As a means to capture everything that was said and to spot salient points at a later stage while transcribing, a data recorder was used. However, prior permission was requested from the interviewees (Yin, 2003).

Direct Observation was undertaken by making field visits to the research site, for example, to observe the teams during their kick-off meeting or during a project's face-to-face meeting.

As a mean to support and supplement the evidence obtained from the various sources, **documentation** was used**.** Examples of documents that proved relevant to the study include minutes, proposals, progress reports, emails, etc. However, these documents were not accepted as literal recordings of events that have taken place, and were used carefully (Yin, 2003). If the documentary evidence is contradictory rather than corroboratory, the topic was further investigated, in for instance, the interviews. All required documents were examined in a systematic way.

A survey is one of the most important methods of questioning or surveying people and recording their responses. The broad area of survey research encompasses any procedures that involve asking questions of respondents. A "survey" can be anything from a short paper-and-pencil feedback form to an intensive one-on-one in-depth interview (Cooper & Schindler, 1998). Surveys therefore can be divided into two broad categories: the questionnaire and the interview. A survey using a questionnaire is a popular data collection instrument in a quantitative research approach. The strengths of conducting a survey via a questionnaire are its versatility and efficiency. Data of all kinds can be gathered by questioning others. A questionnaire distributed via email, mail, the Internet or fax as the medium of communication can cover a large geographic area or population at a fraction of the cost and time of an interview or an observation (Cooper & Schindler, 1998). It therefore supports a quantitative research approach to studying natural phenomena through large representative samples. The major weakness of questionnaires is the quality and quantity of data, depending on the ability and willingness of the respondents to cooperate (Cooper & Schindler, 1998).

In my research I used questionnaires to measure frequent occurrences, for instance, of which web-based tools are being used, how often they are used and for what purposes. The figures arising from the answers helped me to identify specific usage patterns in the different project teams as well

as to explore, during interviews, the social, cultural, and organizational reasons behind these technological usage patterns. The combination of survey questionnaires and interviews enabled me to identify usage patterns and technological preferences but it also took into account the fact that the pure measure of quantitative outcomes often neglects social, cultural, and organizational aspects (Lyytinen, 1987). Table 10 shows a summary of the above discussed data collection methods, relates them to research problem and explains the intended role in my data analysis.

Table 10 - Summary of the Different Data Collection Methods in my Research Approach

Data Collection Methods	Use in the Research Approach related to Research Problem	Role in the Data Analysis
Questionnaires	Measure frequent occurrences, for instance, of which web-based tools are being used, how often they are used and for what purposes	Identify tool usage patterns and technological preferences; identify technological problems; relate the tools to work items/tasks
Project documentation	Studying protocols, team reflective essays and course results to verify collaborative work characteristics and assess team performance	Relate work characteristics and performance to team characteristics and tool usage pattern as well as technological preferences; verify findings of the observations and survey
Observations	Making field visits to the research site, for example, to observe the teams during their kick-off meeting or during a project's face-to-face meeting to assess performance; determine team characteristics and collaborative work characteristics	Identify team characteristics; identify collaborative work characteristics
Interviews	Questioning the selection and use of tools, the social, cultural and organizational background of the use of specific tools	Explore the social, cultural, and organizational reasons behind technological usage patterns; relate the tools to work items/tasks

4.4 Data Analysis

Data analysis was directed by the grounded theory method and the interviews were analysed using the hermeneutic circle, which is, according to Klein and Myers (1999), the fundamental principle of interpretative research. Applying the grounded theory approach in an interpretative stance is in line with Klein and Myers (1999) and has been followed in the research into virtual team field before (e.g., Flammia, Cleary, & Slattery (2010) and Shachaf (2008)). The aim is to generate an explanatory theory for the selection and use of technology (especially Internet-/web-based tools) in virtual teams. Such an approach may be particularly useful, because there are deficiencies in

explanations as to how to align technology (especially web-based tools) so as to influence the effectiveness of those project management processes that have been established to date. Grounded theory focuses on incorporating the complexities of the social, technological, and organizational contexts into an understanding of the phenomenon. This will thus produce accurate and useful results.

However, precautions were taken to corroborate the interpretations made (Miles & Huberman, 1994) and to address common problems of bias, poor recall or inaccurate articulation in the interviews. Emerging concepts were checked for representativeness by examining them across participants. This was achieved via data triangulation and investigator triangulation (Patton, 1987) as well as constant comparative coding (see Du Poy & Gitlin (1998), and Glaser (1992)).

Constant comparative coding is the validating process allowing observations and behaviours to be compared/contrasted with core categories and properties, then coded into categories. The developing conceptual model was modified as new data was explored, while new concepts were integrated into the emerging theory, reviewing and expanding where necessary.

Interview data, project documentation, and notes from the observations were analysed through hermeneutics. The hermeneutical approach to human understanding suggests a way for understanding textual data by ascribing meaning to it (Radnitzky, 1970). It refers to the basic idea that someone's understanding of the text as a whole is established by reference to the individual parts and someone's understanding of each individual part is established by reference to the whole. Neither the whole text nor any individual part can be understood without reference to one another: hence this process is often described as the hermeneutic circle.

According to Gadamer (1976), the hermeneutic circle refers to the dialectic between the understanding of the text as a whole and the interpretation of its parts, in which descriptions are guided by anticipated explanations. As mentioned by Taylor (1976, p. 153),

> Interpretation, in the sense relevant to hermeneutics, is an attempt to make sense of an object of study. This object must, therefore, be a text, or a text-analogue, which in some way is confused, incomplete, cloudy, and seemingly contradictory – in one way or another unclear. The interpretation aims to bring to light an underlying coherence or sense.

Hermeneutics suggests that prejudice, prejudgement or prior knowledge play an important role in our understanding. Our attempts to understand a text always involves some prior knowledge

or expectation about what the text is about. According to Gadamer (1976) the critical task in hermeneutics then becomes one of distinguishing between true prejudices, by which we understand and false ones, by which we misunderstand. Hermeneutics is regarded as appropriate as it attempts to make sense of the whole, and the relationship between people, the organization (here the project team), and web-based technology. This is even more useful, since in any organization people have confused, incomplete, cloudy, and contradictory views on many issues. Through hermeneutics, interpretation, which consists of

> deciphering the hidden meaning in the apparent meaning, in unfolding the levels of meaning implied in the literal meaning (Ricoeur, 1974, p. xiv)

can then be accomplished.

In line with Eisenhardt's (1989) as well as Strauss and Corbin's (1990) suggestion, the iteration between data and concepts will end upon reaching theoretical saturation.

4.5 Summary of Research Methodology

A summary of the research design is given in Table 11. Studying the use of web-based tools in a "virtual" work setting, I took an interpretative research stance (Klein & Myers, 1999) on project teams in an educational environment. I collected data from these project teams via direct observation, questionnaires, and--as main data source--through semi-structured interviews. I followed the grounded theory approach as described by Corbin and Strauss (2008). Guided by experienced researcher (e.g., Dey (1999), Morse (2007), and Urquhart *et al.* (2010)), I aimed to develop a theory to explain (Gregor, 2006) the use and selection of web-based tools in "virtual" project teams.

Table 11 - Summary of Research Design

Research Context	Different student project teams from Cape Town and Berlin
Research Paradigm	Interpretative
Research Method	Grounded Theory
Data Collection Method	Convenience and then Theoretical Sampling Survey/Questionnaire Semi-structured Interviews (Individual and group) Direct Observation (Project teams) Documentation (Protocols, Team reflective essays, Course results)
Data Analysis (Analytic strategy)	Grounded Theory

4.6 Research tools

For the management of my research data and coding results I have used the qualitative analysis software NVivo from QSR, a successor of NUD*IST. The version used was 8.0.265.0 SP3. Nvivo was used to organize the data, to record the codes, and link them with the "raw" data that had contributed to the codes' emergence. NVivo allows the representation of the rich many-to-many relationships that existed among codes and the strips of data. NVivo or its predecessor NUD*IST has been used in many interpretative research studies (e.g., Maznevski & Chudoba (2000), and Sarker, Lau, & Sahay (2000)). One criticism that tools like NVivo face is that the effort of using them efficiently finally directs the researcher to pursue a mechanistic approach (Dean & Sharp, 2006). The following quotation from Crowley, Harre and Tagg (2002, p. 193) highlights the different roles a qualitative software/tool might take:

> One of the characteristics of qualitative research is the abstraction of ideas from data, but the question is whether qualitative software is merely assisting in this process, or if it is somehow actually driving the abstraction in unintended ways. The answer is, it depends upon the user, but software can both assist with and enrich the abstraction.

In my research, NVivo served as a data base management system helping me to organize my interviews, assign data out of these interviews to concepts, and to group concepts into categories. The tool supported me, when necessary, in reading all the data assigned to concepts so far, in rearranging a concept, assigning another property to it, reorganizing a category or making it a sub-category of another category. NVivo helped me managing my research data and coding results.

Especially when drafting relationships, I felt that the tool was too clumsy to support me easily. I therefore used paper and pencil (“the best tool during my research work”) to draw them up. Later, to make transparent the emergence of categories and the relationships, I drew them in MS Visio and integrated them into my thesis.

4.7 Access, Privacy, Confidentiality and Ethics

An issue that is of utmost importance to the researcher, The Department of Information Systems, The Faculty of Commerce and The University of Cape Town at large is the ethics of research. Consequently, I took every possible measure to ensure that the data gathered for the purpose of this study was used strictly for this study alone. 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 so as to refer only to the university and the academic year of the course.

I made every effort to comply with the requirements set forth by the research institution in question. An ethics form was submitted and was sent to an “Ethics in Research” committee in the Faculty of Commerce: this committee was established for the purpose of approving or denying research theses. Furthermore, an interview consent form and an interview agenda were presented to all participants in this study for them to read, understand, agree to, and sign. The ethical protocol was approved and the approval is attached to the thesis.

The report will not be confidential and statements made during the interviews may be used unless it has been otherwise requested. Information obtained from the analysis of documentation will be presented in such a way that no confidential details pertaining to the organization are divulged. Respondents’ participation will be on a voluntary basis. Furthermore, any personal details will not be cited without prior agreement from the respondents.

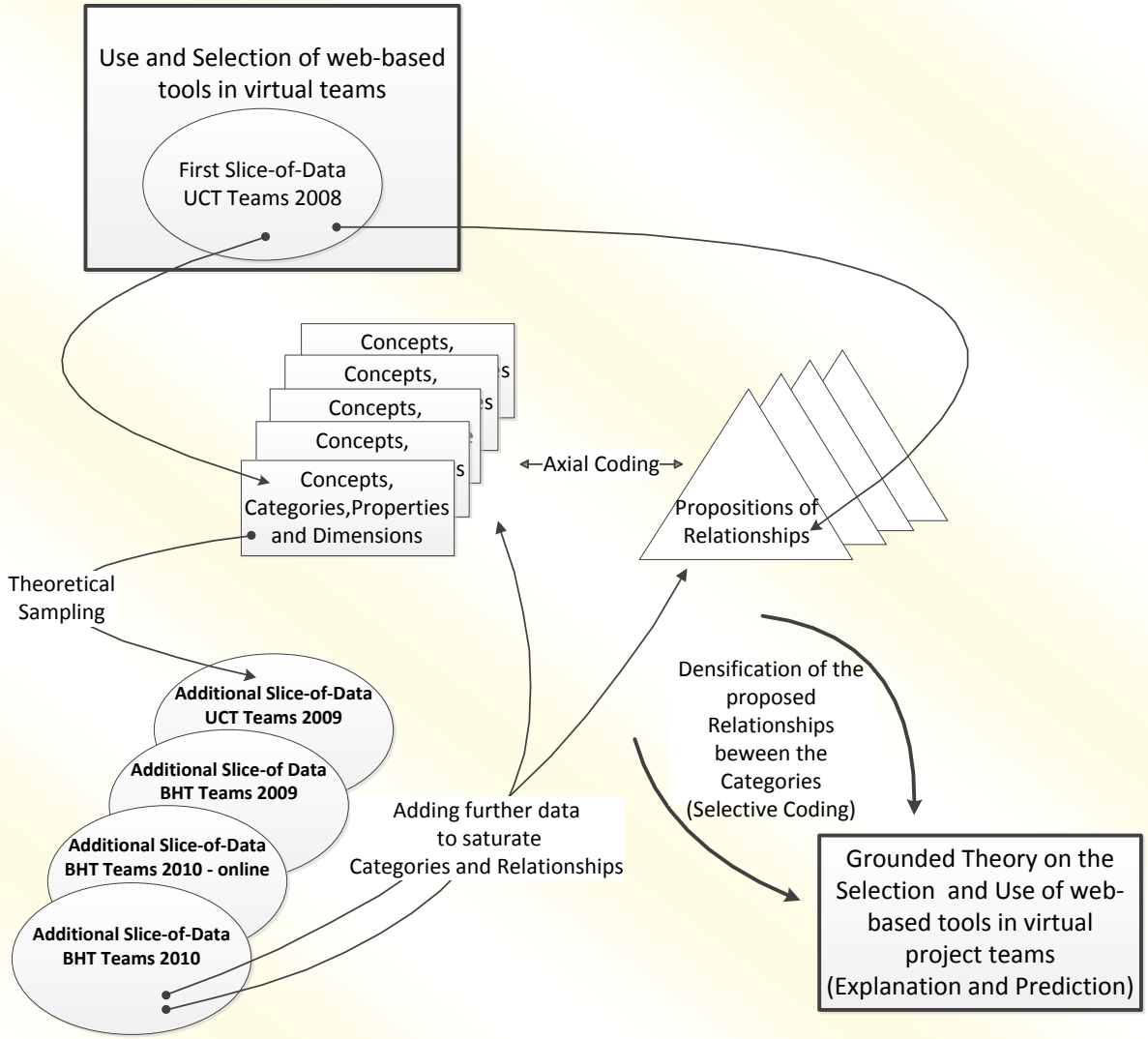
In the next chapter, the resources and plan required for the successful completion of this research study are detailed.

5. Analyses and Coding of UCT and BHT Teams

5.1 *High Level Map of Data Sampling and Collection*

The data were collected from two sources: the University of Cape Town's (UCT) student project teams during the final term of their third year capstone projects in 2008 and 2009, and from undergraduate students at the University of Applied Science in Berlin (BHT) during their second year coursework projects on Project Management in 2009 and 2010. As pointed out by Urquhart *et al.* (2010) sampling is an important aspect in the development of a grounded theory. Hence I will explain the sampling and data collection (see Figure 17) in this section.

Figure 17 - Data Sampling and Collection in my Research Study (adapted from Urquhart, *et al.* (2010))



When the grounded theory approach is used, the emergent theory guides the researcher in the analysis of the data. Following the principle of theoretical sampling, the researcher decides--depending on the analysed data--where to collect the next data for the analysis (Glaser & Strauss, 1967).

Consequently, my research study developed over time and I sampled from a variety of data sources in a number of cycles. In my first cycle I did **convenience sampling** (Morse, 2007) for the initial set of interviews. For the next cycles I followed the **principle of theoretical sampling** (Corbin & Strauss, 2008). Different cases were selected for their similarities as well as for their differences. The technique of theoretical sampling requires considering theoretical relevance and purpose. The selection process as described in the following paragraphs ensures that an emergent theory was likely to be either replicated or extended (Eisenhardt, 1989).

All teams were composed of undergraduate students completing a project following the PMBOK guidelines (Project Management Institute, 2004). In all cases the teams had to cope with virtuality in their project work. This was a similarity among them but virtuality also inserted a difference since the degree of virtuality varied between the teams. The BHT-2010-O teams rarely met because the students of this course studied from home/work. Each of the BHT-2009 and BHT-2010 teams consisted of two sub-teams, each sub-team coming from a different course. Griffith, Sawyer and Neale (2003) define the degree of virtuality by the three dimensions, 'Level of Technological Support', 'Time Apart on Task', and 'Physical Distance'. Taking this into account, the distance between the team members in the BHT-2010-O is larger because they are studying online and not at the university. In addition, all three groups (BHT-teams-2009, BHT-teams-2010 and BHT-teams-2010-O) work apart for, on average, a higher percentage of time than the UCT teams. Consequently the BHT teams face a higher degree of virtuality. With respect to the relevance of the research area addressed, the use and selection of web-based tools was necessary for all project teams to work together in achieving their project goals.

A further difference was the size of the teams, which varied from three to eight members. In addition the teams had different academic backgrounds: Information Systems in the case of UCT and Industrial Engineering and Management as well as Information Systems in the case of BHT. This ensured different levels of enthusiasm as well as varied attitudes and relationships with information technology.

The two reasons for the selection of these particular universities were as follows: first of all, both places have a student community showing high diversity with respect to culture, race, skills, etc. This complies with one issue in virtual team work. Second, during the analysis of the first data slice (UCT), the limited Internet availability and bandwidth seemed to be a major problem in the selection and use of web-based tools. This is supported by the following quotation:

> An increased bandwidth would allow for more possibilities with regards to technical communication (UCT-Team-2008-3).

Therefore, selecting a location in Germany which has a good Internet infrastructure allowed me to analyse the impact of the Internet on my research problem.

To have an industrial sponsor for a project in an education environment gives the teams, on the one hand, a more realistic business setting. On the other hand, it forces the team to communicate and use technologies that meet the sponsor's business requirements. In two data sample slices from BHT, the teams worked on a project task without an industrial sponsor and so affording a comparison between those with and those without a sponsor. This sampling supports research findings in freeing the teams from power relations and technical determinism in order to study the impact on my research results.

The project duration varied from one semester (approximately six months) to two semesters (approximately twelve months). Related to the different study setting and influenced by the analysis of my data, the complexity of the project task was as different as the type of project. The project tasks included:

- Software development,
- Market research study,
- System requirements analysis, and
- Concept development.

At the beginning of each section I will explain, for each data slice, the reasons for the selection of this specific sample. I will also elucidate the theoretical sampling.

According to Glaser and Strauss (1967), data collection, coding, and analysis take place iteratively. Thus, summarizing the above differences and similarities, the sampling happened as follows (see also Figure 17): the UCT teams 2008 were the starting point of my research. In this early phase of my study the questions posed were more open-ended. The UCT 2009 teams were chosen

with questions that had been revised as directed by the emerging concepts and relationships. The teams had been advised on different Internet-based tools. The reasons for deciding on the BHT Teams were that, compared to the UCT teams, all BHT teams had unlimited access to the Internet. In addition, the following parameters for the BHT teams differed from those of the UCT teams: shorter project duration, no sponsor in 2009, less complex project tasks, and increased team size. The BHT teams 2010 online were collected because of a higher degree of virtuality and their habit of working together via the Internet. The BHT 2010 teams had sponsors and there was a high degree of competitiveness between the teams due to their having the same project goals.

As illustrated in Figure 17, my data collection and analysis were alternating activities. The joint interaction of data analysis and data collection is not only defined by Glaser and Strauss (1967) as being central to grounded theory so as to ensure the development of a theory, but it also provides, according to Eisenhardt (1989), a number of advantages:

> [It] not only gives the researcher a head start in analysis, but more importantly allows researchers to take advantage of flexible data collection. Indeed, a key feature of theory-building case research is the freedom to make adjustments during the data collection process (Eisenhardt, 1989, p. 539).

This characteristic of joint interaction of data collection and constant comparison of every newly collected slice of data with existing concepts is central to the grounded theory building process. It has also, for a long time, been a standard method in the social sciences (Urquhart, Lehmann, & Myers, 2010).

In total, 28 project teams with 167 team members were observed, questioned and interviewed. Table 12 shows location, team size, and number of teams in the different data cycles, as well as duration of project.

Table 12 - Teams at UCT and BHT

Teams	Year	Team Size	Number of Teams	Project Duration
UCT	2008	4-5	8	1 year
UCT	2009	3-5	7	1 year
BHT	2009	7-8	5	6 month
BHT	2010	8	6	6 month
BHT-Online	2010	4-5	2	6 month

Due to differing course schedules and extra-curricular commitments, team members at UCT and BHT often find it difficult to work at the same physical location at the same time. Under these circumstances, team members would rely on virtual team technologies to enhance team productivity and assist them in delivering a quality product. Since students at both universities belong to a wide variety of different cultures and nations, the student project teams often showed high diversity with different cultural backgrounds. Thus, they face similar problems to those experienced by global project teams when operating in different countries.

Research data was initially collected via a questionnaire, followed by interviews, observation, and the analysis of course results. The questionnaire was semi-structured and contained both closed and open-ended questions. The interviews were also semi-structured and comprised open-ended questions derived from prior research studies, the questionnaires, and literature on virtual teams. The duration of the interviews was between 30 minutes and one hour. In the first cycle two students from each team were interviewed and in later cycles the whole team was interviewed in group interviews. The interview questions were constantly adapted due to the analysis results of the previous cycles. Triangulation was applied to relate questionnaire data, observation results, interview data, and the course results of the different teams.

In grounded theory it is recommended (see Glaser & Strauss (1967) and Strauss & Corbin (1990)) that analysis begins right after the first interview or observation. In a sequential way, each interview or even interview question should be followed by the analysis. This allows the researcher to identify concepts and to come up with additional questions and follow the interviewee more sensitively (Corbin & Strauss, 2008). In my research this was in most cases only possible between the different data collection cycles because the interviews had to be set up immediately after the team's project presentations. This is appropriate, because Corbin and Strauss (2008, p. 58) also state

> Though alternating data collection with analysis would be ideal there is also the reality of sometimes having to collect data without being able to immediately begin the analysis. . . Sometime several interviews come all at once.

In addition, due to the five different data cycles in the last three years, theoretical sampling has taken place between these cycles with each cycle having a specific emphasis which came up during the previous cycle. The following table gives a summary of unsaturated categories (sub-categories/concepts) analyzed in a specific data collection cycle (see Table 13).

Table 13 - Theoretical Sampling Requirements between the Different Data Collection and Analysis Cycles

Data Collection Cycle	Unsaturated Categories (Specific Emphasis during the Analysis)	Requirements of the Next Case
First Data Collection and Analysis Cycle (UCT 2008)		Convenience sampling
Second Data Collection and Analysis Cycle (UCT 2009)	Project (Task Characteristics) Tool (Selection, Integration, Sharing, Transparency) Internet (Access and Availability) Team (Trust, Performance, Satisfaction, Diversity)	Further investigation regarding the role of the Internet for the selection process and the use of tools. Investigation of the reason for the small variety of selected/used tools.
Third Data Collection and Analysis Cycle (BHT 2009)	Project (Task Characteristics, Duration) Tool (Selection, Integration, Versioning, Sharing, Task Tracking, Task Planning, Central Platform, Transparency) Internet (Access and Availability) Team (Size, Performance, Satisfaction, Trust, Diversity)	Investigate versioning and sharing. Look at teams coming from a different study background which might place a different light on the use and selection of tools. Project tasks were set up by the course convenor; there was no external sponsor involved. Evaluate the necessity to use a tool for project planning, task management, and task tracking in larger teams. Compare the influence of a good Internet infrastructure with the findings of the first two data cycles.
Fourth Data Collection and Analysis Cycle (BHT 2010-O)	Team (Performance, Satisfaction, Team Member Satisfaction, Trust, Diversity) Tool (Selection, Sharing, Integration, Communication, Central Platform, Transparency)	Investigate teams who have more experience in working together in a distributed work setting; Look how the degree of virtuality influences the selection and use of tools.
Fifth Data Collection and Analysis Cycle (BHT 2010)	Project (Task Characteristics) Tool (Selection, Sharing, Integration, communication) Team (Performance, Trust, Satisfaction, Team Member Satisfaction, Diversity)	Investigate how competition due to same projects influences the use of tools as well as team performance and satisfaction. Look how the degree of virtuality influences the selection and use of tools.

5.2 *Analyses of the UCT Teams 2008*

5.2.1 Sampling, Data Collection and Data of the UCT Teams 2008

The research data was collected from UCT's student project teams during the final term of their third year capstone projects in 2008. At UCT in 2008, 39 undergraduate students formed 8 teams of 4-5 students each, with each team finding their own industrial sponsor to supply a business problem (see Table 14). The duration of this project was one year. At UCT a systems development group project is one of the major deliverables of the one year capstone course of the IS undergraduate curriculum. The course includes topics like requirements planning, software design, software construction, and testing. A comprehensive assessment strategy implements various instruments so as to accomplish formal summative assessment, formal continuous assessment, and an informal formative assessment (Scott & van der Merwe, 2003). The course content adheres to international curriculum standards as specified in the IS Model Curriculum (Gorgone, *et al.,* 2003) and the Computing Curricula 2005 (Shackelford, *et al.,* 2006).

Table 14 - Team-specific Project Brief UCT 2008

Teams UCT 2008	Team-specific project brief
UCT-2008-1	Development of a CRM system which aids the customer's organisation in performing multiple administrative tasks, as well as providing an easy-to-use interface for all of its members.
UCT-2008-2	Development of an Enterprise Management System for material management and customer relationship management system customized to the sponsor's needs.
UCT-2008-3	The objective is to develop a point of sale Windows based system to be used by the staff members when creating customer orders; as well as a customer relationship management (CRM) website for customers to view a catalogue of products, the status of their orders and their account balances.
UCT-2008-4	Develop a web-based Customer Relationship Management Information System for a second hand book store.
UCT-2008-5	Development of a web-based Customer Relationship Management (CRM) system aimed at improving the customer's/sponsor's business operations. The ultimate objective is to increase sponsor donations by building an interactive online donation system.
UCT-2008-6	Development of a system focuses on automating the process of providing decent homes to underprivileged communities. The system shall streamline the business processes by enabling a chairperson, on behalf of a group of beneficiaries, to submit an online proposal. Donors, who provide the funding have the opportunity to register online, make donations and view reports for completed and progress of housing projects. Volunteers shall get the chance to register online.
UCT-2008-7	Development of a Cricket Box Management System that improves the process of

Teams UCT 2008	Team-specific project brief
	ticket-booking for the customer's cricket-box, thus allowing it to run more efficiently. This will reduce the time to book tickets as most of the processes will be automated. Costs will also be reduced due to the more efficient running of the cricket-box system.
UCT-2008-8	The goal is to develop a web-based Customer Relationship Management (CRM) system designed for the customer, whose business is operating in the tourism industry. The system was designed enabling the customer increasing efficiency and accuracy in the workplace. It shall also be designed to manage customer relations and to support future growth of the customer's business.

The UCT course has, furthermore, been shaped according to guidelines provided by international curriculum standards, as specified in the IS Model Curriculum (Gorgone, Davis, Valacich, Topi, Feinstein, & Longenecker, 2003) and the Computing Curricula 2005 (Shackelford, et al., 2006). The theoretical part of this course introduces students to important aspects of managing projects and people in the ICT project environment. The practical part of the course involves the application and implementation of these concepts while following the full IS project life cycle, using a team-based approach in a real-life setting. UCT student teams work either in the computer labs, at their sponsors' offices, or at home.

Table 15 - Data Collection Protocol UCT-2008

Data Source	Details
Semi-structured interviews	Interviews with team leader and one team member; written notes; no recording.
Observation of meetings	Team characteristics on behaviour, skills, team procedures regarding problem solving, and team cohesion. This assessment was done by the UCT course convenor.
Questionnaires	Completed by each team member regarding used technologies and problems faced.
Team reflective essays	Team characteristics on behaviour, skills, team procedures regarding problem solving, and team cohesion. This assessment was performed by the UCT course convenor.
Course results of the teams	This assessment was done by the UCT lecturer team.

The data collection, coding, and analysis process was more or less iterative. In the first phase of data collection relating to the 2008 teams, data was collected by means of a survey and semi-structured interviews. The questionnaire was semi-structured and contained closed- and open-ended questions regarding used technologies and problems faced (see sections 4.3 and 10.2). Each team was asked to return at least three questionnaires answered by individual team members. The survey was handed out after the final project presentation and returned by 27 of 39 students. The

questionnaires were treated anonymously. This phase was followed by semi-structured interviews consisting of open-ended questions that guided respondents to explore issues of virtualization, the use of technology, and the availability of and access to technology. Two students (including the team leader) from the same project team participated in each interview, which had a typical duration of 30 to 45 minutes. The content of the interviews was recorded in writing on the basis of notes taken during the interviews and was open-coded to discover recurrent themes around attributions (Strauss and Corbin, 1998) as described in the following section.

Table 16 - Team and Work Characteristics UCT Teams 2008

Teams	Size	Team Characteristics	Collaborative Work Characteristics
UCT-Team-2008-1	5	High technical and organizational expertise High level of trust (friends prior to project)	Good task awareness[17] Good task management
UCT-Team-2008-2	5	Medium level of expertise Low level of trust	Poor task awareness Poor task management
UCT-Team-2008-3	5	Medium level of technical expertise (They even decided to use new technologies with no expertise) Medium level of trust	Good task awareness Average task management
UCT-Team-2008-4	5	Medium to high level of expertise (strong software processes & soft skills; expertise grew during project) High level of trust	Good task awareness Good task management
UCT-Team-2008-5	4	Medium level of technical expertise (2 members were top performers) Medium level of trust	Average task awareness Good task management (time management to be improved)
UCT-Team-2008-6	4	Low level of technical expertise High level of trust	Good task awareness Average task management (improved towards end; managed to resolve misunderstanding)
UCT-Team-2008-7	5	High level of technical expertise High level of trust (Friends prior to project)	Good task awareness - Average task management (goals and standards not always clear led to sluggish development; struggled with time management)
UCT-Team-2008-8	4	Low level of technical expertise Low level of trust	Poor task awareness Poor task and time management

[17] In this context 'task awareness' means the team's understanding of the project problem that has been set by their industrial sponsor. It should not mixed up with 'task awareness' from the CSCW research.

The above team characteristics on behaviour, skills, team procedures regarding problem solving, and team cohesion were assessed together with the UCT course convenor, based on observation, a reflective essay, and team interviews.

Table 17 - Diversity of the UCT Teams 2008

Teams	Gender	Diversity	Cultural Diversity
UCT-Team-2008-1	1 Female 4 Male	1 Black, 3 Whites, 1 Coloured[18]	Medium cultural diversity (2 cultures & different genders)
UCT-Team-2008-2	2 Female 3 Male	2 Coloured, 2 Black, 1 Indian	High cultural diversity (different cultures & gender)
UCT-Team-2008-3	3 Female, 2 Male	4 Whites, 1 Coloured	Low cultural diversity
UCT-Team-2008-4	1 Female, 4 Male	1 Indian, 1 South American, 1 Chinese, 1 White, 1 Coloured	High cultural diversity (5 different cultures; different religions)
UCT-Team-2008-5	5 Male	2 Indians, 2 Whites, 1 Coloured	High cultural diversity
UCT-Team-2008-6	4 Male	4 Black	Low cultural diversity
UCT-Team-2008-7	4 Male, 1 Female	4 Black, 1 Coloured	Low cultural diversity
UCT-Team-2008-8	(2 Male, 2 Female)	4 Indians, 1 Coloured	Low cultural diversity

In my research the emphasis has been on demographic tile team composition (see Chao & Moon (2005), and Paul, Samarah, Seetharaman, & Myktyn (2005)) to see how diversity (see Table 16 and Table 17) influences teams' output and process regarding the selection and use of technology. The team members may differ with respect to several factors, including place of residence, colour, nationality, original nationality (for instance, where team members have migrated), and skills. When members are grouped in a team for a project, the resultant teams can generally be described as being one of two types: homogeneous or heterogeneous.

The following table, with the frequency of face-to-face meetings, was extracted from the survey questionnaire handed to each member of the teams. In the survey, team members were asked to indicate how often they had used the different communication and project management software during their one year capstone project. They had to choose one of the following options: daily, two-three times a week, at least once a week, at least once a month, or never.

[18] South Africa provided five racial categories by which people are classified: "Unspecified/Other", "Black African", "White", "Coloured", and "Indian or Asian". The term "Coloured" is used for people of mixed race.

The answers reflect a range in each team. This can be attributed to the fact that not all team members participated in every meeting. In addition, team members did not keep records of how often they had met but answered the questions from a rather personal point of view. For the purposes of my research, it is important to see whether a team seems to meet more or less often compared to the other teams.

Table 18 – Face-to-Face Meeting Frequency UCT Teams 2008

Teams	Frequency of Face-to-Face Meetings
UCT-Team-2008-1	**Two to three times per week**
UCT-Team-2008-2	From **Two to three times a week** to **At least once a week**
UCT-Team-2008-3	From **At least once a week** to **Daily**
UCT-Team-2008-4	From **At least once a week** to **Daily**
UCT-Team-2008-5	**Two to three times a week**
UCT-Team-2008-6	**Two to three times a week**
UCT-Team-2008-7	From **Two to three times a week** to **Daily**
UCT-Team-2008-8	From **Two to three times a week** to **Daily**

I asked the UCT-2008-Teams, in a survey, for the occurrences of face-to-face meetings during their one year project. In addition, I requested the usage rate for specific communication tools (compare Table 19) and project management related software (compare Table 20). The results were influenced by subjectivity and diversity in the usage. These questionnaires assisted in estimating and comparing how often the different teams had used a certain tool category. Even more important is the information about which tools they preferred and in what combinations they used the tools (media mix).

Table 19 - Use of Communication Technology UCT Teams 2008

Teams	Netmeeting or Skype	Phone Conference	Chat and Vula[19]	eMail	Text Messaging
UCT-Team-2008-1	Never	Never	Daily	From **At least once per month** to **Daily**	Two to three times per week
UCT-Team-2008-2	Never	Never	From Two to three times a week to Daily	From **Never** to **Daily**	From **At least once a week** to **Daily**
UCT-Team-2008-3	Never	Never	**From Two to three times a week** to **Daily**	Daily	From **At least once a month** to **Daily**
UCT-Team-2008-4	At least once a week	From **Never** to **At least once a week**	From **At least once a week** to **Daily**	From **At least once a week** to **Daily**	From **At least once a week** to **Daily**
UCT-Team-2008-5	From **Never** to **At least once a week**	From **Never** to **Two to three times a week**	From **Never** to **Two to three times a week**	From **Two to three times a week** to **Daily**	Two to three times a week
UCT-Team-2008-6	Never	Never	From **Never** to **Two to three times a week**	From **At least once a week** to **Two to three times a week**	Two to three times a week
UCT-Team-2008-7	From **Never** to **Daily**	Never	From **Two to three times a week** to Daily	From **At least once a week** to **Two to three times a week**	Daily
UCT-Team-2008-8	From **Never** to **Two to three times a week**	From **Never** to Two to three times a week	From **Two to three times a week** to **Daily**	Daily	From **Never** to **Two to three times a week**

[19] 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, resource sharing, and collaborative learning.

Table 20 - Use of PM Software UCT Teams 2008

Teams	MS Project Web Access	Web-Based Task tracking	Web-based time sheet management	Team Calendar
UCT-Team-2008-1	From **Never** to **Less than once a week**	From **Never** to **Less than once a week**	Never	Never
UCT-Team-2008-2	From **Never** to **Two to three times a week**	Never	Never	From **Never** to **Two to three times a week**
UCT-Team-2008-3	From **Never** to **At least once a month**	From **Never** to **Less than once a week**	From **Never** to At least once a week	Never
UCT-Team-2008-4	From **Never** to **Less than once a month**	From **Never** to **Two to three times per week**	From **Never** to **At least once a week**	From **Never** to **At least once a week**
UCT-Team-2008-5	At least once a month	Never	From **Never** to **At least once a month**	From **Never** to **At least once a month**
UCT-Team-2008-6	From **At Least Once a week** to **Two to three times a week**	**Never** to **At least once a week**	From **Never** to **At least once a week**	Never
UCT-Team-2008-7	From **Never** to **At least once a month**	Never	Never	Never
UCT-Team-2008-8	At least once a month	Never	From **Never** to **Less than once a week**	Never

Based on their course results, the teams from UCT 2008 were categorized into high, medium, and low performance teams. Project teams in an educational environment are seldom assessed in terms of project success or project failure, as the main emphasis is the transfer of knowledge and experience. Projects at an undergraduate level are for many team members their first experience of developing a comprehensive information system. As a result, these projects might not be of a high enough standard to be implemented in a business environment at the pre-determined hand-in date. However, a comprehensive assessment strategy that includes formal summative assessment, formal continuous assessment, and informal formative assessment can greatly enhance the quality of projects and their chances of successful implementation (Scott & van der Merwe 2003). It can therefore be argued that teams achieving low marks would be more likely to deliver a project failure, and teams with high marks a project success. I set up the interviews before the marking of the teams was finished. I had no influence on the marks and the marking process.

Table 21 - Performance Level UCT Teams 2008

Teams	Performance level
UCT-Team-2008-1	High
UCT-Team-2008-2	Low
UCT-Team-2008-3	Medium
UCT-Team-2008-4	High
UCT-Team-2008-5	High
UCT-Team-2008-6	Low
UCT-Team-2008-7	Medium
UCT-Team-2008-8	Low

During my research work, the project teams at UCT complained about limited Internet availability and Internet bandwidth. I therefore asked the teams at the beginning of the interviews about the availability of the Internet, whether they had their own computer with a modem, wireless or DSL access to the Internet or whether they had to go on campus and use the UCT network to access the Internet. Teams are classified as "Unlimited Availability" if the majority of the team members had their own Internet access. Teams are classified as "Unlimited Bandwidth" if the majority of the team members had an ADSL (broadband) connection to the Internet. Teams with "Limited Availability" and "Limited Bandwidth" are those with Internet access only on campus.

Table 22 - Internet Availability and Internet Bandwidth UCT Teams 2008

Teams	Internet Availability	Internet Bandwidth
UCT-Team-2008-1	Unlimited	Unlimited
UCT-Team-2008-2	Unlimited	Unlimited
UCT-Team-2008-3	Unlimited	Unlimited
UCT-Team-2008-4	Unlimited	Unlimited
UCT-Team-2008-5	Unlimited	Limited
UCT-Team-2008-6	Limited	Limited
UCT-Team-2008-7	Limited	Limited
UCT-Team-2008-8	Limited	Limited

5.2.2 Results from the Open Coding

The starting point of the open coding was the interviews conducted in November 2008. The interviews also marked the beginning of my qualitative research on virtual teams. The interviews

were guided by a number of questions aimed at investigating virtualisation, the use of technology, as well as availability and access to technology:

- Explain the role of Vula in managing your project?
- If you had had fewer possibilities (or organizational needs) to meet in face-to-face meetings, what kind of project management technology would have been the most important for you to help you to manage your project?
- What were the limiting factors when using project management technology in your project?
- Was it always possible for everyone to attend the regular face-to-face meetings? If not, how did you compensate for this (with the help of technology?)

The interviews were coded into NVivo version 9. The following figure shows how the eight transcribed interviews from the UCT 2008 teams relate to the number of concepts ("Nodes") and the number of references in the interviews ("References").

Figure 18 - Interview Sources related to the Concepts

Internals

Name	Nodes	References
Interview UCT-Team-2008-1	10	12
Interview UCT-Team-2008-2	13	14
Interview UCT-Team-2008-3	14	14
Interview UCT-Team-2008-4	10	13
Interview UCT-Team-2008-5	14	15
Interview UCT-Team-2008-6	21	24
Interview UCT-Team-2008-7	14	15
Interview UCT-Team-2008-8	16	19

In the open coding of the eight team interviews in my first data cycle, the following 41 concepts were identified. Due to the comparative analysis, duplicates have already been eliminated and reduced to the concepts as described in Table 23.

Table 23 - Concepts, Sources and Number of References of the UCT Teams 2008

Concept	Sources	Number of References
Chat-Tool	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-7	8
Code Exchange	Interview UCT-Team-2008-3	1

Concept	Sources	Number of References
Communication Media	Interview UCT-Team-2008-3	1
Costs of Internet Access	Interview UCT-Team-2008-5	1
Document Exchange	Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	7
Email	Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-6;	4
Forum	Interview UCT-Team-2008-4	1
Geographical Distance between Team Members	Interview UCT-Team-2008-7	1
Internet Download Quota	Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	3
Internet Speed	Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	3
Knowledge Exchange	Interview UCT-Team-2008-2	1
Learning	Interview UCT-Team-2008-6	1
Limiting Factor	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	7
Media Choice	Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6	6
MS Project	Interview UCT-Team-2008-1; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-8	5
Phone	Interview UCT-Team-2008-6	1
Problem Solving	Interview UCT-Team-2008-3; Interview UCT-Team-2008-8	2
Project Documentation	Interview UCT-Team-2008-1	1
Project Documents Minutes	Interview UCT-Team-2008-6	1
Project Planning	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2; Interview UCT-Team-2008-6	3
Schedule of Face-to-Face Meetings	Interview UCT-Team-2008-2; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	6
SMS	Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-8	6
Spread of Technological Skills	Interview UCT-Team-2008-3	1
Task Planning	Interview UCT-Team-2008-2; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6	3
Task Tracking	Interview UCT-Team-2008-3; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-8	4
Team Rules	Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6	3
Technical Infrastructure	Interview UCT-Team-2008-7	1
Tool Access	Interview UCT-Team-2008-5	1
Tool Adaption	Interview UCT-Team-2008-8	1
Tool Availability	Interview UCT-Team-2008-5	1
Tool Selection	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2	2

Concept	Sources	Number of References
Tool Integration	Interview UCT-Team-2008-1; Interview UCT-Team-2008-3; Interview UCT-Team-2008-8	3
Tool Licence	Interview UCT-Team-2008-4	1
Tool Training	Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	3
Tool Use	Interview UCT-Team-2008-1; Interview UCT-Team-2008-6; Interview UCT-Team-2008-8	5
Version Control	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-5; Interview UCT-Team-2008-6; Interview UCT-Team-2008-7	8
Videoconferencing	Interview UCT-Team-2008-6; Interview UCT-Team-2008-7;	2
Virtualisation	Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-4; Interview UCT-Team-2008-7	4
Voice Over IP	Interview UCT-Team-2008-2; Interview UCT-Team-2008-3; Interview UCT-Team-2008-5; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	5
Vula	Interview UCT-Team-2008-1; Interview UCT-Team-2008-2; Interview UCT-Team-2008-6; Interview UCT-Team-2008-7; Interview UCT-Team-2008-8	7
Vula Announcement	Interview UCT-Team-2008-8	1

In the light of the questions raised, concepts are identified that relate to:

- specific technologies like email, SMS, MS Project or Vula *("*Speed is a limiting factor for most of the tools except Vula . .*"* (UCT-Team-2008-6)),
- the task they perform using these technologies ("Improvement will be apparent if every individual in the team is equipped with the necessary skills to utilise the technological tools available efficiently and effectively . ." (UCT-Team-2008-3)) and
- the limitations they are facing when applying or not applying certain technologies, like the Internet speed ("An increased bandwidth would allow for more possibilities with regards to technical communication."(UCT-Team-2008-3)), the access to computers in the lab ("Internet bandwidth and less authority restriction would improve the work in my project" (UCT-Team-2008-6)) or the missing knowledge about a specific technology ("Crucial software did not work and bandwidth was scarce. The team should have been more educated on certain software." (UCT-Team-2008-5)).

5.2.3 Results from the Axial Coding

In the axial coding phase the interviews were analysed again, taking into account previous memos, team characteristics (like size, skills, work, and diversity), the frequency with which the

teams use the different communication and project management tools, and how often teams meet face-to-face, as well as the team results. Another important factor was Internet availability and bandwidth in the different UCT teams 2008. The goal was to organize the concepts into recurring themes and to identify stable categories covering as much of the data as possible. Each category was therefore linked to a number of associated concepts. Some of the results (like the identification of properties and the dimensions of the categories) presented in this section have already occurred in the open coding phase. They were refined during the axial coding and are described in this section to avoid recurrences.[20]

5.2.3.1 Categories, Properties and Dimensions

According to Corbin and Strauss (2008), categories are much broader in scope than concepts. They represent a group of similar or related concepts and emerge during the process of analysis. While comparing the different data elements and coding them, the researcher identifies additional properties and concepts as part of a category. In the axial coding process, the 41 concepts have been grouped into 4 main categories:

TEAM, **PROJECT**, **TOOL,** and **INTERNET**

For these main categories the concepts/properties and dimensions[21] are listed below.[22] These concepts and sub-categories relate to main categories that help to answer questions such as who, where, why, when, and how about the specific category.

Table 24 - Concepts, Properties and Dimensions of the Category TEAM

Category	Concept/Property	Dimensions
Team	Communication Level	Low, Medium, High
Team	Cultural Diversity	Low, Medium, High

[20] As noted by Corbin & Strauss (2008, p. 198), "open coding and axial coding go hand in hand. The distinctions between the two types of coding are 'artificial' and for explanatory purposes only."

[21] Dimensions of the concepts were listed if the emerged and were relevant for the relationships of the concepts.

[22] These categories, sub-categories, properties, and dimensions have been analyzed on the first set of data (interviews and questionnaires) collected during the starting phase of my research. After this first phase in 2008, the interview questions were refined to gather richer qualitative data related to my research questions.

Category	Concept/Property	Dimensions
Team	Expertise	Low, Medium, High
Team	Gender Mix	All Male, All Female, Mixed
Team	Performance Level	Low, Medium, High
Team	Trust Level	Low, Medium, High
Team	Size	Small, Medium, Large
Team	Social Cohesion	Low, Medium, High
Team	Social Engagement	Low, Medium, High
Team	Task Management	Poor, Average, Good
Team	Task Awareness[23]	Poor, Average, Good
Team	Friendship	
Team	Geographical Distance between Team Members	
Team	Spread of Technological Skills	
Team	Steering Processes	
Team	Rules	
Team	Virtuality	

Table 25 - Concepts, Properties and Dimensions of the Category PROJECT

Category	Concept/Property	Dimensions
Project	Documentation	
Project	Documents - Minutes	
Project	Planning	
Project	Face-to-Face Meetings	Never, Daily, Two to three times a week, At least once a week, At least once a month
Project	Limiting Factors	
Project	Media Choice	
Project/Project activities	Code Exchange	
Project/Project activities	Document Exchange	
Project/Project activities	Knowledge Exchange	

[23] In this context task awareness means how well the team understands the project problem that has been set by their industrial sponsor. It should not be identified with the 'task awareness' from the CSCW research.

Category	Concept/Property	Dimensions
Project/Project activities	Learning	
Project/Project activities	Problem Solving	
Project/Project activities	Scheduling of Face-To-Face Meetings	
Project	Task Planning	
Project	Task Tracking	

Table 26 - Concepts, Properties and Dimensions of the Category TOOL

Category	Concept/Property	Dimensions
Tool	Access	No, Limited, Unlimited
Tool	Adaption	
Tool	Availability	No, Limited, Unlimited
Tool/ Chat-Tool		
Tool	Selection	
Tool/Email		
Tool/Forum		
Tool	Integration	
Tool	Internet-Based	No, Yes
Tool	Licence	
Tool/MS Project		
Tool/Phone		
Tool/SMS		
Tool	Technical Infrastructure	
Tool	Training	
Tool	Usage	Never, Daily, Two to three times a week, At least once a week, At least once a month
Tool/Version Control		
Tool/Voice of IP		
Tool/Vula	Announcement	

All specific tools (**CHAT-TOOL, EMAIL, FORUM, MS PROJECT, PHONE, SMS, VERSION CONTROL, VOICE OVER IP** and **VULA**) have the following properties in common:

Table 27 - Properties and Dimensions of Specific TOOLS

Property	Dimension
Communication related Usage	No, Yes
Information, Data and Source Code Sharing Related Usage	No, Yes
Project Management Related Usage	No, Yes
Usage Frequency	Never, Daily, Two to three times a week, At least once a week, At least once a month

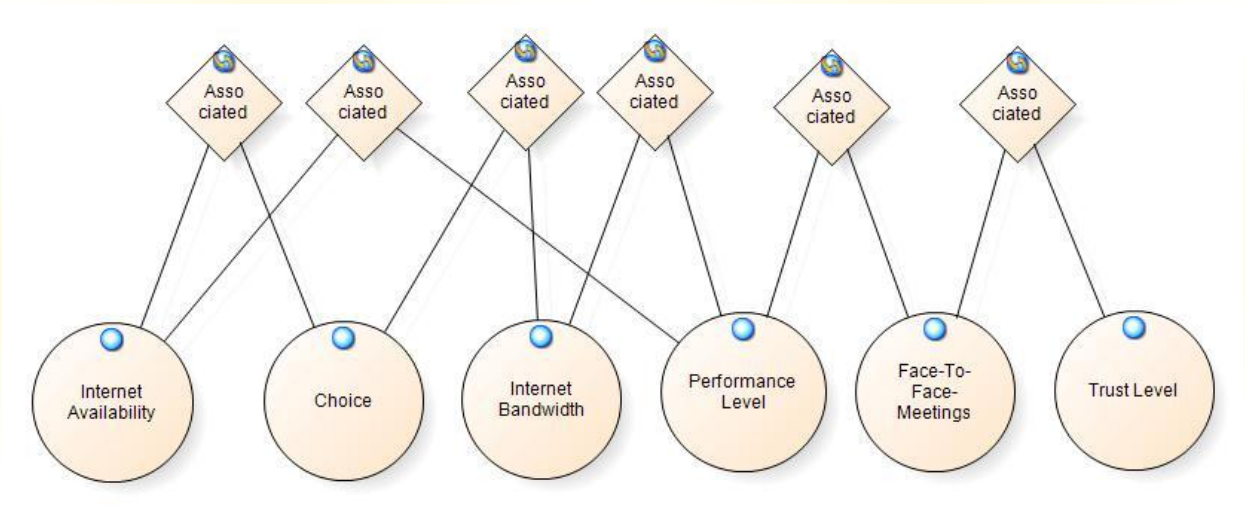
Table 28 - Concepts, Properties and Dimensions of the Category INTERNET

Category	Concept/Property	Dimensions
Internet	Bandwidth	Limited - Unlimited
Internet	Availability	No, Limited, Unlimited
Internet	Cost of Access	
Internet	Download Quota	

5.2.3.2 Relationships

During this early phase of my analysis I identified a couple of relationships that strongly influenced the questions in the second data collection cycle of the UCT 2009 Teams (see Figure 17).

Figure 19 - Relationships based on the analysis UCT 2008 Teams (from NVivo)



I did not classify them according to the paradigm model--for example, whether they are causal or intervening conditions between the early categories--because they were based only on my first slice of data.

R-UCT-2008-1[24]: A low **TRUST LEVEL** in the **TEAM** is associated with an increased frequency of **FACE-TO-FACE MEETINGS** in the **PROJECT** to build up trust. If **TEAMS** with a low **TRUST LEVEL** cannot meet more often a low **TEAM PERFORMANCE LEVEL** might be the consequence.

R-UCT-2008-2: Some **TOOLS** support specific **PROJECT ACTIVITIES** better than other **TOOLS**.

R-UCT-2008-3: Teams use specific **TOOL COMBINATIONS** to overcome the limited **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH**.

R-UCT-2008-4: Limited **INTERNET AVAILABILITY** and limited **INTERNET BANDWIDTH** reduce the **EFFECTIVENESS** of the different **PROJECT ACTIVITIES**.

R-UCT-2008-5: Limited **INTERNET AVAILABILITY** and limited **INTERNET BANDWIDTH** seem to contribute to lower **TEAM PERFORMANCE LEVEL**.

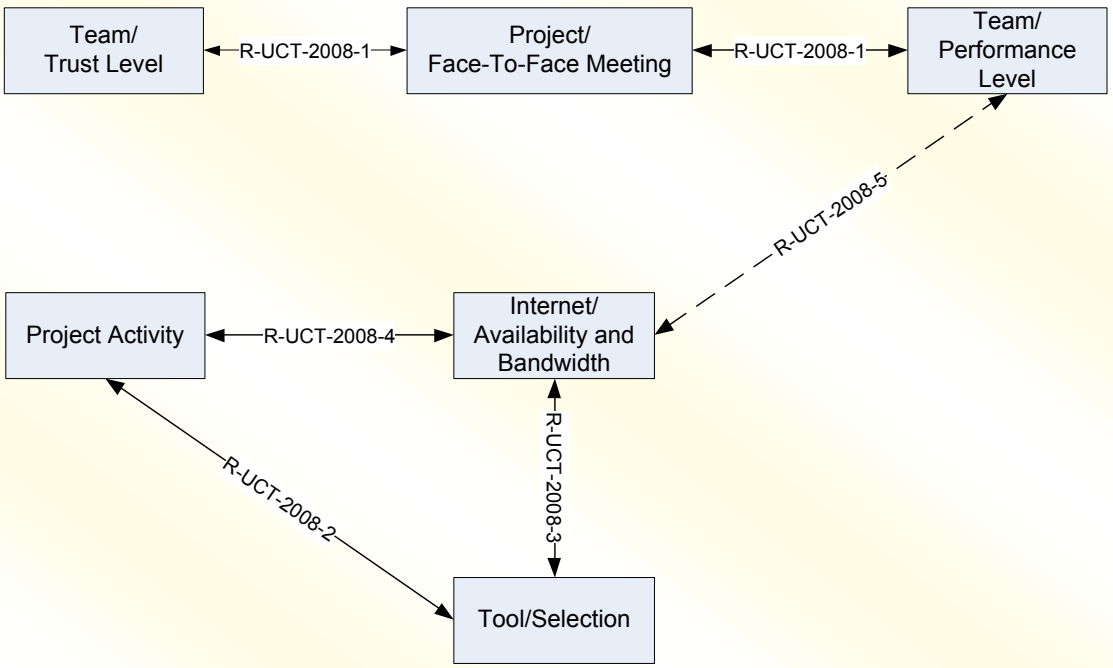
As recommended by Corbin and Strauss (2008), I drew an early diagram to visualize these relationships and to support my comparing the data slice (UCT Teams 2009) with the previous findings (see Figure 20). These relationships also guided the interviews of the next data slice. Urquhart (2007, p. 353) sees one advantage of diagrams:

> . . that the relationships between categories are more systematically considered than might otherwise be the case.

Urquhart (2007) sets up five guidelines for using the grounded theory method. In one guideline she emphasizes that the use of theoretical memos and diagrams supports the theory building process. I bore this guideline in mind in the data analyses of the different cycles.

[24] The relationships (R) are referring to the institution (UCT and/or BHT) and years (2008/2009/2010). They are numbered separately for each additional data slice.

Figure 20 - Early Diagram on the Influence of the INTERNET on TEAMS



After the analysis of the data from 8 UCT project teams in the first data cycle, 41 concepts were identified and grouped into 4 main categories. First drafts of relationships show the influence of Internet availability and Internet bandwidth on the tool selection and the use for specific project activities. Further, the team's performance level seems to be affected by such lack of availability. Relationships show the strong influence of face-to-face meetings on the team's trust and performance level.

5.3 *Analyses of the UCT Teams 2009*

5.3.1 Sampling, Data Collection and Data of the UCT Teams 2009

Having developed a higher understanding of the problem and analysed my first slice of data, I wanted to collect the data in my second cycle from a similar set of teams. As I realized during the first cycle that the variety of tools the teams used was relatively small, I gave the whole course a lecture on web-based project management tools. In addition, I had a discussion with each team at the onset of the course (the teams had just formed themselves) on web-based tools to support their projects.

In 2009 at UCT, 32 undergraduate students formed 7 teams of 3-5 students each, with each team finding their own industrial sponsor to supply a business problem (see Table 29). The duration of this team project was one year. All teams had five team members, except UCT-Team-2009-7, which formed a team of three students. 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.

Table 29 - Team-specific Project Brief UCT 2009

Teams UCT 2009	Team-specific project brief
UCT-Team-2009-1	Development of a web based application for linking contractors and companies that need contract work done. It shall allow contractors to build a track record of ratings for contract work that they have been completed and help firms to find reliable contractors with track records.
UCT-Team-2009-2	Development of CMS system that aims to manage customers/sponsors business processes and information in a secure and effective way. The system shall allow users to maintain and manage employees, suppliers, customers and community projects. In addition, the system shall help to design and to manage the sponsor's product catalogue, automates its process of allocating work to weavers, as well as their order procedure.
UCT-Team-2009-3	The goal is to develop for the customer/sponsor a content management system; it shall store all their resources (word documents, excel documents, etc.) and allow them to manage their volunteers, activities and resources.
UCT-Team-2009-4	The objective of the project is to automate current paper-based disabled student management systems at universities across the country. It shall enable disabled students to interact properly with the respective facilities offered by the institution.
UCT-Team-2009-5	Development of a web-based application to administer, manage and review efficiently the core business process data of the customer/sponsor. The system shall enhance the captured data, in real time, to generate automatic notices and create dynamic, rich, and

Teams UCT 2009	Team-specific project brief
	customisable reports on the fly, providing information which enables system users to identify trends and make informed decisions.
UCT-Team-2009-6	Development of a student residence management system for handling room allocations, equipment allocations, student registration, announcements, disciplinary records and visitor records.
UCT-Team-2009-7	The objective of the project is to develop a web based content management system for the customer that facilitates online member and client applications and the maintenance of their profiles. It also handles the sharing of resources, participating in discussions through a chat room and providing general information about the customer/sponsor.

The collection of data was carried out through approximately 30-minutes interviews which were tape-recorded or recorded using the computers recording facilities. In one case the tape recorder used for recording the interview malfunctioned. In all UCT-2009 cases notes where taken as an additional back-up.

Table 30 - Data Collection Protocol UCT-2009

Data Source	Details
Semi-structured interviews	Interviews with team leader and one team member (average length of the interview was 30 minutes); recording and written notes.
Observation of meetings	Team characteristics on skills, trust, team procedures regarding problem awareness and task management.
Questionnaires	Completed by each team regarding used technologies and problems faced.
Course results of the teams	This assessment was done by the UCT lecturer team.

As already explained in the previous section, project teams in an educational environment are rarely assessed in terms of project success or project failure, but never the less their performance level gives an indication of whether the project might have been successful or not.

Table 31 - Performance Level UCT Teams 2009

Teams	Performance level
UCT-Team-2009-1	High
UCT-Team-2009-2	High
UCT-Team-2009-3	Medium
UCT-Team-2009-4	Medium
UCT-Team-2009-5	High
UCT-Team-2009-6	Low
UCT-Team-2009-7	Low

During the first cycle it became clear that the limited Internet availability and bandwidth that some of the teams battle with influenced their selection and use of the tools to support communication and project management. In addition, this obstacle also seems to have had an impact on the team's success. In my survey data I collected information regarding Internet access and Internet bandwidth of the team members in the different teams (see Table 32). As already mentioned, teams are classified as "Unlimited Availability", "Unlimited Bandwidth", "Limited Availability" and "Limited Bandwidth".

Table 32 - Internet Availability and Internet Bandwidth UCT Teams 2009

Teams	Internet Availability	Internet Bandwidth
UCT-Team-2009-1	Unlimited	Unlimited
UCT-Team-2009-2	Limited	Limited
UCT-Team-2009-3	Limited	Limited
UCT-Team-2009-4	Unlimited	Unlimited
UCT-Team-2009-5	Unlimited	Unlimited
UCT-Team-2009-6	Limited	Limited
UCT-Team-2009-7	Limited	Limited

According to Connaughton & Shuffler (2007), the cultural background is only one factor in the team's group structure that influences the outcome and processes of a virtual team. Therefore, as already mentioned, I looked at the diversity of the teams and not merely cultural background. Examining diversity meant examining the teams' skills, relationships, gender, and organizational structure.

Table 33 - Diversity of the UCT Teams 2009

Teams	Gender	Diversity	Cultural diversity
UCT-Team-2009-1	1 Fem.; 4 Male	1 Coloured; 2 Whites; 1 Black	Medium cultural diversity
UCT-Team-2009-2	3 Fem.; 2 Male	2 Coloureds; 2 Whites; 1 Black	High cultural diversity (different cultures & gender)
UCT-Team-2009-3	3 Fem.; 2 Male	1 Coloured; 2 Whites; 2 Blacks	High cultural diversity
UCT-Team-2009-4	1 Fem.; 4 Male	5 Whites	Low cultural diversity
UCT-Team-2009-5	5 Male	3 Coloureds; 2 Whites	Medium cultural diversity
UCT-Team-2009-6	2 Male; 2 Fem.	4 Blacks	Low cultural diversity
UCT-Team-2009-7	3 Fem.	1 Coloured, 2 Blacks	Low cultural diversity

As far as project organization is concerned, teams did not necessarily elect a project leader, as shown by the following quotation:

> There was no one coordinating our tasks. We didn't have a project leader. We all had a role in the coordination of the project. We discussed all the issues. What is happening over here and are we on track with this (UCT-Team-2009-1).

In addition, I asked the course convenor to give me an assessment of task awareness and task management. This was verified and discussed with the UCT course lecturer based on the interviews. Quotations like the following were considered:

> Why spend 20 minutes for writing down all the tasks you want to do, while everybody knew what he had to do. We were all discussing our project and tasks (UCT-Team-2009-1).

and

> Task tracking and task management is so complicated and therefore needs a person dedicated to this job. In the industry you have someone doing that task. Right in the beginning we have had problems with task/project complexity and the estimation of the time [needed]. Task tracking and time estimation is hard. The project management function should be handled by an experienced person (UCT-Team-2009-3).

Trust among team members was assessed based on the interviews and on observation of the teams by the UCT lecturers; in most cases, their observations were verified by the interviews. In the interview the team members were asked about trust and friendship within the team and I had a number of answers to verify the first assessment, such as the following:

> Yes, high trust was built up because we were all [working] face-to-face and we could see what the others were doing (UCT-Team-2009-4).

Table 34 - Team and Work Characteristics UCT Teams 2009

Teams	Size	Team Characteristics	Collaborative Work Characteristics
UCT-Team-2009-1	5	High level of technical and organizational expertise High level of trust (partly friends prior to project; no project leader)	Good task awareness Good task management (struggled with the time management at the end of the project)
UCT-Team-2009-2	5	Medium level of expertise Medium to high level of trust	Good task awareness Average task management (struggled with the time estimation of the tasks)

Teams	Size	Team Characteristics	Collaborative Work Characteristics
UCT-Team-2009-3	5	Medium level of technical expertise Low level of trust grew to medium level of trust (had never worked together before)	Average task awareness Poor to average task management
UCT-Team-2009-4	5	Medium level of expertise High level of trust	Average task awareness Average task management
UCT-Team-2009-5	5	Medium level technical expertise High level of trust (partly friends)	Average awareness Good task management
UCT-Team-2009-6	4	Low to medium level of technical expertise Low to medium level of trust (grew because they were working together face-to-face)	Poor to average task awareness Average task management
UCT-Team-2009-7	3	Low level of technical expertise Medium to high level of trust (no real team leader, just a formal team leader)	Poor to average task awareness Average task management
UCT-Team-2009-7	3	Low level of technical expertise Medium to high level of trust (no real team leader, just a formal team leader)	Poor to average task awareness Average task management

Looking at survey results, it seems that most of the teams met on a daily basis (see Table 35). According to the UCT course convenor and in line with my own observations, these results are biased by the project deadline, which happened to fall in the period when the survey took place. During the weeks before the deadline, teams were meeting more often than during other phases of the project.

> Towards the end of the project we worked and on different parts of the system. Everybody was working everywhere on the system. You could have had this [properly] distributed if you had had more time. But towards the end of the project we did not have the time to wait for someone to say that he has finished his task. You needed to work as fast as possible (UCT-Team-2009-1).

This impression that teams did not meet on a daily basis was also supported by the following words indicating that sometimes not everybody participated in the face-to-face meetings ("Walter worked from home, and others partly from home but mostly in the Lab" (UCT-Team-2009-3)). The fact that sometimes the teams could not meet is underpinned by the following:

> [Question: What is the effect of the web-based communication and PM tools on communication and cooperation in teams?] It took off the pressure to meet every single week. If someone could not make it was not a big deal because we had Vula (UCT-Team-2009-2).

As I have already mentioned with regard to the earlier cycle (UCT Teams 2008), it is important for the purposes of my research to establish whether the teams met more or less often compared to other teams (from UCT as later on also from BHT). In addition, compared to the 2008

teams, where the single team members were given the questionnaire, in this survey the teams filled in the questionnaire as a whole team.

Table 35 – Face-to-Face Meeting Frequency UCT Teams 2009

Team	Face-to-Face Meetings
UCT-Team-2009-1	Daily
UCT-Team-2009-2	Two to three times per week
UCT-Team-2009-3	Two to three times per week
UCT-Team-2009-4	Daily
UCT-Team-2009-5	Daily
UCT-Team-2009-6	Daily
UCT-Team-2009-7	Daily

As in the previous data collection cycle, I used a survey to determine the occurrence of face-to-face meetings. In addition, I collected the usage rate of specific communication tools (compare Table 36) and project management related software (see Table 37). These results aided in estimating how often the different teams used a tool category compared to each other. It is even more important to see which tools they preferred to use and in what combination they used them (media mix/tool combination).

Table 36 - Use of Communication Technology UCT Teams 2009

Team	Netmeeting or Skype	Phone/ Phone Conference	Chat and Vula[25]	eMail	Text Messaging
UCT-Team-2009-1	At least once a week	At least once a week	Daily	At a month	Daily
UCT-Team-2009-2	Never	Two to three times per week	Daily	Daily	Daily
UCT-Team-2009-3	Never	At least once a week	Daily	Daily	Two to three times per week
UCT-Team-2009-4	Never	Daily	Two to three times per week	At least once a week	Daily
UCT-Team-2009-5	Never	never	Daily	At least once a month	Daily

[25] 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, resource sharing and collaborative learning.

Team	Netmeeting or Skype	Phone/ Phone Conference	Chat and Vula[25]	eMail	Text Messaging
UCT-Team-2009-6	Never	Two to three times per week	At least once a week	At least once a week	Daily
UCT-Team-2009-7	Never	Daily	Daily	Daily	Daily

Table 37 - Use of PM Software UCT Teams 2009

Team	MS Project Web Access	Web-Based Task tracking	Web-based time sheet management	Team Calendar
UCT-Team-2009-1	Never	Never	Never	Never
UCT-Team-2009-2	At least once a month	Never	Never	Never
UCT-Team-2009-3	At least once a month	Never	Never	Never
UCT-Team-2009-4	Never	Never	Never	Never
UCT-Team-2009-5	At least once a month	At least once a month	Never	Never
UCT-Team-2009-6	At least once a month	Never	Never	Never
UCT-Team-2009-7	At least once a month	At least once a month	Never	Never

5.3.2 Integrating the UCT Teams 2009 into the Results

5.3.2.1 Coding Results and Changes to Categories, Concepts, Properties and Dimensions

Due to the more specific questions on my research topic in the interviews with the UCT teams 2009, many concepts have been coded that contribute to answers of why, who, when and what. In total, about 130 concepts have been grouped into the four categories **TEAM, PROJECT, INTERNET,** and **TOOL**. A number of sub-categories have also been identified. The 4 categories group together about 20 sub-categories. Compared to the previous coding step, there are additionally 400 references from the interviews with UCT Team 2009 that investigate different concepts.

Category TOOL

Most of these sub-categories are in the category Tool, specifying and explaining tool specifics, use and usage frequencies, as well as the functionalities that were addressed during the different project activities. Additional concepts added to this category are listed in Table 38.

Table 38 - Additional Concepts/Properties in the Category TOOL

Concept/Property	Dimensions
Usability	Low, Medium, High
Keeping the Team on Board	
Reliability	Low, Medium, high
Speed	

Concept/Property	Dimensions
Effort	
Task Tracking System	

The concepts/properties column describes characteristics of tools like **USABILITY, RELIABILITY** or **SPEED** as well as special **EFFORT** in using them. In addition, they point out the special role that a tool plays within the project, as described in the following quotation from UCT-Team-2009-2:

> It was Vula that motivated the team. In the time when we could not schedule a team meeting, Vula helped to keep everybody on board by the way that we could communicate. We were connected via Vula and therefore it did keep us motivated.

Category INTERNET

Even though there are many references in the category **INTERNET** no concepts have been added, but often the coded data showed relations with 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).

Category TEAM

New concepts in the category **TEAM** are described in the following table (see Table 39).

Table 39 - Additional Concepts/Properties in the Category TEAM

Concept/Property	Dimensions
Effectiveness	Reduced, Increased, Normal
Member	
Problems	
Self-organizing	
Team Leader	
Work from Home	

Category PROJECT

Most of the new concepts are coded into the category **PROJECT** (see Table 40).

Table 40 - Additional Concepts/Properties in the Category PROJECT

Concepts/Property	Dimensions
Communication Intensity	Low, Medium, High

Deadline	
Work Setting	Face-To-Face, Distributed, Home
Phase	
Quality	Low, Medium, High
Requirements	
Responsibilities	
Speed	
Size	Small, Medium, Large
Stage	
Success	

The following sub-categories are changed and extended. Many references taken from the interviews show the significance of the different **PROJECT ACTIVITIES** as well as **TASK MANAGEMENT** for my research questions, such as the relevance of **TASK COMPLEXITY** for the **FACE-TO-FACE MEETINGS.** Such relevance is 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.

Figure 21 and Figure 22 illustrate the parent and child relationships of both sub-categories in the NVivo models.

Figure 21 - Parent-Child-Relationships of the Sub-category TASK MANAGEMENT

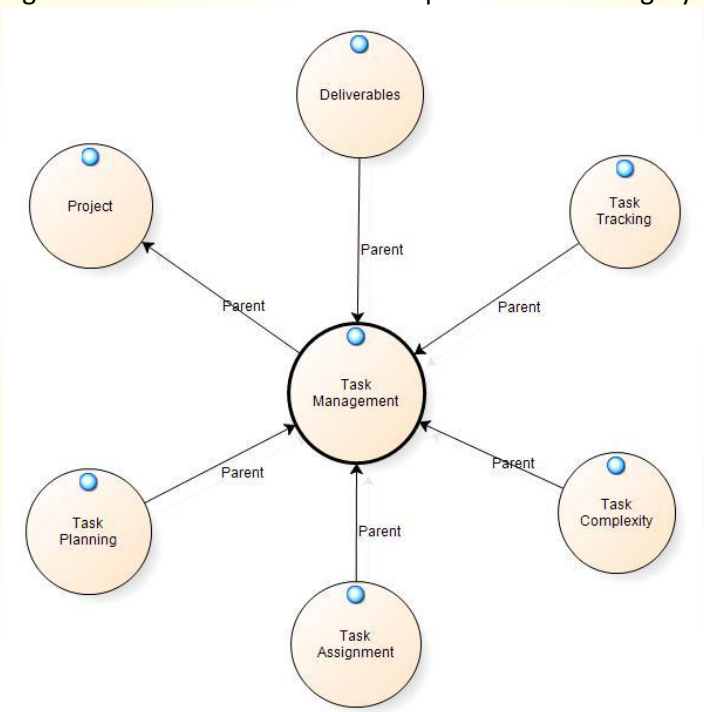
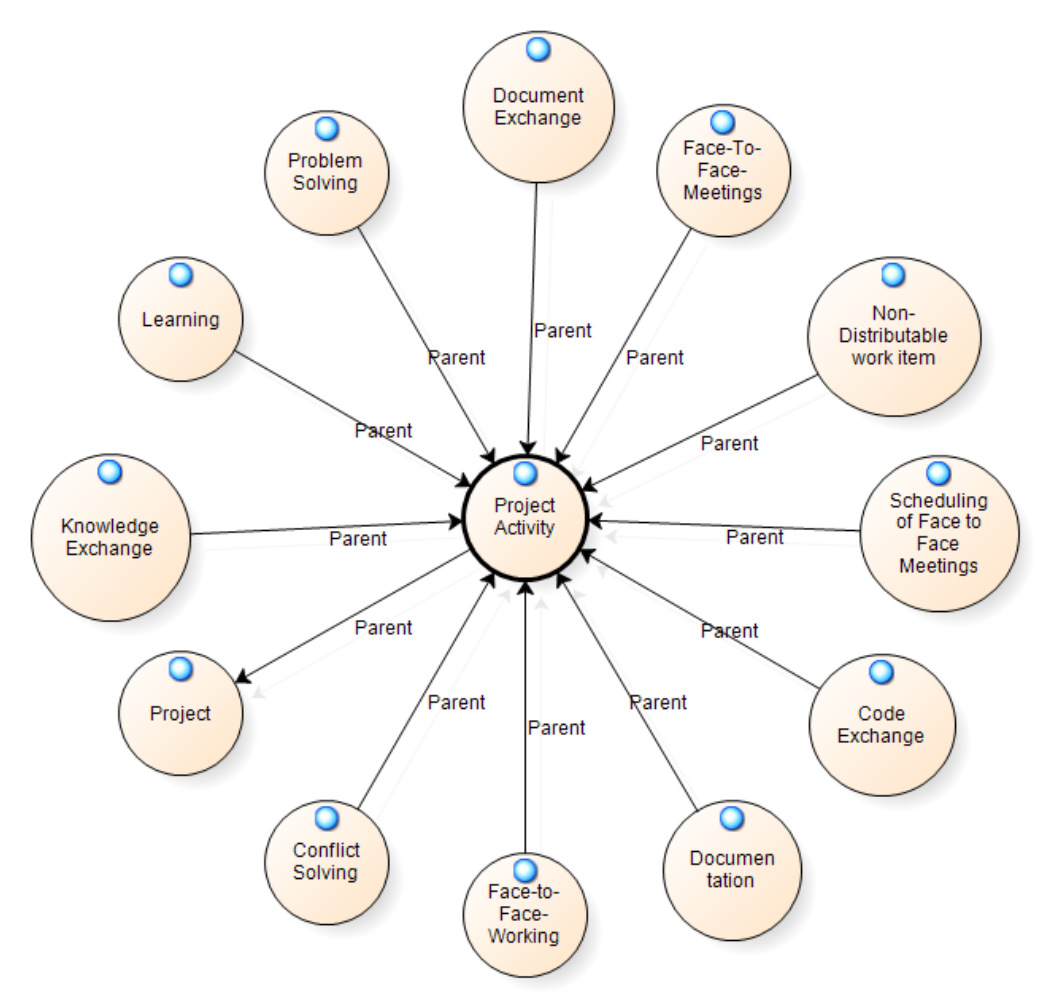


Figure 22 - Parent-Child-Relationships of the Sub-category PROJECT ACTIVITY



The sub-categories **PROJECT ACTIVITY** and **TASK MANAGEMENT** have the following concepts, properties, and dimensions (See Table 41).

Table 41 - Concepts, Properties and Dimensions of PROJECT ACTIVITY and TASK MANAGEMENT

Sub-category	Concept/Property	Dimensions
Project Activity	Conflict Solving	
	Code Exchange	
	Documentation	
	Document Exchange	
	Face-To-Face Meetings	Formal, Informal
	Face-to-Face Working	
	Knowledge Exchange	

Sub-category	Concept/Property	Dimensions
	Learning	
	Non-Distributable work item	
	Problem Solving	
	Scheduling of Face-to-Face Meetings	
Task Management	Deliverables	
	Task Assignment	
	Task Complexity	Low, Medium, High,
	Task Planning	Ad hoc, Advanced
	Task Tracking	Transparent, Non-Transparent

5.3.2.2 Refined Relationships UCT Teams 2008 and 2009

In the following section relationships between the different categories and concepts are described. These are early hints that help me to understand and explain the data, support me in the upcoming interviews, and help me to build my theory in the selective coding after all data has been collected and analysed. The relationships and early drawings are my way of memorizing my thoughts about the data, as it is recommended by Corbin and Strauss (2008).

R-UCT-2008/9-1:	If **TEAM MEMBERS** know each other or have been working together in the past; they tend to have a higher **TRUST LEVEL** in the **TEAM**. A high **TRUST LEVEL** in the **TEAM** is associated with better **TEAM PERFORMANCE**.

In project-based team work the facts that team members have either worked together before, know each other well or were friends previous to the project all influence the trust level in the team (see Table 42).

Table 42 - Relationship between FRIENDSHIP and TRUST LEVEL in a TEAM

Team	Trust Level	Team Performance	Friendship or Acquaintance or previously Worked Together
UCT-Team-2008-1	High	High	Yes
UCT-Team-2009-1	High	High	Yes
UCT-Team-2009-5	High	High	Yes

The above relationship is based on a number of quotations, such as:

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

R-UCT-2008/9-2: If **TEAMS** have limited **INTERNET AVAILABILITY** and limited **INTERNET BANDWIDTH**, then the **LEARNING** process regarding the **USE OF TECHNOLOGY** in the **TEAM** is delayed.

The above relationship is underpinned by complaints by the teams that the limited Internet access and limited Internet Bandwidth hindered them in their learning process on technology and the use of technology. One example of such a complaint 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.

Regarding the question on limiting factors, in their project UCT-Team-2008-2 gave this answer:

> Access to websites for learning stuff is too slow.

R-UCT-2008/9-3: The **COMMUNICATION INTENSITY** varies according to the different **STAGES** of a **PROJECT**.

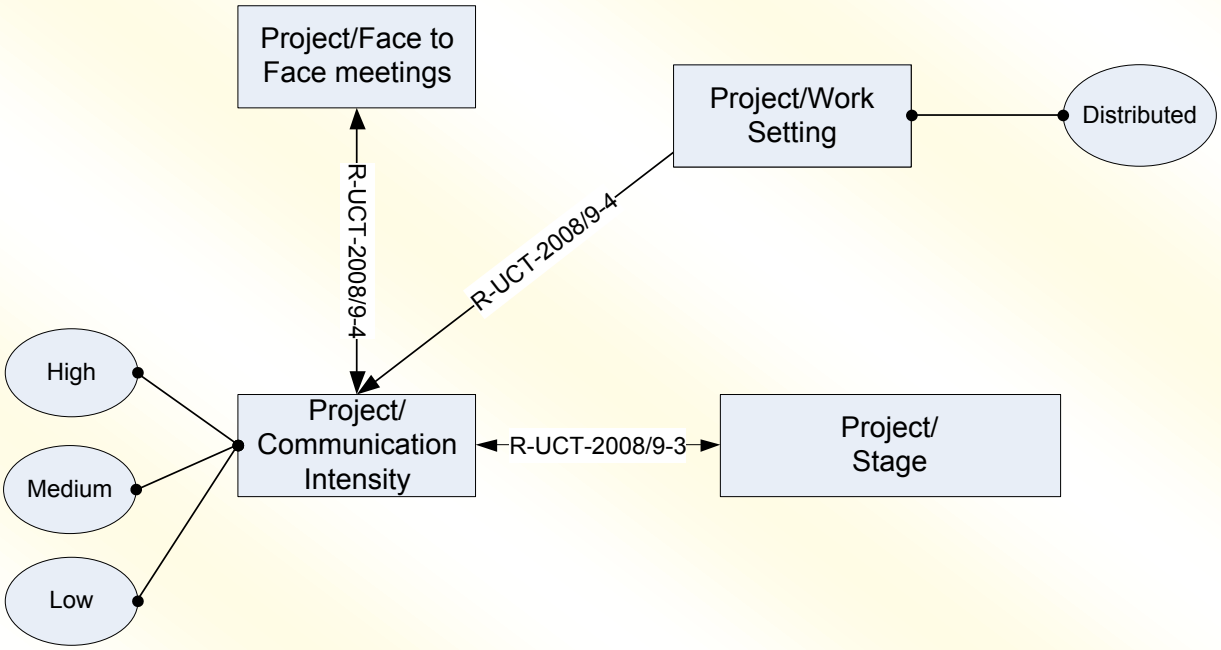
There are certain periods in a project when the need for intensive communication is high and, conversely, other times when less communication is needed to perform a project task. There seems to be a difference between stages and phases. Stages refer to a certain time period of a project where either more or less communication is necessary. Sometimes a stage can occur during a certain phase of the project, such as the start or end phase of a project. Whether or not communication is intense or not might depend on how much the team members know each other.

R-UCT-2008/9-4: If the **COMMUNICATION INTENSITY** in the **PROJECT** is high then **FACE-TO-FACE MEETINGS** are more adequate than a distributed **WORK SETTING**.

The above relationships indicate that the intensity of communication varies depending on the stage of the project. The teams spoke about stages, especially about stages in which intensive communication was needed. This is not necessarily a certain phase of a project as defined in project management. In the stages of intensive communication, face-to-face meetings are more satisfactory than a distributed work setting. These stages of intensive communication seem to differ from team to team: for UCT-Team-2009-1 it was the time when they prepared for their customer interviews:

> Later on, when there are for example the customer Interviews, then it is difficult to do it purely via Vula. Even if Vula is very cool. We all worked together in one room – in the labs.

Figure 23 - Early Diagram on the WORK SETTING in the PROJECT



R-UCT-2008/9-5:	If a **PROJECT ACTIVITY** needs several **TEAM MEMBERS** working quasi simultaneously on it, then a distributed **WORK SETTING** can hinder accomplishing the **PROJECT ACTIVITY** effectively. However, this quasi simultaneous working by several team members might be necessary in certain **STAGES** of the **PROJECT** (for example, a deadline or a milestone).

Another stage of a project that requires more face-to-face work is the period before a deadline, especially for team members who are working quasi simultaneously on an item, such as a document or some software, and are under pressure of time. This is underlined by the following quotation:

> Towards the end of the project we worked on different parts of the system. Everybody was working everywhere on the system. You could have done it distributed if you would have had more time. But towards the end of the project we did not have the time to wait for someone to say that he has finished his task. You need to do it as fast as possible (UCT-Team-2009-1).

R-UCT-2008/9-6:	The **FREQUENCY** of the **USE OF A TOOL** varies according to the **STAGE** of the **PROJECT** and the **PROJECT ACTIVITY**.

At certain stages of a project it is effective for the team to work distributed on tasks and to communicate and coordinate the work via a tool (like Vula), especially if the communication and coordination requirements are low. At other stages, when communication intensity is high, it is necessary to switch to a communication form that is more adequate for synchronous communication. For the UCT 2009 teams this communication form was face-to-face, as can be seen in the following quotation:

> It depends on the stage of project you are in. In an earlier stage it is easier to work more distributed, when there is less communication required. The work can be done separately, like working on the database. Later on, when there are for example the customer Interviews, then it is difficult to do it purely via Vula (UCT-Team-2009-1).

R-UCT-2008/9-7:	The different **PROJECT ACTIVITIES** and **WORK SETTING** (home or face-to-face or distributed) determine the **USE OF THE TOOL**.

The different project activities as well as work setting of the teams and team members strongly influence the use of the different tools; again this is UCT-Team-2009-1:

> We had version control and used the SVN until we reached the last days when we did it manually. We didn't want to have a huge conflict. We were all at the university and were working on one copy. Before that we did the majority of the work at home and used SVN.

R-UCT-2008/9-8:	The larger the **SIZE** of the **TEAM** the more **TASK PLANNING** is needed. This is especially true in a distributed **WORK SETTING**.

Often the teams pointed out that the size of the team strongly influences the need and importance of task planning, especially for a distributed work setting. They also argued that there was less need for detailed task planning if their team was relatively small:

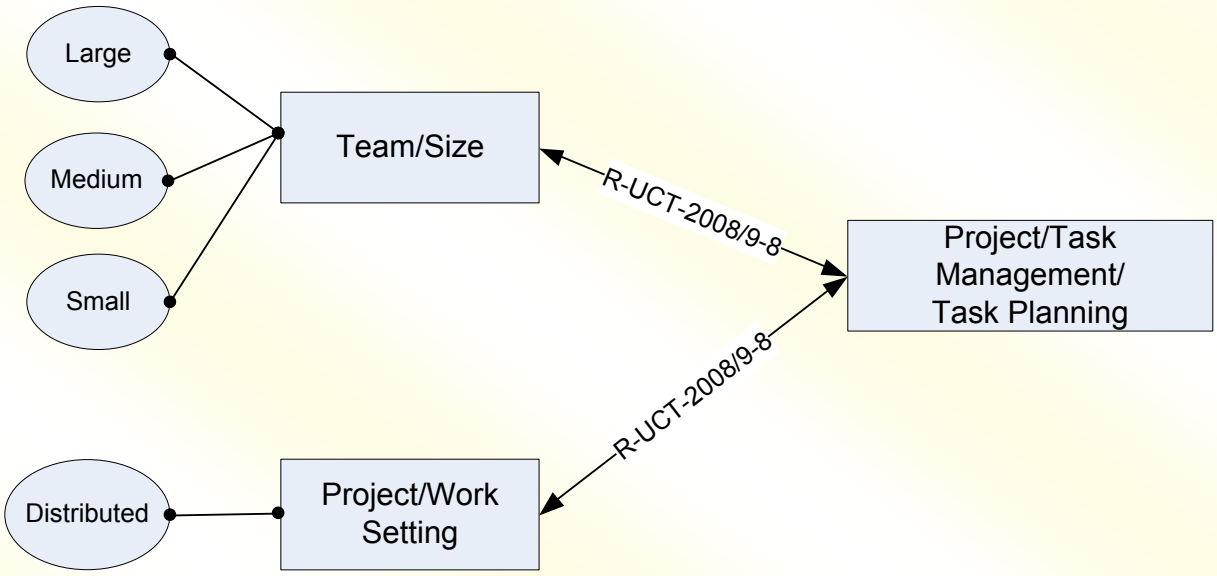
> We had an emergent, ad hoc approach to task management. We talked about our work and discussed the task that needed to be done. Then everybody went home and did his work. We all knew pretty much what needed to be done. Our approach would

fall down on a larger scale of project but it worked fine with us and that size of project (UCT-Team-2009-1).

Or as pointed out by UCT-Team-2009-7:

If we were a bigger group we would have used more tools. More coordination needed.

Figure 24 - Early Diagram on the Influence of TEAM SIZE and WORK SETTING on TASK PLANNING

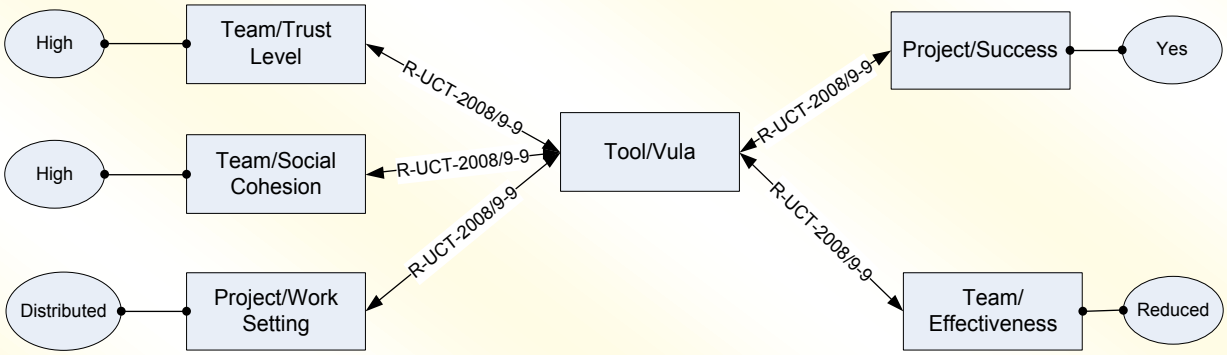


R-UCT-2008/9-9:	**TEAMS** with high **SOCIAL COHESION** and **TRUST LEVEL** are confident of managing a **PROJECT** in distributed **WORK SETTING** successfully, if they have the right **TOOL** supporting them (here it seems to be **VULA**). But they admit that they would perform the project with reduced **EFFECTIVENESS**.

A tool like **VULA,** with a variety of features, seems to be adequate to support the project work in a distributed work setting. The above relationship is supported by the following, from UCT-Team-2009-1:

[Question: What would have happened if we would have split up the team to work in Cape Town and Johannesburg [with the customer]?] Could we have kept using Vula? [Yes!] Then it would have worked out fine. It would have taken a lot more time by the end. [Question: Could you rely on each other also with the task management right from the beginning?] Yes. I was very confident working with my team mates and girls.

Figure 25 - Early Diagram on the Role of a TOOL like VULA in a distributed WORK SETTING



R-UCT-2008/9-10: In the **LEARNING ACTIVITIES** in the **PROJECT** the **TEAMS** very often rely on **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH**.

The above relationship is especially interesting in the light of instances when Internet availability and Internet bandwidth are limited. The following quotation from UCT-Team-2009-1 underpins this relationship:

> Yes, time estimation was a problem. We spent more time on Google than planned. We did not know a lot of the things that we should implement. Therefore we had to teach ourselves on those things and that took more time than planned.

R-UCT-2008/9-11: In a **PROJECT** the **TEAMS** use Text Messaging (**SMSs**) mainly to schedule/coordinate **PROJECT ACTIVITIES** such as **FACE-TO-FACE MEETINGS**.

The above relationship shows that there is a specific role for text messaging, as is also supported by the following quotation:

> We used SMSs to announce that someone is late for a meeting. (UCT-Team-2009-5) and
>
> We saw each other a lot; when we were working we were together. We used SMSs to organize our meetings (UCT-Team-2009-6).

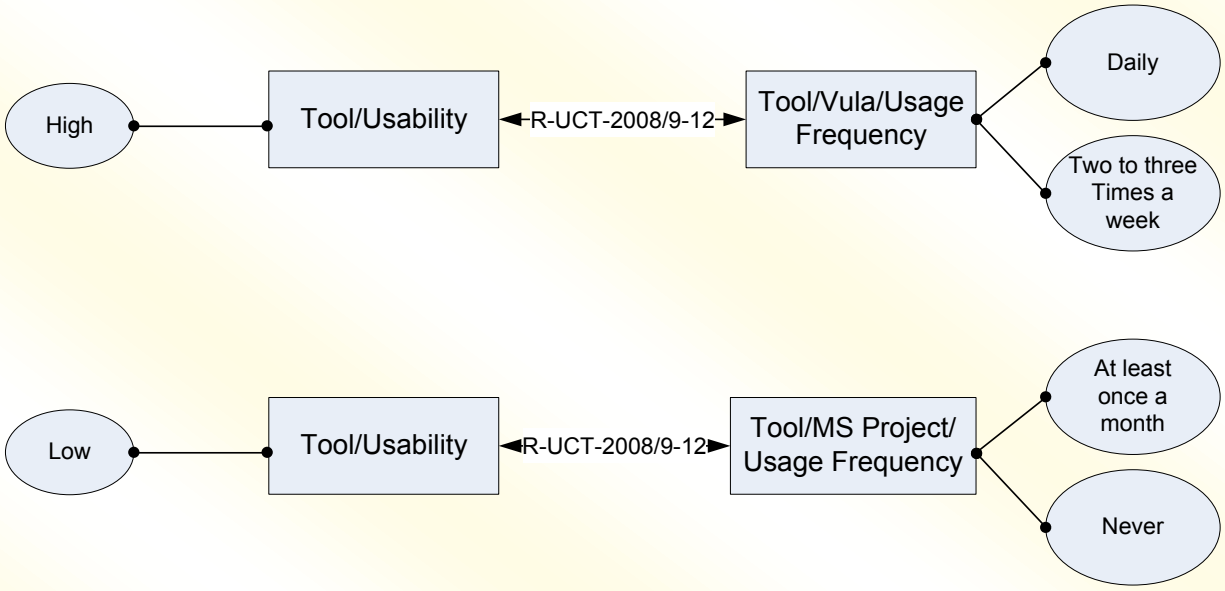
R-UCT-2008/9-12: The **USABILITY** of a **TOOL** influences the **TOOL'S USAGE FREQUENCY**.

Several quotations and the results of the survey support the above relationship for the tools MS Project and Vula. The following early figure (Figure 26) makes this relationship transparent for the UCT 2008/2009 Teams. The usage frequency for MS Project in the UCT 2008 teams is higher and for Vula is lower. The interviews underline this relationship:

Intuitive tools are more useful to use; it is not true that intuitive tools turn you off. (UCT-Team-2009-5) or

[Question: What is the reason in your opinion that a specific tool supports a specific task better than other tools?] Vula was fast and easy to access (UCT-Team-2009-6).

Figure 26 - Early Diagram on the Relationship between USABILITY and USAGE FREQUENCY



R-UCT-2008/9-13: Some **TOOLS** have a low **USAGE FREQUENCY** because the **TEAMS** experience that they would need more **TRAINING** to use a particular **TOOL** effectively in the **PROJECT**.

Very often the teams complained that they didn't use MS Project[26] because they did not know how to use it. UCT-Team-2009-2 noted:

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.

[26] When students mention MS Project they are not referring so much to the Gantt chart done in MS Project as to 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. However, the teams found this collaborative project management tool complicated and difficult to use.

This is related to the usability of MS Project as illustrated by the following quotation:

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

Another quotation from UCT-team-2009-3 supports this relationship:

> 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.

R-UCT-2008/9-14: The **USABILITY** of a **TOOL** relates to the **INTEGRATION OF FUNCTIONALITY** within the **TOOL**. The **INTEGRATION OF FUNCTIONALITY** increases the **TEAM'S EFFECTIVENESS**.

Relationship R-UCT-2008/9-14 relates to the complaints of UCT teams about the difficult maintenance of data in MS-Project and the need to change to another tool. This relationship must also be seen in the context of relationship R-UCT-2008/9-13. The following words endorse this relationship:

> Time estimation is a problem and it is therefore difficult to use task management with a project server where you have to update the Gant charts all the time. And it also takes time to do the updates. It is a bit of a hassle to do those things with MS Project. It would be fine to have it all on 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 were causing 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 task management. Version control of a system was 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).

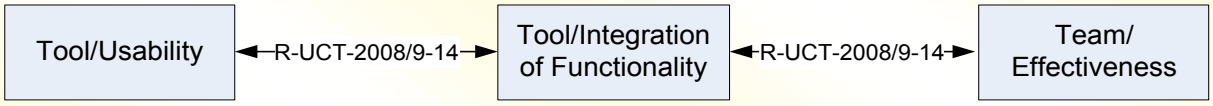
The UCT-Team-2009-3 even proposed the integration of the three tools: Vula, Version Control, and MS Project:

> I would really consider using a technology that combines Version Control, Vula chatroom, and MS Project. We met a lot but I am sorry to say that most of meetings were useless. They were really a waste of time. We came there and often waited for

> everybody to show up and then sat there for an hour for no reason at all. Towards the end, the Version Control and Vula chatroom was very effective in the way we did it. How would it been if we would have done it differently right from the beginning? Instead of waiting for hours and having long discussions.

The following Figure 27 illustrates the relationship.

Figure 27 - Early Diagram on TOOL USABILITY – INTEGRATION – TEAM EFFECTIVENESS



R-UCT-2008/9-15: **TEAM RULES** and **INTEGRATION OF FUNCTIONALITY** in **TOOLS** seem to support the **TEAM'S SOCIAL COHESION**.

The use of an integrated tool combined with specific rules that the team members have to obey seem to influence the team's social cohesion, as illustrated by the following quotation:

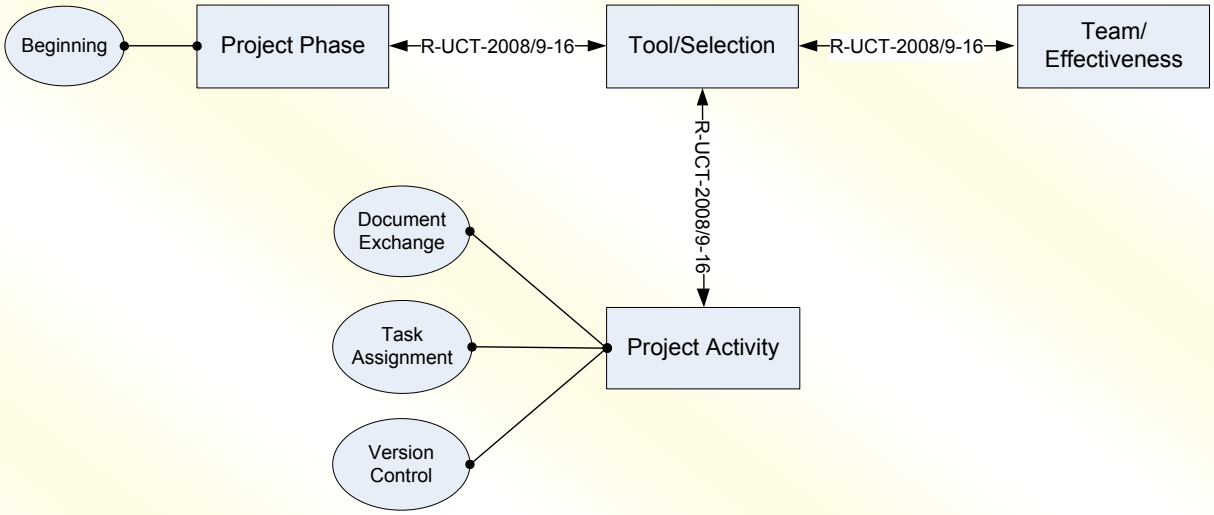
> Yes, Vula helped to integrate the team. Instead of sending an SMS, I can send an email or chat with my colleagues. Everyone had the responsibility to check Vula regularly. Everyone has access to all documents. The versioning was cool. It was easier to hold to the deadlines because everyone had the responsibility to upload. We had a file with all the responsibilities, tasks, dates, and deliverables. We uploaded it onto Vula (UCT-Team-2009-2).

R-UCT-2008/9-16: The **TEAM'S EFFECTIVENESS** is strongly influenced by the **TOOL SELECTION** that takes place at the beginning of the **PROJECT** to support the different **PROJECT ACTIVITIES**.

The above relationship proposes that the team's effectiveness also depends on an early selection of appropriate tools to support the different tasks in a project. Figure 28 illustrates the described relationships. The proposed relationship 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 honours 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).

Figure 28 - Early Diagram on the Relationship of PROJECT PHASE, TOOL CHOICE and TEAM EFFECTIVENESS

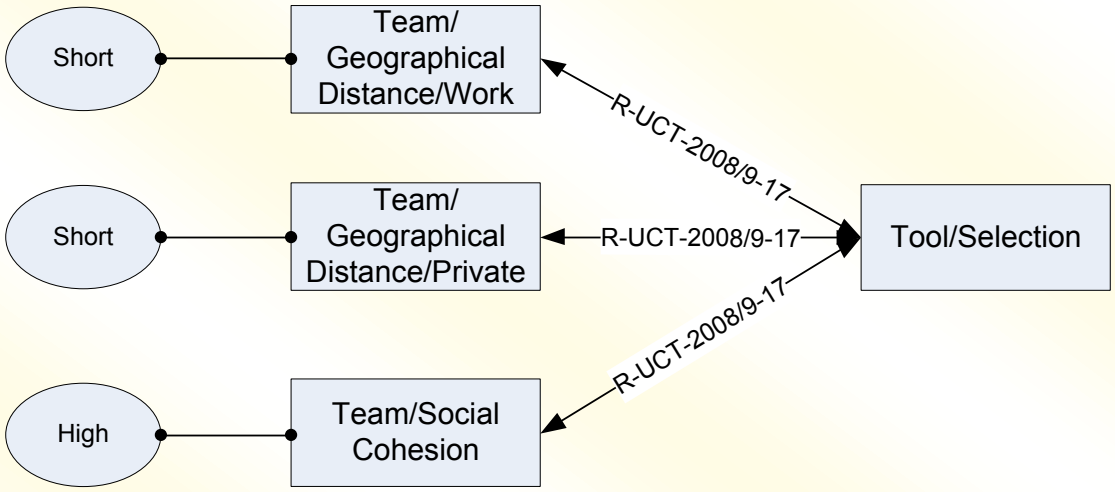


R-UCT-2008/9-17: The **TOOL SELECTION** is influenced by the **TEAM'S SOCIAL COHESION** and **GEOGRAPHICAL DISTANCE,** privately and when working.

This relationship can be 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 live a few minutes from each other. Take a flash drive and that's it.
>
> Face-to-face meetings, we 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 Kath's house. We had 2 3G Cards and ADSL was available. It's not that all five of us needed the Internet at the same time. It was that one or two needed to do something via the Internet.
>
> [Question: How does the team size influence the use of web-based tools?] Yes definitely, if someone would live really far away, then we couldn't meet that often and there would be the need to use more tools. With a bigger team it would be more likely that someone is not as close as we are to each other.

Figure 29 - Early Diagram on the Relationship of PRIVATE GEOGRAPHICAL DISTANCE and TOOL SELECTION

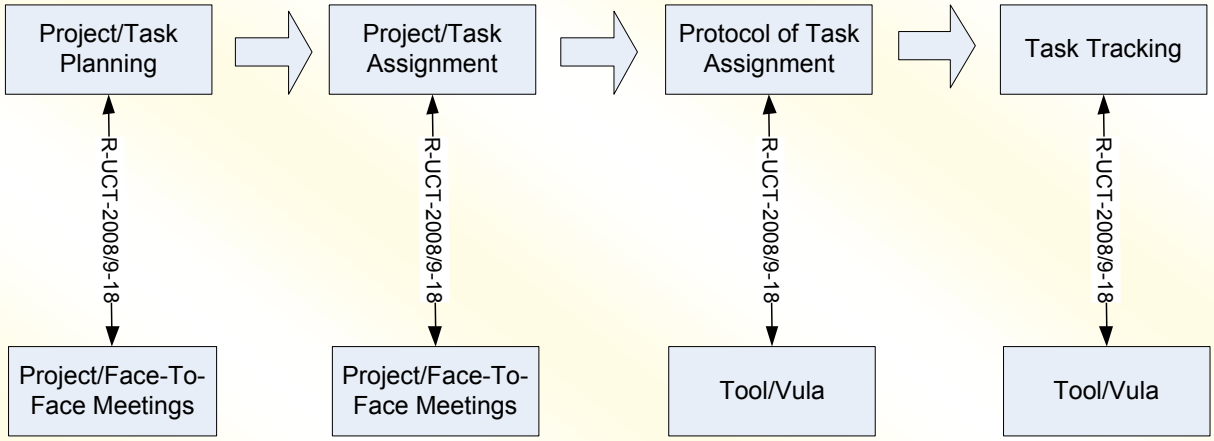


R-UCT-2008/9-18:	In the different **PROJECT PHASES of the TASK MANAGEMENT** different **TOOLS** are preferred by the **TEAMS**.

Figure 30 illustrates the sequence of phases and the related tools as they are proposed in the above statement. The following quotations support the information in this diagram on the role of different tools in different phases:

> 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 a 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 were allocated to whom. We could see the uploads and check the quality of the others easily (UCT-Team-2009-2).

Figure 30 - Early Diagram on the TOOL PREFERENCES in TASK MANAGEMENT

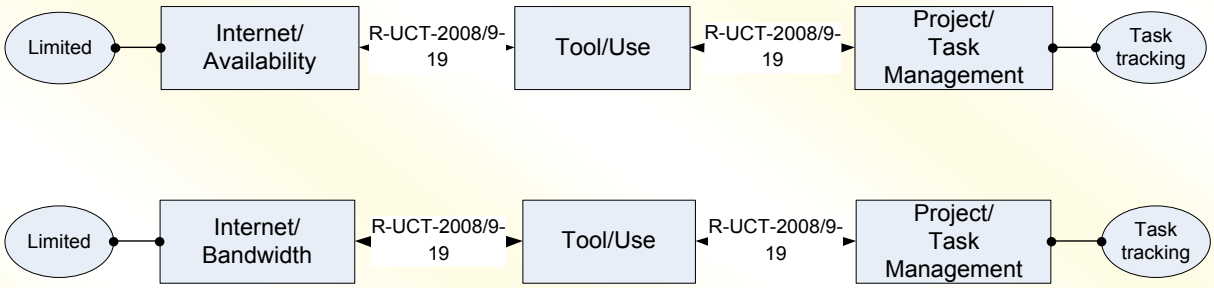


R-UCT-2008/9-19:	Limited **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH** prohibited the **USE** of **TOOLS** for certain **TASK MANAGEMENT** activities**.**

Limited Internet availability and limited Internet bandwidth influence the use of tools. These restrictions seem especially to prohibit the use of 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.

Figure 31 - Early Diagram on the Influence of the INTERNET on TASK MANAGEMENT

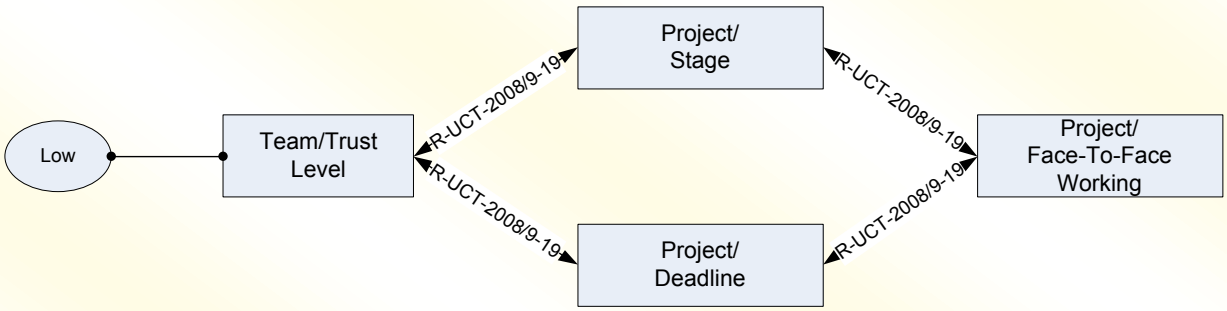


R-UCT-2008/9-20:	A low **TRUST LEVEL in the TEAM** and a critical **PROJECT STAGE** or a **DEADLINE** require **FACE-TO-FACE WORKING** in the **PROJECT**.

This is described 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, and then I maybe would trust the person the next time.

Figure 32 - Early Diagram on the Relationship of TRUST LEVEL on the PROJECT STAGE



R-UCT-2008/9-21:	If a **TEAM** has a low **TRUST LEVEL** then additional **TEAM BUILDING** seems to be necessary to support a successful distributed **WORK SETTING**.

The above relationship can be supported by the following statements by UCT-Team-2009-3, a team with a low trust level at the beginning of the project:

> No, we had low trust level at the beginning and in the middle and then trust did increase when VSS[27] [version control] was used towards the end [the last five weeks]

[27] Microsoft Visual SourceSafe (VSS) is version control software that helps to manage the changes to source code in software development.

> because also Walter was working from home. We did a lot of work not being together.
>
> There has been a teambuilding process until the end of the project. The project would have worked much better if we had started as that team that we are now! [laughing]

After the second cycle in my analysis, I now had the data of 13 teams collected and coded into 130 concepts. Due to the more specific questions, the 4 main categories give a more detailed reflection of my research domain. The role of limited Internet availability and bandwidth on the selection and use of tools was backed up in the different relationships. In addition the importance of tool integration and task management and its impact on effectiveness was supported in different team and project contexts.

5.4 *Analysis of the BHT Teams 2009*

5.4.1 Sampling, Data Collection and Data of the BHT Teams 2009

The teams were formed by undergraduate students registered for their degree in Industrial Engineering and Management at the University of Applied Science in Berlin (BHT). The curriculum is evaluated on a regular two year official accreditation procedure. The students were in their second year and had to accomplish coursework projects on project management. In spring 2009, 38 undergraduate students were asked at the BHT to form 5 project teams, to have between 7 and 8 members each. Different project tasks of similar complexity (see Table 43) were provided by the course convenor, who presented these tasks to the teams together with documents necessary to clarify the project goals and desired project results. The duration of the projects was one semester. All teams signed a team contract with team rules at the beginning of the course. All teams followed the protocols set out by the course. Because of different course schedules and extra-curricular commitments (many students at the BHT work part-time), team members at BHT often find it difficult to physically participate in regular project workshops and face-to-face meetings. Under these circumstances, team members rely on virtual team technologies to enhance team productivity and assist in the delivery of a quality product.

Table 43 - Team-specific Project Brief BHT 2009

Teams BHT 2009	Team-specific project brief
BHT-2009-1 **BHT-2009-3** **BHT-2009-5**	The objective of the project was to analyze and apply the functionalities of Google's web-workplace to support international distributed project teams. The functions had to be mapped with typical project management requirements. Another objective was to highlight the different advantages and disadvantages of the Google's web-based workplace.
BHT-2009-2 **BHT-2009-4**	The goal of the project is to make a market research study on integrated web-based task tracking and task management systems that are suitable to support virtual team work. Based on in-depth tool evaluation the best system shall be selected, customized to the current project and analysed regarding advantages and disadvantages to support project-based team work.

For this cycle of interviews, theoretical sampling was an important issue. Arising from the analysis of the last data cycle, the upcoming concepts and relationships needed to be verified. Glaser (1992) highlights that emergent theory shows where to sample next and helps to refine the questions as the research problem becomes clearer. My analysis brought up a number of questions needed to clarify the drafted categories and relationships.

The BHT teams 2009 differed from the UCT teams (2008 and 2009) in a number of ways. All teams had, as stated above, between 7 to 8 members. During the interviews of the UCT teams it was often noted that the team size was smaller than necessary to use a tool for project planning, task management, and task tracking:

> We had an emergent, ad hoc approach to task management. We talked about our work and discussed the task that needs to be done. Then everybody went home and did his work. We all knew pretty much what needed to be done. Our approach would fall down on a larger scale of project but it worked fine with us at that size of project (UCT-Team-2009-1).

Or, as UCT-Team-2009-7 pointed out:

> If we were a bigger group we would have used more tools. More coordination was needed.

One major issue in the distributed work of the UCT Teams 2008 and 2009 was the versioning and sharing of software code. Consequently, the BHT Teams, with students completing degrees in industrial engineering and management might, with their projects tasks and goals located in another area, might place a different light on the use and selection of tools that supported their project management related tasks. In addition, project tasks of the BHT 2009 projects were set up by the course convenor; there was no external sponsor involved.

The third major factor to influence the sampling and, especially, the selecting of a location in Germany, was that of the good Internet infrastructure, so as to facilitate comparison with the findings of the first two data cycles. During the analysis of the first two data cycles, the limited Internet availability and bandwidth seemed to be a major factor influencing the selection and use of Internet-based tools in the project work. See the following quotations:

> Speed is a limiting factor for most of the tools except Vula (UCT-Team-2008-6).

> Also the limited Internet access and bandwidth on campus prohibited the use of task tracking/planning tools (UCT-Team-2009-3).

Each of the BHT 2009 teams consisted of two sub-teams, each sub-team being drawn from a different course. Hence, the BHT 2009 teams worked on average a higher percentage of time apart on a task than did the UCT teams. The BHT teams should then, according to Griffith, Sawyer and Neale (2003) have a higher degree of virtuality.

Table 44 - Data Collection Protocol BHT-2009

Data Source	Details
Semi-structured interviews	Interviews with team leader and one team member (average length of the interview was 30 minutes); all interviews were recorded with the computer and in addition, as the researcher I took notes.
Observation of meetings	Team characteristics like skills, team procedures regarding problem solving, task awareness, task management and trust were assessed by the course convenor.
Questionnaires	Completed by each team member regarding used technologies and problems faced.
Course results of the teams	This assessment was done by the lectures of the BHT teams.

As mentioned before, I looked at the diversity of the teams and not just team members' cultural background. Diversity meant examining skills, relationships, gender, and team organization. Table 45 and Table 46 elucidate this diversity. Berlin's multi-cultural background resulted in a team composition with a high diversity and team members from various cultural backgrounds.

Table 45 - Team and Work Characteristics BHT Teams 2009

Teams	Size	Team Characteristics	Collaborative Work Characteristics
BHT-Team-2009-1	8	Good level of technical and organizational expertise High level of trust	Good task awareness Good task management
BHT-Team-2009-2	8	High Level of expertise High level of trust	Good task awareness Good task management
BHT-Team-2009-3	7	Medium level of technical expertise Medium level of trust grew to high level of trust	Average task awareness Good task management
BHT-Team-2009-4	7	Medium level of technical expertise Low level of trust	Average task awareness Poor task management
BHT-Team-2009-5	8	Low level technical expertise Low to medium level of trust	Average task awareness Average task management

Table 46 - Diversity of the BHT Teams 2009

Teams	Gender	Diversity	Cultural Diversity
BHT-Team-2009-1	2 Fem.; 6 Male	1 French; 7 German	Low cultural diversity
BHT-Team-2009-2	1 Fem.; 7 Male	7 Germans; 1 Czech	Low cultural diversity
BHT-Team-2009-3	2 Fem.; 5 Male	1 French; 3 Germans; 2 Turkish; 1 Iran	High cultural diversity
BHT-Team-2009-4	7 Male	1 Indian; 1 Indonesian; 3 Germans; 2 German (Turkish)	High cultural diversity
BHT-Team-2009-5	1 Fem.; 7 Male	1 Egyptian; 2 Germans; 1 Slovene; 4 German (Turkish);	High cultural diversity

Based on their course results, the teams from BHT were categorized into high, medium, and low performance teams. The marking of the BHT Teams was done by the lecturer prior to the interviews and the collection of the survey results.

Table 47 - Performance Level BHT Teams 2009

Teams	Performance level
BHT-Team-2009-1	High
BHT-Team-2009-2	High
BHT-Team-2009-3	High
BHT-Team-2009-4	Medium
BHT-Team-2009-5	Low

In a survey, the team members were asked to indicate how often they had used the different communication tools and project management software during their half a year capstone project. The survey was handed out after the final project presentation and returned by 30 of 38 students. They had to choose one of the following options: daily, two-three times a week, at least once a week, at least once a month, or never.

Interviews averaged 30 minutes and were audiotaped with permission of the participant. Participants were first asked a few background questions, and then were interviewed on research questions which were based on the results from the last interviews with UCT Teams 2008 and 2009. All of the citations from the interviews of the German teams were translated into English.

The following quotations underline the importance of the face-to-face meetings for the Berlin teams. The frequency of the face-to-face meetings in the different teams was determined by means of the survey and is illustrated in Table 48.

> The face-to-face team meeting is quite a convenient tool to arrange the next steps for the teams and to handle misunderstandings and disputes (BHT-Team-2009-2).

> Face-to-Face communication cannot be replaced by any electronic technology (BHT-Team-2009-4).

The lecturer observed that teams BHT-team-2009-4 and BHT-team-2009-5 met face-to-face less often than they had indicated. Often team members were missing for their face-to-face meeting, especially in the team BHT-team-2009-5. The answers reflect a range in each team; this can be attributed to the fact that not all team members participated in every meeting. This also meant that members did not keep a record of how often they had met but answered the questions rather subjectively. In addition, due to the division into sub-teams, the frequency of face-to-face meetings often reflected meetings as sub-teams. For my research it is important to know which teams meet

more or less often compared to other teams. Furthermore, the number of face-to-face meetings relates to the use of specific tools as supported by the following quotation:

> Face-to-face meetings are the most effective way to prevent misconceptions and to accomplish a fair allocation of tasks. Groupware and web-based time sheet management is especially useful in the allocation and tracking of tasks because all team members are then able to see what's going on (BHT-Team-2009-2).

Table 48 – Face-to-Face Meeting Frequency BHT Teams 2009

Teams	**Frequency of Face-to-Face Meetings**
BHT-Team-2009-1	From **At least once a month** to **Daily**
BHT-Team-2009-2	From **At least once a week** to **Two to three times a week**
BHT-Team-2009-3	From **Two to three times a week** to **At least once a week**
BHT-Team-2009-4	From **Two to three times a week** to **At least once a week**
BHT-Team-2009-5	**At least once a week**

In the same survey I asked for the frequency of face-to-face meetings. Besides this, I determined the usage rate for specific communication tools (see Table 49) and project management related software (see Table 50). These results assist in estimating how often the different teams have used a tool category compared with other teams. Even more important is to identify which tools they have selected and in what combination they have applied them (media mix/tool combination). The following quotation reveals an example of the shift from SMS to Phone and also explains the reason:

> [Question: Hence SMS played an important role?] No, we would rather phone. In particular, because everyone has a flat rate (BHT-Team-2009-4).

Table 49 - Use of Communication Technology BHT Teams 2009

Team	**Netmeeting or Skype**	**Phone/ Phone Conference**	**Moodle**	**Chat**	**eMail**	**Text Messaging**
BHT-Team-2009-1	From **Never** to **At least once a month**	From **Never** to **At least once a week**	From **Never** to **At least once a week**	**Never**	From **two to three times per week** to **Daily**	From **Never** to **Less than once per week**
BHT-Team-2009-2	From **At least once a month** to **Daily**	From **Less than once a week** to **Two to three times per week**	From **Never** to **Daily**	From **Never** to **At least once a week**	**At least once a month** to **Two to three times per week**	From **Never** to **Less than once per week**
BHT-Team-2009-3	From **At least once a month**	From **At least once a month**	From **Never** to **At least**	From **Less than**	From **Two to three**	From **Never** to **Two to three**

Team	Netmeeting or Skype	Phone/ Phone Conference	Moodle	Chat	eMail	Text Messaging
	to **Two to three times per week**	to **Two to three times per week**	**once a week**	**once per week** to **At least once a week**	**times per week** to **Daily**	**times per week**
BHT-Team-2009-4	From **Never** to **At least once a week**	From **At least once a month** to **Two to three times per week**	From **Never** to **At least once a week**	**Never**	From **Two to three times per week** to **Daily**	From **Never** to **Two to three times per week**
BHT-Team-2009-5	From **Never** to **Two to three times per week**	From **Two to three times per week** to **Daily**	From **Never** to **Two to three times per week**	From **Less than once per week** to **At least once a week**	**Two to three times per week**	From **At least once a month** to **Two to three times per week**

Compared to the UCT Teams, the campus platform (Moodle) was not the central place for the BHT Teams for document exchange, chat or task tracking. This role was performed either by Google tools (Google Groups[28] or Google Docs[29]) or a Web-based Task Tracking tool. In the survey the teams were asked how often they used Moodle. The interviews showed that the usage did not relate as much to project activities (e.g., sharing of data or communication) as to downloading course materials and uploading of the project deliverables (project reports, status reports, and minutes of meetings) for the course convener. The role of Moodle in the work of the BHT Teams is therefore not comparable to the role Vula played for the UCT Teams.

In general, all Berlin 2009 teams and team members have good Internet availability and Internet bandwidth. There was only one team in which one team member had restricted Internet availability. This quotation from BHT-Team-2009-4 emphasizes again how Internet access restricts a team in the selection of its project management and communication platform:

Ocan had only limited access to the Internet; therefore we used email and phone.

[28] Google Groups is a web-based document sharing and storage facility from Google that allow members of the project team to upload and download project documents (for example protocols, deliverables, project plans).

[29] Google Docs offers a web-based office and data storage service. It allows the team member to create and to edit documents in a collaborative work-setting.

Table 50 - Use of PM Software BHT Teams 2009

Teams	Web-Based Task tracking	Web-based time sheet management	Team Calendar
BHT-Team-2009-1	From **At least once a month** to **Two to three times per week**	From **Never** to **Less than once a week**	From **Never** to **At least once a week**
BHT-Team-2009-2	From **At least once a week** to **Two to three times per week**	From **Never** to **Two to three times per week**	From **Never** to **Less than once a week**
BHT-Team-2009-3	**Never**	From **At least once a month** to **At least once a week**	From **At least once a month** to **Daily**
BHT-Team-2009-4	From **At least once a month** to **Two to three times per week**	From **At least once a month** to **Less than once a week**	From **Never** to **At least once a week**
BHT-Team-2009-5	**Never**	**At least once a month**	From **At least once a week** to **Two to three times per week**

5.4.2 Integrating the BHT Teams 2009 into the Results

5.4.2.1 Coding Results and Changes to Categories, Concepts, Properties and Dimensions

The BHT 2009 teams from those at UCT differ in several ways: the teams are larger; they have a different kind of project task; they are forced to select their own tools to support their project work; the project duration is shorter; they are subdivided into two sub-teams, and they have no industrial sponsor. In the interviews regarding their project many answers point to the same concepts as was the case with the UCT Teams, but there are also a number of new concepts coming up. In total there are now about 170 concepts grouped into the very same four categories **TEAM, PROJECT, INTERNET,** and **TOOL**. In the 4 categories, there are now 25 sub-categories. Sub-categories relate to a main category and answer questions such as who, where, why, when, and how about that category (Corbin & Strauss, 2008).

Category TOOL

The BHT Teams 2009 had to select their own tools to support them in their project work. There was no specific tool required by the course convenor. This explains a couple of new concepts arising in this category. In their interviews the teams explained the role these tools played in their project work: how the tools have contributed to their performance and how they personally experienced the tool. Hence these selected tools contributed to new concepts. Especially interesting is the new concept **CENTRAL PLATFORM**. Every BHT team 2009 selected a tool that had a central role in

their exchange of information, data, minutes or tasks and of discussion of project relevant issues. The following three quotations make the importance of the central platform transparent:

> We started with Google Groups and I found the free file sharing great, and then also the automatic email notification after changes in the documents. This helped in the team's cooperation and made work easier (BHT-Team-2009-2).

> [Question: How was the trust in the team? Did the tools affect the trust?] With the use of tools you create at least a baseline for trust, because at least everybody has the information about what is going on in the project. If everybody is going to perform without such a tool, some members may not know what is going on (BHT-Team-2009-3).

For the UCT team, this central platform in most cases was Vula; therefore the need for a central platform was not obvious in the analysis of the data. The importance of a central tool came up in the interviews with the BHT teams. These interviews made it clear that a central platform is an important part of the project setting for both UCT and BHT teams, as the following words show:

> [Question: What would have happened if we would have split up the team to work in Cape Town and Johannesburg (with the customer)?] Could we have kept using Vula? [Yes!] Then it would have worked out fine (UCT-Team-2009-1).

There are also reasons why the BHT-Learning-Platform Moodle has not taken the same central role for the BHT-Teams. In Moodle, group specific up- and download features are missing and there is no appropriate user account management.

The concepts added to this category are described in the following table (see Table 51).

Table 51 - Additional Concepts in the Category TOOL

Concept/Property	Dimensions
Central Platform	Yes, No
Change	Yes, No
Document Sharing	
Communication	Synchronous, Asynchronous
User Account Management	Yes, No
Google Docs	
Google Calendar	

Concept/Property	Dimensions
Google Groups	
Shared Document Handling	
Web-based Task Management	

All specific tools (Chat-tool, Email, Forum, MS Project, Google Groups, Google Calendar, Google Docs, Phone, SMS, Web-based Task Management, Version Control, Voice over IP and Vula) have the following properties in common (see Table 52):

Table 52 - Common Properties of the Different Specific TOOLS

Property	Dimension
Communication related Usage	Yes, No
Information, Data and Source Code Sharing Related Usage	Yes, No
Shared Document Handling	Yes, No
Project Management Related Usage	Ye, No
Usage Frequency	Never, Daily, Two to three times a week, At least once a week, At least once a month
Wiki	Yes, No

In addition, arising from the teams' selection of their tools, concepts have been summarized under sub-category **ACCEPTANCE:** this reflects team members' motivation or frustration as well as the maturity of tools or personal preferences. This sub-category also includes the concepts **USABILITY, RELIABILITY,** and **SPEED** (see Table 53).

Table 53 - Sub-category ACCEPTANCE

Sub-category	Concept/Property	Dimensions
Acceptance	Frustration	Low, Medium, High
	Maturity level	Low, Medium, High
	Motivation	Low, Medium, High
	Personal Preferences	
	Professionalism	
	Reliability	Low, Medium, High
	Response Time	
	Self-Explicatory	Yes, No

Sub-category	Concept/Property	Dimensions
	Speed	
	Usability	Low, Medium, High
	User-friendliness	Low, Medium, High

Category INTERNET

There are only a few references to category **INTERNET** and no additional concept has been added. This can be explained by the BHT Teams working within an environment (Germany) with good Internet infrastructure.

Category TEAM

New concepts in the Category **TEAM** are listed in the next table (see Table 54).

Table 54 - New Concepts in the Category TEAM

Concept/Property	Dimensions
Common Ground	
Personal Performance	
Performance	
Sub Teams	
Team Contracts	
Team Goal	
Team Building	

Category PROJECT

Most of the new concepts (including those of the sub-categories) are coded into the category **PROJECT** (see Table 55).

Table 55 - Additional Concepts in the Category PROJECT

Concept/Property	Dimensions
Responsible Person	
Duration	
Complexity	

The following sub-categories are changed and extended. The sub-categories **PROJECT ACTIVITY** and **TASK MANAGEMENT** have now the following concepts, properties and dimensions (see Table 56).

Table 56 - TOOL Sub-categories PROJECT ACTIVITY and TASK MANAGEMENT

Sub-category	Concepts/Property	Dimensions
Project Activity	Code Exchange	
	Conflict Solving	
	Discussion of Critical Issues	
	Document Exchange	
	Face-To-Face Meetings	Formal, Informal
	Face-to-Face Working	
	Information Exchange	
	Knowledge Exchange	
	Learning	
	Problem Solving	
	Scheduling of Face-to-Face Meetings	
	Set-Up a Team Contract	
Task Management	Deadline	
	Deliverables	
	Non-Distributable work item	
	Task Assignment	
	Task Complexity	
	Task Planning	
	Task Tracking	
	Task Status	
	Task Transparency	
	Time Sheet Management	
	Work Break Down Structure	

5.4.2.2 Refined Relationships - UCT Teams 2008, 2009 and BHT 2009

The following section extends some of the relationships from the last collecting cycle and defines new relationships derived from the analysis of the interviews of the BHT 2009 teams. Again I used drawings to visualize the relationships and added selected quotations from the interviews to underpin them.

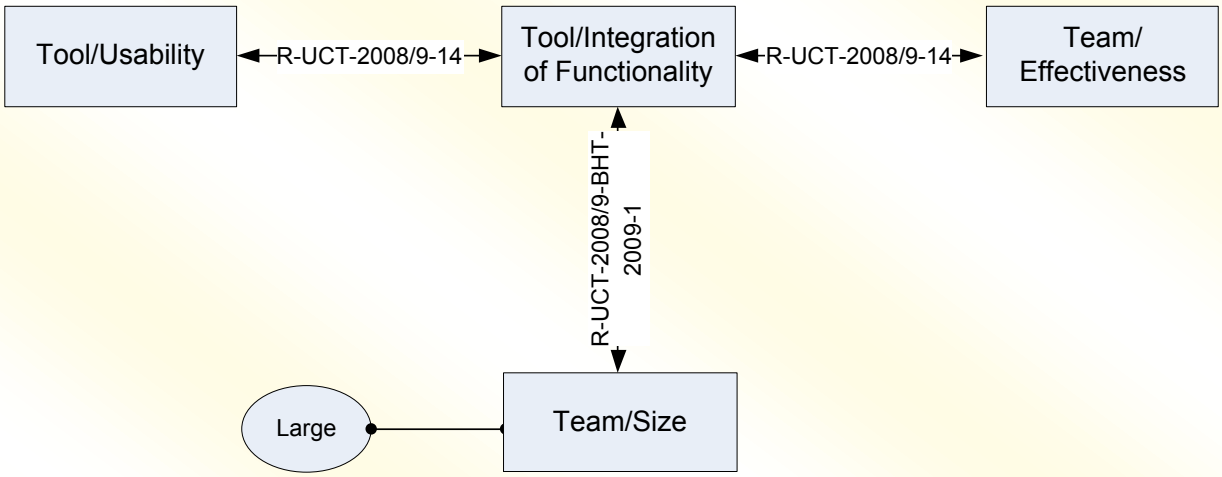
R-UCT-2008/9-BHT-2009-1: The **USABILITY** of a **TOOL** relates to the **INTEGRATION OF FUNCTIONALITY** within the **TOOL**. The **INTEGRATION OF FUNCTIONALITY** increases the **TEAMS EFFECTIVENESS**. The larger a **TEAM** is, the more it needs an integrated **TOOL**.

The above relationship is an extended version of R-UCT-2008/9-14, taking into account the size of a team. Because the BHT teams are larger than the UCT teams, they have been more attuned to different management activities, including the user administration of different tools. The above relationship is supported by the following quotation from BHT-Team-2009-1:

> However, we did not face major problems; we only had to create users in both tools. The question is whether two tools can still be used so efficiently if the teams become bigger. This is something someone has to examine.

The team size was one point to take into account when sampling the BHT teams, revealing that teams would need integrated tools to cope with a larger size of teams.

Figure 33 - Early Diagram on Tool Usability - Team Size – Integration – Team Effectiveness



R-UCT-2008/9-BHT-2009-2: The **SELECTION** of a **TOOL** takes place at the beginning of the **PROJECT** and influences the **TEAM'S EFFECTIVENESS**.

This can be deduced from the following quotation:

> The choice fell, at the beginning of the project, on Google Groups because it was available and easy to handle, free of charge, and offered the functionality we thought we would need. At the beginning of the project documents were wildly sent by email and nobody knew what the latest version of a document was and therefore we

needed to organize ourselves as fast as possible. After we got to know myintervals[30], we asked ourselves whether we wouldn't start the project differently next time (BHT-Team-2009-1).

R-UCT-2008/9-BHT-2009-3: The wrong **SELECTION** of a **TOOL** at the beginning of the **PROJECT** or the **CHANGE** of a **TOOL** during the **PROJECT** reduces the **EFFECTIVENESS** of a **TEAM**.

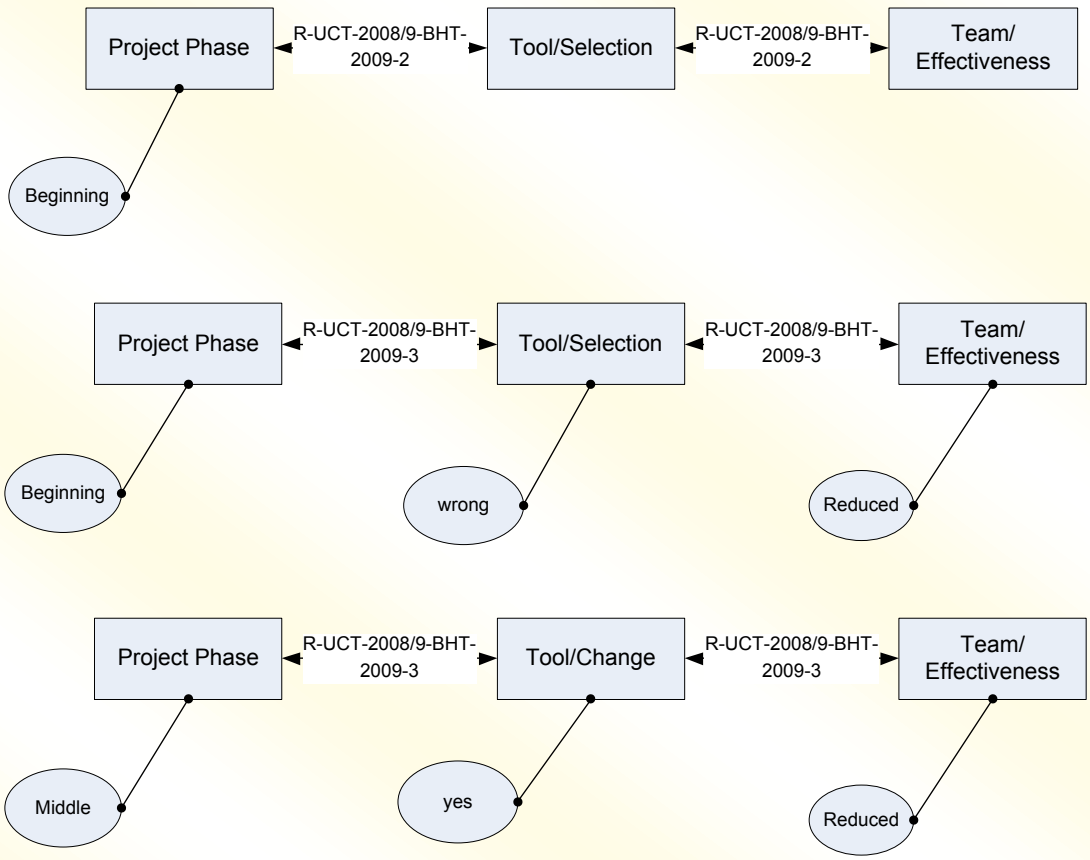
The selection of tools seems to be crucial for a virtual team. The decision takes place at the beginning of a project and, if a wrong tool is chosen or there is a change in the tools, this will influence the team's effectiveness. Two Teams with low project results changed their tools during the project:

[Question: Explain the role of Vula to manage your project?] [Team Member:] Specific adaptation of Vula (for a weekly breakdown of tasks) for the tasking, exchange of documents, and chatting. At the beginning, there was also code sharing. Later via Subversion (UCT-Team-2008-2).

[Question: What would you recommend to a team starting a similar project?] I would recommend the same things that an honour's student recommended to us. Get source control; get some place online to manage your documents effectively (UCT-Team-2009-3).

[30] *myintervals* is a *web-based task tracking system,* that is, a specific type of issue-tracking system that manages and maintains a list of tasks as needed by the project. This list is often initiated during project planning.

Figure 34 - Early Diagram on PROJECT PHASE, TOOL SELECTION, and TEAM EFFECTIVENESS

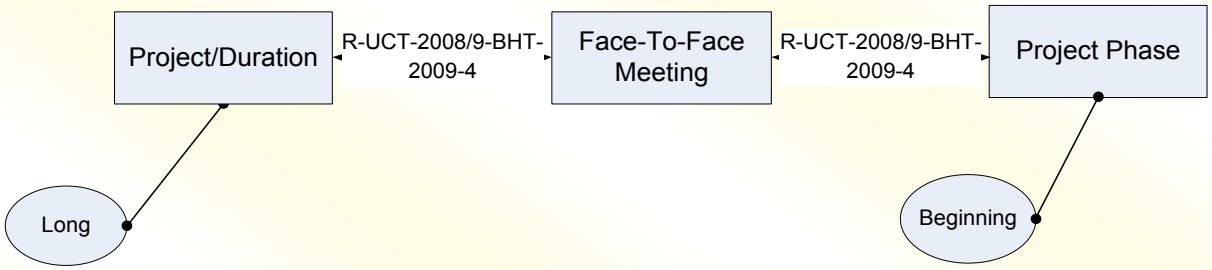


R-UCT-2008/9-BHT-2009-4: The longer a period for which a **PROJECT** is scheduled, the more it is necessary to set up a **FACE-TO-FACE MEETING** at the beginning of the **PROJECT** in order for success within a distributed **WORK SETTING**.

Looking back to the UCT teams, where the teams worked together for almost a year, this proposition is supported by an average of more weekly face-to-face meetings during their project, especially within the successful teams. The following quotation from BHT-Team-2009-1 underlines the above proposition:

> If someone works together over a longer time period, for example, half a year, in a bigger project, then it is necessary to have at least one longer face-to-face-meeting at the beginning of the project.

Figure 35 - Early Diagram on FACE-TO-FACE MEETINGS in Long-term Projects



R-UCT-2008/9-BHT-2009-5: The **TEAM'S EFFECTIVENESS** is increased by the **SHARED DOCUMENT HANDLING** in a **TOOL** introduced at the beginning of the **PROJECT**.

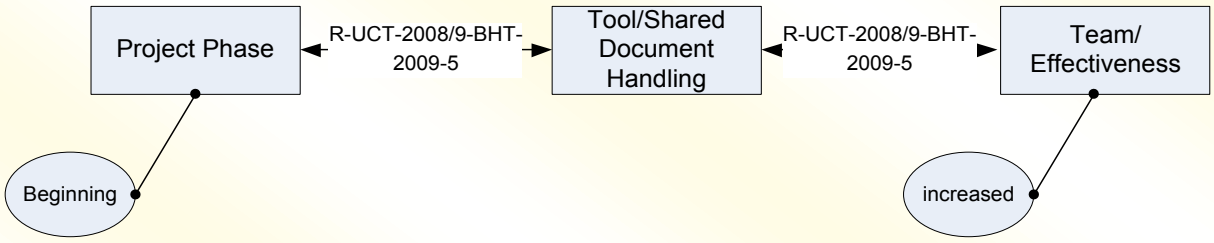
The above relationship extends the relationship R-UCT-2008/9-15 from the previous section and specifically points to the increase of effectiveness in the shared document handling referred to in this quotation from BHT-Team-2009-2:

> We started with Google Groups and I found the free file sharing great, and then also the automatic email notification after changes in the documents. This helped in the team's cooperation and made work easier.

A negative example where the shared document handling has not been applied, demonstrates the decrease in effectiveness:

> Tibor and I have not inter-coordinated on one work item. Anne uploaded a template file for the technical report. Tibor downloaded it and started to work on the file. I also downloaded the file and entered my texts. In the meantime, Anne updated the template file. Finally, we had to assemble all the bits and pieces into one document with much more effort than necessary (BHT-Team-2009-3).

Figure 36 - Early Diagram on SHARED DOCUMENT HANDLING and TEAM EFFECTIVENESS



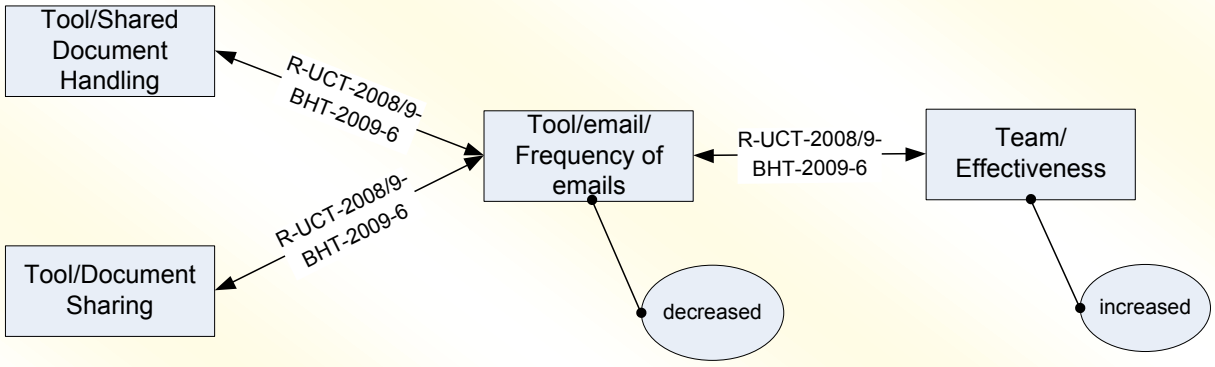
R-UCT-2008/9-BHT-2009-6: The **TEAM'S EFFECTIVENESS** is increase by the **SHARED DOCUMENT HANDLING** or the **DOCUMENT SHARING** via a **TOOL,** because the number of project related **EMAILS** is decreased.

The proposed relationships might be one explanation of why the project teams' effectiveness is increased by the use of certain features of a tool: this explanation is found in the following quotation:

> We first discussed in the team the allocation of the tasks and then wrote them down with names and dates. This task list and work results from the different team members were uploaded into Google Groups. By this means we avoided being flooded with emails (BHT-Team-2009-3).

The UCT teams showed that this relationship might be extended to the sharing of resources (program code, documents, information) in general.

Figure 37 - Early Diagram on SHARED DOCUMENT HANDLING/DOCUMENT SHARING and TEAM EFFECTIVENESS

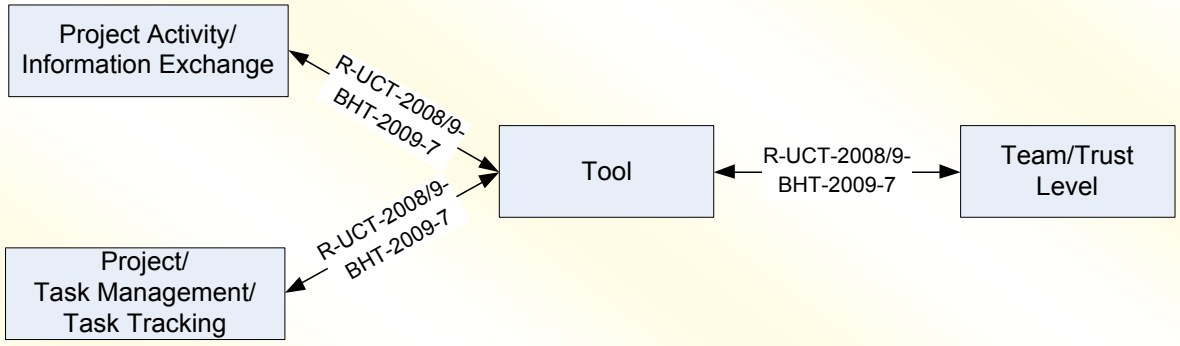


R-UCT-2008/9-BHT-2009-7: The support of certain **PROJECT ACTIVITIES** such as **INFORMATION EXCHANGE** and **TASK TRACKING** via a **TOOL** has a positive influence on the **TRUST LEVEL** in a **TEAM**.

Trust is not just a precondition for the successful team work with tools in a virtual work setting: in addition, the use of tools to support activities like information sharing and task tracking has a positive influence on the level of trust in the team, as outlined by the following quotation from BHT-Team-2009-3:

> [Question: How was the trust in the team? Did the tools affect the trust?] With the use of tools you have created at least a baseline for trust, because at least everybody has the information about what is going on in the project. If everybody is going to perform without such a tool, some members may not know what is going on.

Figure 38 - Early Diagram on INFORMATION EXCHANGE/TASK TRACKING and TEAM'S TRUST LEVEL



R-UCT-2008/9-BHT-2009-8: The **TEAM'S TOOL SELECTION** on a **CENTRAL PLATFORM** influences **THE TEAM'S EFFECTIVENESS**.

Most of the BHT teams 2009 selected a tool that had a central role in their exchange of information, data, minutes or tasks, and of their discussion of issues relevant to the project. The team's tool choice on a central platform influences the team's effectiveness. This is endorsed by the following quotations:

> There was no necessity to look at different places and gather information on the project from different places. If you wanted to know something about the project, you logged onto Google Groups and everything accomplished so far was documented there (BHT-Team-2009-2).

> What we up to now had not experienced in project work was that not everybody would ask: 'Have you already done this?' or 'Is this already finished?' The program [myinterval] provided a nice transparency which made these questions unnecessary. Everybody knew what he had to do. This is my task and this is my deadline. At last the tool we were using also contributed to our good results (BHT-Team-2009-1).

UCT's central platform was predefined VULA as explained in the following quotation:

> We used Vula a lot. It is so easy. We all log on. There is a chat room for us. We leave messages for each other. We can post an announcement if there is something really important for us. We upload all the documents of the project and all the resources that are important for the project. It is reliable in most of the time. We are used to the tool. We used the chat real-time. We wrote tens of thousands of messages. Me and Brad we used it a lot. If there is something to discuss that takes a long time to talk about, we chatted about it (UCT-Team-2009-1).

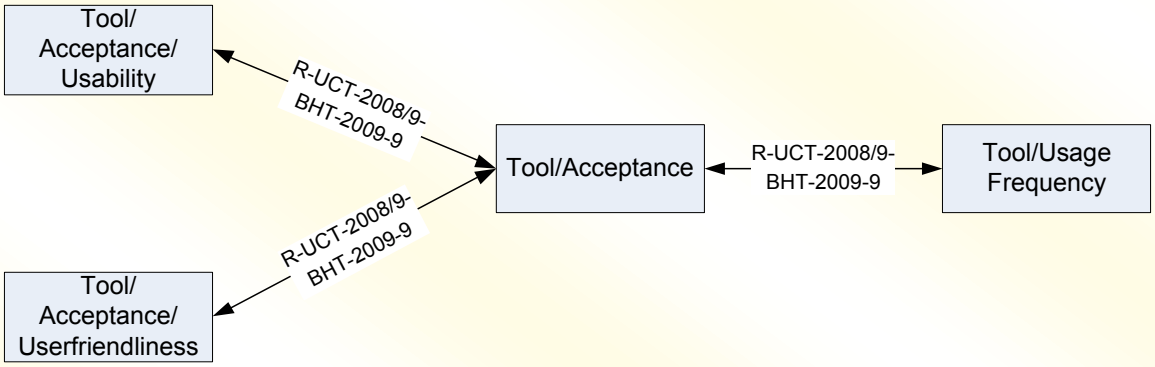
Figure 39 - Early Diagram on CENTRAL PLATFORM and TEAM EFFECTIVENESS

R-UCT-2008/9-BHT-2009-9: **USABILITY** and **USER FRIENDLINESS** influence the **TOOL'S ACCEPTANCE** and the **USAGE FREQUENCY** of a **TOOL**.

As pointed out, arising from the UCT teams as well as from the BHT Teams, the aspects of usability and user friendliness have a strong impact on the tool's acceptance and the frequency with which it is used. This statement finds support in the following quotation:

> [Question: Did the user's interface and its usability play an important role?] Yes, because one spends a lot of time in front of the system therefore it is important to feel comfortable. The system must be clearly arranged (BHT-Team-2009-4).

Figure 40 - Early Diagram on the Influence of USABILITY and USER FRIENDLINESS on USAGE FREQUENCY



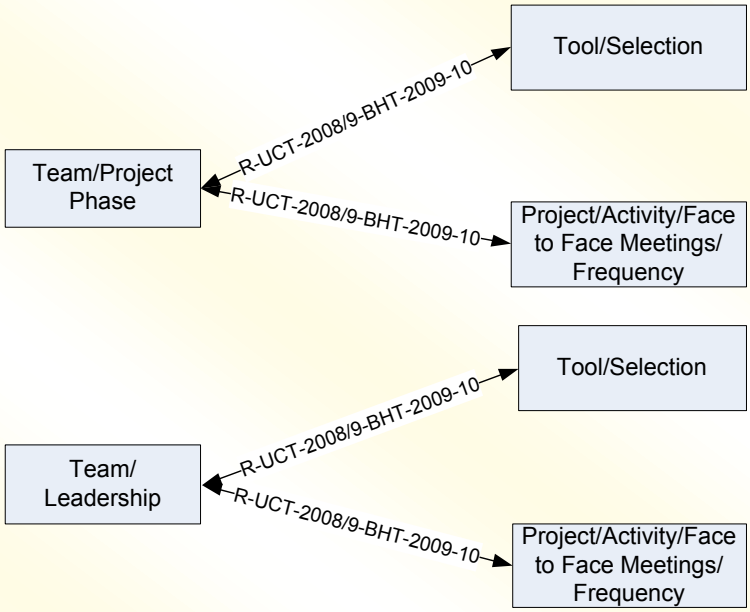
R-UCT-2008/9-BHT-2009-10: **TEAM LEADER(-SHIP)** and **PROJECT PHASE/PROJECT STAGE** influence the **SELECTION OF TOOLS** and the frequency of **FACE-TO-FACE MEETINGS** in a **PROJECT**.

Teams with high communication intensity (in the early phase of the project, or at a specific stage of a project) or democratic leadership structure (for instance, among student teams) need more synchronous group communication functionality (group discussion in Skype) or face-to-face meetings. The following quotations make this evident:

> I have thought about it, why myintervals was developed like that and why there is no communication functionality. It became clear to me that one assumes in myintervals that there is a clear hierarchy and a project manager who distributes and assigns the tasks. Though we chose a project manager in each sub-team, we are all at the same hierarchical level and, hence, there is a fair amount of discussion about the assigning of the tasks. There is no single person who makes the decision. Hence, the missing communication component in myintervals is comprehensible from the developer's point of view but crucial for our decision on Google Groups and myintervals (BHT-Team-2009-1).
>
> There are some topics where the other team member must be present and then you can discuss it with him/her. Even if you use the videophone, this is not comparable. Examples are the team contract and the allocation of tasks. Especially the fundamental things that you have to decide and discuss at the beginning of the project. Especially when the subject causes controversial opinions, you have to discuss face-to-face, also to discuss points on which you have to find an agreement (BHT-Team-2009-1).

It depends on the stage of project you are in. In an earlier stage, it is easier to work more distributed when there is less communication required. The work can be done separately, like working on the database. Later on, when there are, for example, the customer Interviews, then it is difficult to do it purely via Vula. Even though Vula is very cool (UCT-Team-2009-1).

Figure 41 - Early Diagram - the Influence of LEADERSHIP CONCEPT and PROJECT PHASE on TOOL SELECTION and FACE-TO-FACE MEETING FREQUENCY



R-UCT-2008/9-BHT-2009-11: A low **TOOL MATURITY LEVEL** reduces the **TEAM'S EFFECTIVENESS**.

Due to the Internet, new web-based services are coming up in shorter intervals. These tools do not always offer the maturity that the user might expect. The following discussion provides an example of how the BHT-Team-2009-1 experienced the low maturity level of a tool:

[Team Member:] It was absolutely strenuous that in Google Groups there are no folders and that one could not login properly. [Team Member:] The tools have not matured yet. We had 71 documents at the end. It was just confusing. [Team Member:] In particular after someone has worked with it for several weeks, it becomes absolutely confusing. [Team Member:] From my point of view, Google Groups is not that bad, but it has not matured yet, because of the repeated uploading of a document, the problems with the login and the unpredictable email messages. Further, there are the missing structuring possibilities and missing overview in the document handling.

R-UCT-2008/9-BHT-2009-12: The **TRANSPARENCY OF TASKS** allocated to the **TEAM MEMBERS** and the work progress on these **TASKS** reduces the amount of **COMMUNICATION** required in the **TEAM**.

Team members in a virtual work setting constantly wish to know how tasks allocated to the other team members are progressing because this influences the success of the project. In addition, tasks are often interdependent and the results of colleagues' work are needed. Other than in a face-to-face setting, they are unable to observe whether their colleague is in fact working on the project. The following quotations show the role of tools in making the work on the tasks transparent:

> What we up to now had not experienced in project work was that not everybody would ask: 'Have you already done this?' or 'Is this already finished?' The program [myinterval] provided a nice transparency which made these questions unnecessary. Everybody knew what he had to do. This is my task and this is my deadline. At last the tool we were using also contributed to our good results (BHT-Team-2009-1).

> Face-to-face meetings are the most effective way to prevent misconceptions and to accomplish a fair allocation of tasks. Groupware and web-based time sheet management is especially useful in the allocation and tracking of tasks because all team members are then able to see what's going on (BHT-Team-2009-2).

R-UCT-2008/9-BHT-2009-13: **USER FRIENDLINESS** influences the need for **TRAINING** on a **SPECIFIC TOOL**.

This relationship also depends on the tasks that the tool supports. The stated relationship is backed up by the following quotation:

> Yes, [we would need] more training for MS Project. No training for Vula is needed. It is so easy to use. It is very user friendly (UCT-Team-2009-2).

R-UCT-2008/9-BHT-2009-14: **TOOLS** that support **TASK TRANSPARENCY** in the **TASK MANAGEMENT** increase the **TEAM MEMBERS' SATISFACTION** in the **PROJECT**.

For team member in the UCT Teams as well as in the BHT teams, it was an important matter to know the status of a task assigned to a team member, especially while working in a distributed work setting. Tools that supported the task management by means of making transparent the actual status increased the team members' satisfaction.

> The timer [in myintervals] is a good function to keep track of how much time has been consumed on a task, but foregrounds the fact that everybody should want to take part and make his performance transparent. Otherwise it is not only the time a team member consumes but also the performance that he delivers (BHT-Team-2009-1).
>
> [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 nagged 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).

Task transparency was improved by the use of specific tools supporting task management and as a result the satisfaction of team members was increased. Nevertheless some doubts remained, as is evident in the following quotation:

> Via a tool it is possible to check the status of working packages before the deadline, but the status is not always fully transparent. In a personal conversation I can better handle the fears of the project leader or team member that the work will not be completed in time. With a tool it is also easier to pretend a degree of completion than in a face-to-face meeting! (BHT-Team-2009-4)

Therefore this relationship might also be related to the trust level in the team. The trust level in this team, BHT-Team-2009-4, was relatively low (see Table 45).

Figure 42 - Early Diagram on the Influence of TASK TRANSPARENCY on TEAM MEMBER SATISFACTION

After the third cycle, 170 concepts grouped into the very same four categories: **TEAM, PROJECT, INTERNET** and **TOOL,** now with 25 sub-categories. Due to the theoretical sampling, the analysis of the data brought new insight regarding the use and the selection of tools. It showed the relationships between different features of the **TOOLS** and **TEAM MEMBER'S SATISFACTION** and the **TEAM'S EFFECTIVENESS.** It also highlighted the different relationships of the **TOOLS** with **TEAM COHESION** and **TEAM TRUST**.

5.5 *Analysis of the BHT Teams 2010-O and 2010*

5.5.1 Sampling and Data Collection of the BHT Teams 2010-O

The course "Information Systems Project" at BHT is taken by undergraduate students in their third year of an online Bachelor of Information Systems degree. This course comprises a major capstone project, through which students must demonstrate their ability to integrate the theoretical and practical knowledge acquired during the previous two years of studying Information Systems. Prior to this project, students will have completed courses adhering to the national German curriculum (Wissenschaftliche Kommission (WK) Wirtschaftsinformatik im Verband der Hochschullehrer, 2007) and will have participated in a project management course taught according to the PMBOK (Project Management Institute, 2004).

This course has been selected for several reasons. Compared to all other teams, team members in these two teams have been participating in a blended online course. Therefore they have been exposed to a number of Internet-based tools in order to communicate with each other and with the different course convenors. During the whole project BHT students have only two scheduled face-to-face meetings with their project mentor. Apart from this, they communicate through Internet technology. The teams meet the lecturer once a week online via Skype or Adobe Connect.

The same project task (see Table 57) was provided to both teams by the course convenor. The teams followed the protocols set out by the course. Email was used for asynchronous communication and document exchange, together with Moodle, BHT's web-based open-source learning, collaboration, and research content management systems.

Table 57 - Team-specific Project Brief BHT 2010 online

Teams BHT 2010 online	Team-specific project brief
BHT-2010-O-1 **BHT-2010-O-2**	The development of a concept that that shows how the project management processes for a sponsor in the consulting business could be supported via an integrated web-based task-tracking and project management tool. This emphasis shall be placed on the multi project management issue within the consulting business. Based on the results of a tool evaluation an implementation guide for the selected tool shall be developed.

As in the previous data collection cycle, I used a survey to determine the occurrence of face-to-face meetings. In addition, I collected the usage rate of specific communication tools and project management related software. These results help with estimating how often the different teams

have used a tool category compared with the other teams. It is even more important to see which tools they have preferred to use and in which combination they have used the tools (media mix/tool combination).

Table 58 - Data Collection Protocol BHT-2010-Online

Data Source	Details
Semi-structured interviews	Interviews with the team via Skype/Adobe Connect[31] (average length of the interview was 20 minutes); all interviews were recorded with the computer and in addition, as the researcher I took notes.
Protocols of meetings/Team reflective essays/weekly online meeting with team leader	Team characteristics on behaviour, skills, team procedures regarding problem solving.
Questionnaires	Completed by the team regarding used technologies and problems faced.
Team reflective essay in their final project report and weekly protocols	Team characteristics, task awareness, task management and trust (assessed by the lecturer).
Course results of the teams	This assessment was done from the course lecturer prior to the interviews.

5.5.2 Sampling and Data Collection of the BHT Teams 2010

The teams were formed by undergraduate students at the University of Applied Science in Berlin (BHT) during their second year coursework projects on project management in Spring 2010. At BHT, 47 undergraduate students were asked to form 6 project teams, to have between 7 and 8 students. Different project tasks of similar complexity were provided by an industrial sponsor (see Table 59), who presented the project tasks to the teams together with the documents necessary to clarify the project goals and the desired project results. The duration of the projects was one semester. All teams signed a team contract at the beginning of the course. All teams followed the protocols set out by the course. Each of the BHT-2010 teams consisted of two sub-teams, each sub-team drawn from a different course. This resulted in the BHT Teams 2010 working separately on a task for a higher percentage of time, on average, than the UCT teams. The BHT teams therefore have, according to Griffith, Sawyer and Neale (2003), a higher degree of virtuality.

[31] Adobe Connect is a web-based software that can be used to share online presentations, for web conferencing, and to share the user desktop.

Table 59 - Team-specific Project Brief BHT 2010

Teams BHT 2010	Team-specific project brief
BHT-2010-1	The objective of project is to develop a concept of a web-based idea management for the customer/sponsor. The goal is to integrate the company's staff members into an idea finding process.
BHT-2010-2	The goal is to do a market research on a web-based tool to support the managerial accounting of the customer's/sponsor's international projects. A tool shall be selected that meets the customer's requirements and this tool shall be customized to his needs. Further, based on his requirements project guidelines for the use of the web-based tool shall be developed.
BHT-2010-3	Development of a concept for a web-based risk-management that support the sponsor to identify, analyze, control and prevent risks that influence the company's success. In addition, the tool shall help the customer in the decision process by reducing risk factors.
BHT-2010-4	The customer´s/sponsor´s goal is to develop an overall risk management system and an adequate implementation strategy. Based on a tool selection, the concept shall take into account general risks as well as the customer's business.
BHT-2010-5	The objective of the project is to develop the concept of a web-based complaint-management system for the sponsor. The system shall take into account different target groups. Further the system shall integrate the management of target group specific proposals for improvements.
BHT-2010-6	Development of a concept that improves business processes of the complaint management within the sponsor's company. Based on a market research appropriate tools that meet the customer's requirements shall be identified and evaluated.

Unlike the BHT 2009 teams, the BHT Teams 2010 had an industrial sponsor. Most of the teams had a different project task (but some teams competed on the same project task (BHT-Team-2010-3 and BHT-Team-2010-4 as well as BHT-Team-2010-1 and BHT-Team-2010-6). The sponsor was also involved in the assessment of the teams' results and marking of the teams.

Table 60 - Data Collection Protocol BHT-2010

Data Source	Details
Semi-structured interviews	Interviews with team leader and one team member (average length of the interview was 20 minutes); all interviews were recorded with the computer and in addition, as the researcher I took notes .[32]
Observation of meetings	Team characteristics on behaviour, skills, team procedures regarding problem solving, team cohesion, task awareness and task management.
Questionnaires	Completed by each team member regarding used technologies and problems faced.

[32] In team BHT-2010-5, two team members did not give their permission for recording the interview, therefore notes have been taken.

Data Source	Details
Course results of the teams	This assessment was done from the course lecturer and the sponsor of the projects prior to the interviews.

In the survey (questionnaires) the team members were asked to indicate how often they had used the different communication tools and project management software during their half a year capstone project. The survey was handed out after the final project presentation and returned by 45 of 48 students.

5.5.3 Data of the BHT Teams 2010-O and the BHT Teams 2010

The data regarding diversity, cultural background, tools, and meeting frequency are described together, as there are only two online teams. Thus, differences can easily be described in one section and yet keep the analyses results transparent. As with the other BHT teams, Berlin's multi-cultural background resulted in a team composition with a high diversity and different cultural backgrounds (see Table 61 and Table 62).

Table 61 - Diversity of the BHT Teams 2010

Teams BHT 2010	Gender	Diversity	Cultural Diversity
BHT-Team-2010-O-1	1 Fem.; 3 Male	2 Germans; 2 Germans (Polish)	Medium cultural diversity
BHT-Team-2010-O-2	2 Fem.; 3 Male	3 Germans; 1 German (Turkish), 1 German (Greek)	Medium cultural diversity
BHT-Team-2010-1	3 Fem.; 5 Male	5 Germans; 1 Moroccan; 1 Vietnamese; 1 German (Turkish)	Medium cultural diversity
BHT-Team-2010-2	3 Fem.; 5 Male	2 Germans; 1 German (Dutch); 1 German (Polish); 1 German (Tunisia); 1 German (Lebanon): 1 German (French); 1 German (Turkish)	High cultural diversity (different cultures & gender)
BHT-Team-2010-3	2 Fem.; 6 Male	7 Turkish/German (Turkish); 1 Indian	Low cultural diversity
BHT-Team-2010-4	2 Fem.; 5 Male	2 Germans; 3 Germans (Turkish); 1 South-American, 1 Arabian,	High cultural diversity
BHT-Team-2010-5	6 Fem.; 2 Male	1 Chinese, 3 Germans, 1 French, 3 Turkish	High cultural diversity
BHT-Team-2010-6	1 Fem.; 7 Male	8 Germans	Low cultural diversity

Table 62 - Team and Work Characteristics BHT Teams 2010

Teams	Size	Team Characteristics	Collaborative Work Characteristics
BHT-Team-2010-O-1	4	High level of technical expertise High level of trust	Average to good task awareness Good task management
BHT-Team-2010-O-2	5	Medium level of technical expertise High level of trust	Good task awareness Average task management

Teams	Size	Team Characteristics	Collaborative Work Characteristics
BHT-Team-20010-1	8	Good level of technical expertise High level of trust	Average task awareness Good task management
BHT-Team-2010-2	8	High level of expertise High level of trust	Good task awareness Good task management
BHT-Team-2010-3	8	Low level of technical expertise Low level of trust grew to medium level of trust	Poor task awareness Poor task management
BHT-Team-2010-4	7	Medium level of technical expertise Medium to low level of trust	Good task awareness Poor task management
BHT-Team-2010-5	8	Medium level technical expertise Low level of trust	Average task awareness Average task management
BHT-Team-2010-6	8	High level technical expertise High level of trust	Good task awareness Good task management

Based on their course results, the teams from BHT were categorized into high, medium, and low performance teams. The marking of the BHT 2010 teams was done by the lecturer and the industrial sponsor prior to the interviews and collection of the survey results. Based on their course results, the teams from BHT were categorized into high, medium, and low performance teams. The marking of the BHT-2010-O teams was done by the lecturer prior to the interviews and the collection of the survey results.

Table 63 - Performance Level BHT Teams 2010

Teams BHT 2010	Performance level
BHT-Team-2010-O-1	High
BHT-Team-2010-O-2	High
BHT-Team-2010-1	Medium
BHT-Team-2010-2	High
BHT-Team-2010-3	Medium
BHT-Team-2010-4	Low
BHT-Team-2010-5	Medium
BHT-Team-2010-6	High

The teams were subdivided into two sub-teams and this might explain the broad spectrum of answers in the questionnaires. While one sub-team met quite often (two to three time per week), the other rarely met (but at least once per month). The questionnaire made this subdivision into two sub-teams transparent regarding the frequency of the face-to-face meetings as related to the usage patterns of the tools.

Table 64 – Face-to-Face Meeting Frequency BHT Teams 2010

Teams	Frequency of Face-to-Face Meetings
BHT-Team-2010-O-1	**Less than once per week**
BHT-Team-2010-O-2	**Less than once per month**
BHT-Team-2010-1	From **At least once per month** to **Two to three times per week**
BHT-Team-2010-2	From **At least once per month** to **At least once per week per week**
BHT-Team-2010-3	From **At least once per week** to **Two to three times per week**
BHT-Team-2010-4	From **At least once per week** to **Two to three times per week**
BHT-Team-2010-5	From **Less than once per week** to **At least once per week**
BHT-Team-2010-6	From **At least once per month** to **Two to three times per week**

I used the same survey to ask for the occurrence of face-to-face meetings and the usage rate of specific communication tools (see Table 65) and project management related software (see Table 66) during their six-month project. These results should help to estimate how often the different teams used a specific class of tools. It was even more important to evaluate which tools they preferred to select and in what combination they applied the tools (tool combination).

Table 65 - Use of Communication Technology BHT Teams 2010-O and BHT Teams 2010

Team	Netmeeting or Skype	Phone/ Phone Conference	Moodle	Chat	eMail	Text Messaging
BHT-Team-2010-O-1	At least once per week	At least once per month	Never	Never	Two to three times per week	Never
BHT-Team-2010-O-2	At least once per week	At least once per month	Never	Never	Two to three times per week	Never
BHT-Team-2010-1	From **Never** to **Two to three times per week**	From **Two to three times per week** to **Daily**	**Never**	From **Never** to **Two to three times per week**	**Daily**	From **Never** to **Daily**
BHT-Team-2010-2	From **At least once a week** to **Daily**	From **Two to three times per week** to **Daily**	**Never**	From **Daily** to **Never**	**Daily**	From **At least once per week** to **Two to three times a week**
BHT-Team-2010-3	From **Never** to **Daily**	From **At least once a week** to **Daily**	From **Never** to **Two to three times a week**	**Never**	From **at least once a week** to **Daily**	From **At least once per week** to **Daily**
BHT-Team-	From **Never** to	From **At least**	From **Never**	Never	From **Never** to	From **At**

Team	Netmeeting or Skype	Phone/ Phone Conference	Moodle	Chat	eMail	Text Messaging
2010-4	**Two to three times a week**	**once per month** to **Two to three times a week**	to **Daily**		**Two to Three times a week**	**least once per month** to **At least once per week**
BHT-Team-2010-5	From **Never** to **At least once a month**	From **Two to three times a week** to **Daily**	From **Two to three times a week** to **Daily**	Never	From **Less than once a week** to **Daily**	From **Never** to **At least once a week**
BHT-Team-2010-6	From **Never** to **Less than once per week**	From **At least once per week** to **Daily**	From **Never** to **Two to three time a week**	From **Never** to **Less than once per week**	From **At least once a week** to **Daily**	From **At least once a month** to **Two to three times a week**

Table 66 - Use of PM Software BHT Teams 2010-O and BHT Teams 2010

Teams	Web-Based Task tracking	Web-based time sheet management	Team Calendar
BHT-Team-2010-O-1	Never	Never	Never
BHT-Team-2010-O-2	At least once a week	At least once a week	Never
BHT-Team-2010-1	From **At least once a month** to **Two to three times per week**	From **Never** to **Less than once a week**	From **Never** to **At least once a week**
BHT-Team-2010-2	From **At least once a week** to **Two to three times per week**	From **Never** to **Two to three times per week**	From **Never** to **Less than once a week**
BHT-Team-2010-3	**Never**	From **At least once a month** to **At least once a week**	From **At least once a month** to **Daily**
BHT-Team-2010-4	From **At least once a month** to **Two to three times per week**	From **At least once a month** to **Less than once a week**	From **Never** to **At least once a week**
BHT-Team-2010-5	From **Never** to **Two to three times per week**	From **Never** to **Daily**	From **Never** to **Daily**
BHT-Team-2010-6	From **At Least once a month** to **Daily**	From **At least once a week** to **Daily**	From **Never** to **Daily**

The BHT-2010-teams selected different systems for support in different project management tasks. BHT-Team-2010-1 regularly used, in one sub-team, “Google Docs”. BHT-Team-2010-2 pointed out that they used their integrated project management tool “Projectplace” from **Two to three times**

per week to **Daily.** BHT-Team-2010-5 selected "Dropbox"[33] for the data exchange and BHT-Team-2010-6 used "MS Office Groove"[34] from **Two to three times a week** to **Daily** for their teamwork on the result documents and protocols.

All BHT-2010 team members had good Internet availability and bandwidth. Regarding the question of Internet access, two students pointed out that they also used their cellphones to work via the Internet on project relevant issues, as can be seen in the following quotation:

> But I also have, for example, Internet access via my mobile phone, so that I could access my emails all the time and I always knew when someone sent something to me (BHT-2010-Team-1).

5.5.4 Integrating the BHT Teams 2010 into the Results

5.5.4.1 Coding Results and Changes to Categories, Concepts, Properties and Dimensions

The interviews with the BHT-2010-teams changed the categories, in three areas mainly. First of all, it became clear that the use and selection of tools was strongly influenced by not only the view shared by the team but also the perspective of each individual team member. Therefore the main category **TEAM** acquired the sub-category **MEMBER**. The **MEMBER** sub-category reflects, for example, the personal preferences, skills, and the personal work setting.

Category TEAM and Sub-category MEMBER

Table 67 - Concepts in the Category TEAM

Concept/Property	Dimensions
Common Ground	No, Partly, Yes
Communication Level	Low, Medium, High
Cultural Diversity	Low, Medium, High
Effectiveness	Reduced, Increased, Normal
Expertise	Low, Medium, High

[33] Dropbox is a web-based file sharing and storage service which allows people to exchange data files and documents.

[34] Microsoft Office Groove is a desktop application designed for document collaboration in teams with members who are not always online.

Concept/Property	Dimensions
Friendship	No, Partly, Yes
Gender Mix	All Male, All Female, Mixed
Performance Level	Low, Medium, High
Size	Small, Medium, Large
Social Cohesion	Low, Medium, High
Social Engagement	Low, Medium, High
Spread of Technological Skills	
Sub Teams	
Task Awareness	Poor, Average, Good
Task Management	Poor, Average, Good
Team Building	
Team Contracts	
Team Goal	
Rules	
Trust Level	Low, Medium, High
Trust in Technology	
Work Setting	

Table 68 - Concepts in the Sub-category MEMBER

Concept/Property	Dimensions
Distance to Work	Short, Medium, Long
Geographical Distance between Team Members	Short, Medium, Long
Effectiveness	
Satisfaction	
Technological Preferences	
Technological Skills	Low, Medium, High
Work Preference	Home, Office, Face-To-Face

Specific relationships like R-UCT-2008/9-17 and R-UCT-2008/9-BHT-2009-11 undermine the necessity to have a sub-category **MEMBER** in the category **TEAM**. The sub-category **MEMBER** is also a counterpart to the sub-category **ACCEPTANCE** in the category **TOOL**, because the sub-category **ACCEPTANCE** is strongly influenced by the individual team member. The following three quotations from different teams and different data cycles back up the role of the sub-category in determining the use and selection of tools:

> [Team Member:] The choice of the medium for the communication also depends on the person; I am, for example, somebody who prefers to write an email. Phoning always costs too much time. [Project Manager:] Yes, this is right; from you I have always got written comments (BHT-Team-2010-1).
>
> [Question: Did you have common social activities in the team?] No, not at all. It is very difficult to find a date on which all of us have time to meet. Actually, the virtual work setting suited us well (BHT-Team-2010-6).
>
> [Question: Did you have some preferences or aversions?] When I am at home I only use my computer to do work on it. I use it enough in my job and I want to use it privately as little as possible. So, I have problems with many computer-related activities. For example, I have never used Skype in my life before. I have my mobile phone and my phone, why I do I need Skype? At last I got into it. Some team mates urged me to use it. After that I got used to Google Groups. I even liked it and working with Google Groups inspired me. Then I also saw the advantages of the tool (BHT-Team-2009-2).
>
> No, we had a low trust level at the beginning and in the middle, and then trust did increase when VSS (version control) was used towards the end (the last five weeks), because Walter was working from home. We did a lot of work not being together (UCT-Team-2009-3).

The second issue is that the ubiquitous Internet supports the selection and use of a wide variety of web-based tools. Consequently additional specific tools (MS Office Groove, MSN[35], Dropbox, Projectplace[36] and Google Docs) were added to the main category **TOOL** or subsumed under more general categories like **WEB-BASED PROJECT MANAGEMENT TOOLS**.

The third issue was related to the security of web-based tools. A security incident forced two teams to change the web-based tool that was supporting the project management and information

[35] MSN offers a variety of Internet based services. It also changed during the years. The team used the Windows Live Messenger to send online and offline message.

[36] Projectplace is a *web-based task tracking system,* in other words, a specific type of issue-tracking system: it manages and maintains a list of tasks as needed by the project, a list that is often initiated during project planning.

exchange in their teams. Both teams used the same platform (**Wikispaces**[37]), but only realized a few weeks later that the security features did not prevent the other team from accessing project data. Both teams had the same sponsor and were competing against each other regarding the same project task. In consequence, the teams lost trust in web-based tools, encrypted their documents, manually exchanged documents, and, in turn, were less effective and also less successful. The interviews revealed the consequences of tool change and security incidents on performance and trust in technology. Related concepts were coded into the tools category, and relationships added and explained in the next section.

There were many references in the interviews with the BHT 2010 teams that related to existing concepts in the main categories, but only a few additional concepts. The main category **INTERNET** became a new concept: **MOBILE ACCESS**. No additional concepts emerged in the main category **PROJECT**.

5.5.4.2 Refined Relationships UCT Teams 2008, 2009 and BHT 2009, 2010-O, 2010

R-UCT-2008/9-BHT-2009/10-1:	The **SECURITY FEATURES** of a **TOOl** strongly influence the **SELECTION** of a **TOOL**. **SECURITY INCIDENTS** can force the **TEAM** to **CHANGE** the **TOOL** and such a change reduces the **TEAM'S EFFECTIVENESS**.

BHT-Team-2010-3 and BHT-Team-2010-4 faced security problems. The teams were competing against each other to deliver the same concepts to the customer (sponsor). Both teams decided on the same platform, Wikispaces, to share their documents and to interact. There was no user concept with access restrictions on this platform and the result was that the teams could see each other's documents. Both teams lost trust in this web-based platform and changed their tool. This caused a reduction in the team's effectiveness. The following quotations make the consequences transparent:

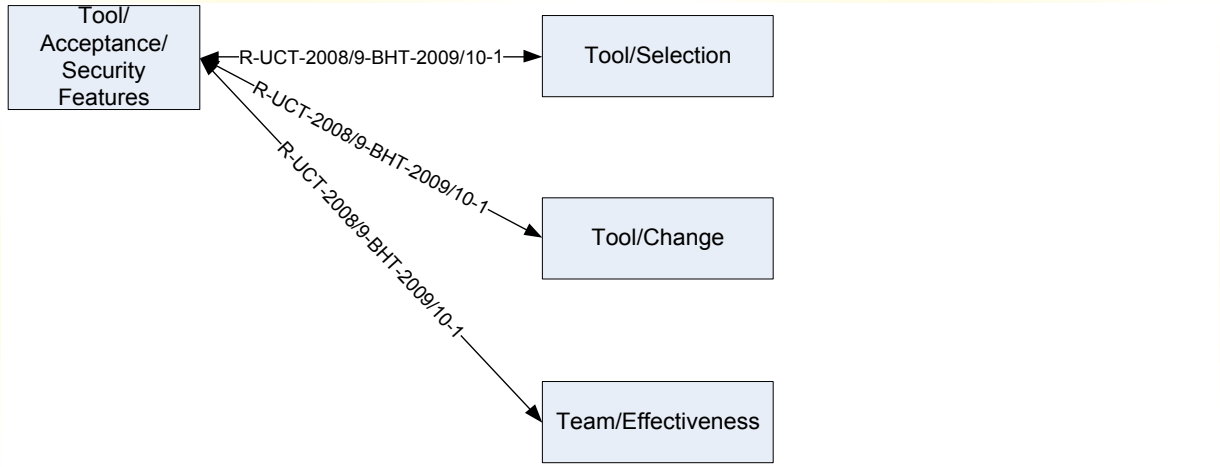
> [Question: How did the data exchange take place?] Via email. At first we used Wikispaces until we found out that everybody had access to our data. As a result, we exchanged data during our face-to-face meetings (BHT-Team-2010-3).

[37] Wikispaces is a free website for groups and individuals that allows writing a wiki, up- and download of files, and it has revision functionality.

[Question: My first question relates to the use of tools during your project. Which tools did you use for communication in the team and the coordination between the two sub-teams?] We first used Wikispaces, until we found out that everybody had access to it. In particular the team we competed against used the same platform. We had to protect the data on the platform, so we encoded our minutes. Then we set up a group on MSN. Via MSN we communicated and did our data exchange. It was a platform to upload and to download our files (BHT-Team-2010-4).

For the assignment and allocation of the tasks we used a mixed approach. First I wrote down the tasks, then printed them out and handed them over personally. Later on, I sent them via email. In the beginning we uploaded them onto our unprotected platform (BHT-Team-2010-4).

Figure 43 - Early Diagram on the Influence of the TOOLS SECURITY FEATURES



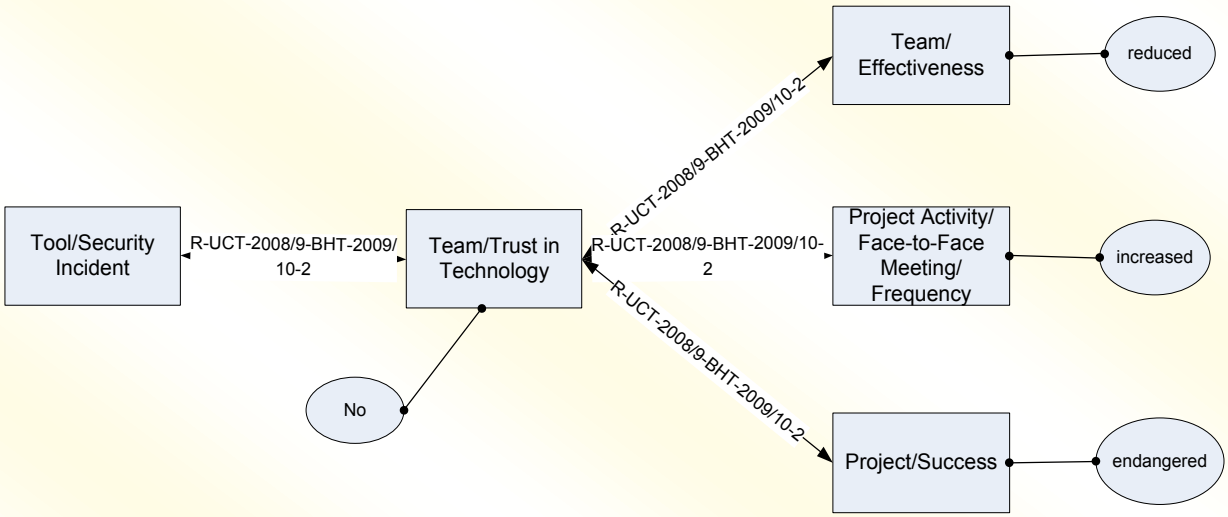
R-UCT-2008/9-BHT-2009/10-2:	A **SECURITY INCIDENT** reduces the **TRUST IN TECHNOLOGY** and in turn reduces the **TEAM'S EFFECTIVENESS** as it increases the number of **FACE-TO-FACE MEETINGS**, so endangering the **SUCCESS** of the **PROJECT**.

The above mentioned security incident of BHT-team-2010-3 and BHT-team-2010-3 had even more consequences. They encoded their protocols and finally decided to have more team meetings: (see Table 64, where there seems to be a slightly higher frequency of such meetings, but the significance is difficult to assess. Teams the sizes of 8 members often have sub-team meetings between some team members. The interview statements are more meaningful.) In addition, they manually exchanged documents and changed the platform. These activities show that the teams lost trust in technology. All these additional activities contributed to the reduction in effectiveness in the

project work and were one reason for these teams (BHT-Team-2010-3 and BHT-Team-2010-4) being less successful than the other teams. They performed on a low and medium level (see Table 63). The loss in effectiveness was also caused by their adaptation to the new circumstances being too slow, as shown by the following quotation:

> [Question: Why didn't your project team perform in the beginning?] Because most of our activities took place via the platform [Wikispaces], the platform was causing [security] problems, and in addition we seldom met face-to-face. We had problems at the start and then towards the project deadline we came together again to work face-to-face (BHT-Team-2010-4).

Figure 44 - Early Diagram shows the Possible Consequences of a SECURITY INCIDENT



R-UCT-2008/9-BHT-2009/10-3:	**TEAM MEMBERS' PREFERENCES** strongly influence the **SELECTION OF TOOLS** and in turn also influence the **EFFECTIVENESS** of the **TEAM** and **TEAM MEMBERS**.

Team members have their preferences as to which tool or tools they wish to use in their work. They will even disregard the project manager's preferred way of communication if they feel uncomfortable with it. This aspect of behaviour is supported by this quotation:

> [Question: Is social loafing supported by virtual team work?] [Team Member:] Not regarding the quality and the deliverables; but regarding the effort, it is difficult to estimate how much time somebody needed for the job. [Project Manager:] To avoid this, communication is still an important tool, via email as well as via phone. [Team

member:] The choice of the medium for the communication also depends on the person; I am, for example, somebody who prefers to write an email. Phoning always costs too much time. [Project manager:] Yes, this is right; from you I have always got written comments (BHT-Team-2010-1).

[Question: How did you follow up with the tasks and deadlines?] This depends on the people. Some prefer to work with the computer and others always need personal contact (BHT-Team-2010-2).

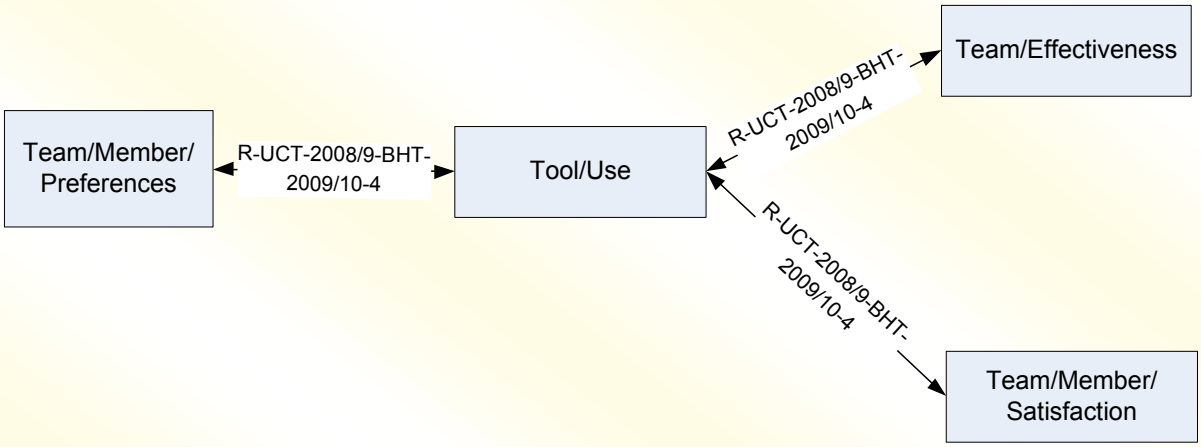
Figure 45 - Early Diagram on the Influence of the TEAM MEMBER'S PREFERENCES on the TOOL SELECTION

R-UCT-2008/9-BHT-2009/10-4:	The **TEAM MEMBERS' WORK PREFERENCES** and the way the **TEAMS** work together via a **TOOL** influence the **TEAM'S EFFECTIVENESS** and **TEAMS AND TEAM MEMBERS' SATISFACTION**.

If the team member's distributed work setting is based on his/her personal preferences, then this influences the member's perception of the used tools. It also will influence the effectiveness of the team and the team member's satisfaction.

[Question: How could it have affected performance, if you had not been distributed, but had worked together (in one place)?] [Team Member:] It would have impacted us both positively and negatively. On the one hand, because of the proximity we would have had less need for discussion because topics could be clarified immediately. On the other hand, this kind of [distributed] cooperation was very positive; as each team member could integrate the project work into his/her individual work. Everyone could work at times that suit him/her best, and when s/he was personally most effective. It also could tie in better with other tasks or the individual's daily work schedule. If we had had to come together, say, at fixed times in one place, we would not have been able to provide the same performance. [Another Team Member:] The virtual work gives a certain individual freedom. If you work together in one place, conflicts can more easily arise between team members. With the virtual team setting you keep at a distance from your team members and at the same time you are close to the project through the phone conferences (BHT-Team-2010-O-1).

Figure 46 - Early Diagram on the Influence of the TEAM MEMBERS' PREFERENCES on the USE of a TOOL



R-UCT-2008/9-BHT-2009/10-5:	**TEAMS** in which **TEAM MEMBERS** know each other well or are friends (high **TEAM COHESION**) and are used to working together via the **INTERNET,** seem to prefer to use leaner **TOOLS**.

It seems that teams and team members who regularly use different tools on the Internet prefer to use leaner media. In both teams of the online course the members preferred to use only Skype or Adobe Connect without the video functionality. The degree of friendship among team members and the fact that they had worked together before, led to team cohesion.

> [Question: How did you work with Adobe Connect?] [Team Member:] At the beginning of each meeting slides and the agenda were uploaded in Adobe Connect. Documents often were changed in real time mode. This worked perfectly. We mainly used the phone conferencing and not the video feature of the tool. Changes we often also transferred via email (BHT-Team-2010-O-2).

> [Question: Did you use Skype as a video conference or phone conference tool?] [Team Leader:] For phone conferencing; because Thomas, Rafael, and I already know each other quite well, so no problems came up just because we used a leaner communication medium. We essentially used course-scheduled project meetings for a face-to-face exchange. Otherwise, it was good enough to use the Skype conference feature and we did not need the visual component (BHT-Team-2010-O-1).

R-UCT-2008/9-BHT-2009/10-6:	The **USE** of asynchronous **TOOLS** might cause **MISUNDERSTANDINGS**, therefore, it is necessary to use those **TOOLS** together with synchronous **TOOLS** in the **PROJECT** or schedule regular **FACE-TO-FACE MEETINGS**.

Email can cause misunderstandings among the members during team work. It is, therefore, helpful to have a combination of synchronous communication tools (like Skype) and asynchronous communication tools, or to schedule regular face-to-face meetings to resolve/avoid misunderstandings. This recommendation is supported by the following quotation:

> [Question: Were there any misunderstandings caused by the use of a tool?] [Team Member:] Yes, we had a number of problems with emails. We found that out by ourselves, and therefore it was so important that we met in person or had these weekly virtual project meetings, where you are able to see what the team member's attitude is, and could ask the team members what they meant in a specific email. These misunderstandings only occurred with email and not with Skype (BHT-Team-2010-O-1).

R-UCT-2008/9-BHT-2009/10-7:	The necessity for immediate response makes the **TOOL/PHONE** the first medium of choice (**TEAM/TEAM RULES**).

There are specific reasons that call for the (cell)phone as the first medium with which people can expect to get hold of a team member. This is supported by the following quotation:

> [Team Member:] The phone we used only for task-related problems that urgently needed to be handled (BHT-Team-2010-O-1).

The analyses of the BHT-Teams-2010 revealed only a few more interesting results, caused by a security incident involving two teams. Further, the analyses of the BHT-2010 online teams offered the insight that teams do not necessarily go for richer media in communication, even when such media are not associated with additional costs and effort for the team members.

5.6 *Selective Coding in the Research Study*

5.6.1 Theoretical Saturation and Development of Theory

In total, about 200 concepts were identified and coded in the different open coding cycles in my research. I interviewed, questioned, and observed 28 project teams with, in total, 167 students/team members over a period of two and a half years in two different countries.

In the axial coding phases the interviews were iteratively analysed, taking into account previous memos, team characteristics (like size, skills, work, and social characteristics), the frequency with which a team used the different method of communication, collaboration, and project management tools, 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 and the dimensions of the categories) had already occurred in the open coding phase. As noted by Corbin & Strauss (2008).

> [O]pen coding and axial coding go hand in hand. The distinction between the two types of coding is 'artificial' and for explanatory purposes only . . .

During the analysis of the BHT 2010 teams, relatively few new concepts and relationships came up. During the coding, many references pointed to already existing concepts and relationships, except for one issue: two teams competing against each other had a security incident. They selected the same tool platform to share documents and protocols. Unfortunately there was no adequate user concept or data security concept on the platform, meaning that members of the one team could read the documents of the other team. This incident provided more insight into the use of tools, but, as remarked by Corbin and Strauss (2008), new variations can always be discovered. In reality, when collecting new data there will always be a new property or dimension to the one or the other category. Regarding the analysis in my research field, I reached what is called **theoretical saturation**: the last data gathering and analysis added little that was new to the conceptualization. The categories, concepts, properties, and relationships were sufficiently well developed.

Urquhart *et al.* (2010, p. 6) describe the **saturated** concepts and the next steps in building a grounded theory as follows:

> Constant comparison with previous data, categories, concepts and constructs is the key. Additional data are acquired using theoretical sampling until the existing

> categories are 'saturated' (i.e. there are no more instances of them in the data), and until no more new conceptual categories or relations emerge. The 'saturated' concepts are then reduced as much as possible to the relationships between core categories, which then form a 'grounded' theory. The grounded theory that is produced is thus firmly anchored in the data that led to its formulation.

At this point in my thesis it is important to emphasise again the difference between theoretical sampling and saturation compared to statistical sampling. While the first is done in order to discover categories, properties, and relationships, the latter serves to obtain accurate evidence on distributions of people among categories, to be used in description or verification (Glaser & Strauss, 1967).

The strength of the grounded theory methods is that they are grounded in the data. The main sources of data were the interviews, conducted in the different cycles. In the immediately preceding sections of this chapter I proposed a number of categories with sub-categories, concepts, properties and dimensions. I also drafted a number of relationships, illustrated them with figures, and supported them with selected interview quotations. In the different sections in this chapter I have tried not to repeat myself too often. On the other hand, I wished to clarify my procedures and my chain of evidence (Urquhart, 2007). Further, it was sometimes necessary to revisit a relationship from the previous cycle and back it up with additional quotations from the recent cycle. Now in the last cycle, I will construct my theory. Consequently I will revisit my relationships, figures, and memos, all of which I stored in the tool (inVivo) and compare them again with the data I collected in my interviews and observations during the different cycles. In the following section I will describe the generated theory. I therefore have again to add quotations to support the different statements of my theory. Accordingly, I will have to repeat different quotations from this chapter because I wish to elucidate the chain of evidence, as is recommended by Urquhart (2007) in her guidelines:

> **Guideline 5: Clarity of procedures and chain of evidence**
>
> One of the strengths of GTM is its ability to provide a chain of evidence. For every aspect of the generated theory discussed, there are many examples in the data. Illustrating the theory with the data contributes greatly to the plausibility of the research account, and also allows readers to assess for themselves the researchers claims (Charmaz, 2006). (Urquhart, 2007, p. 354)

5.6.2 Summarized Main Categories

In the axial coding process the codes were grouped into four main categories: PROJECT, TEAM, TOOL, and INTERNET. These concepts, and sub-categories related to the main categories, helped 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. The following tables summarize the categories, sub-categories, concepts/properties, and dimensions identified in the different data collection and analysis cycles.

Table 69 - Summarized Category PROJECT

Category	Concept/Property	Dimensions
Project	Complexity	
Project	Communication Intensity	High, Medium, Low
Project	Documentation	
Project	Documents – Minutes	
Project	Duration	
Project	Face-to-Face Meetings	Never, Daily, Two to three times a week, At least once a week, At least once a month
Project	Limiting Factors	
Project	Media Choice	
Project	Planning	
Project	Phase	
Project	Quality	Low, Medium, High
Project	Requirements	
Project	Responsibilities	
Project	Responsible Person	
Project	Size	Small, Medium, Large
Project	Speed	
Project	Stage	
Project	Success	
Project/Project Activity	Code Exchange	
Project/Project Activity	Conflict Solving	
Project/Project Activity	Discussion of Critical Issues	
Project/Project Activity	Document Exchange	

Category	Concept/Property	Dimensions
Project/Project Activity	Face-To-Face Meetings	Formal, Informal
Project/Project Activity	Face-to-Face Working	
Project/Project Activity	Information Exchange	
Project/Project Activity	Knowledge Exchange	
Project/Project Activity	Learning	
Project/Project Activity	Problem Solving	
Project/Project Activity	Scheduling of Face-to-Face Meetings	
Project/Project Activity	Set-Up a Team Contract	
Project/Task Management	Deadline	
Project/Task Management	Deliverables	
Project/Task Management	Non-Distributable work item	
Project/Task Management	Task Assignment	
Project/Task Management	Task Complexity	Low, Medium, High
Project/Task Management	Task Planning	Ad-Hoc, Advanced
Project/Task Management	Task Status	
Project/Task Management	Task Tracking	Transparent, Non-Transparent
Project/Task Management	Task Transparency	
Project/Task Management	Time Sheet Management	
Project/Task Management	Work Break Down Structure	

Table 70 - Summarized Category TEAM and Sub-Category TEAM MEMBER

Category	Concept/Property	Dimensions
Team	Common Ground	No, Partly, Yes
Team	Communication Level	Low, Medium, High
Team	Cultural Diversity	Low, Medium, High
Team	Effectiveness	Reduced, Increased, Normal
Team	Expertise	Low, Medium, High
Team	Friendship	No, Partly, Yes
Team	Gender Mix	All Male, All Female, Mixed
Team	Performance Level	Low, Medium, High
Team	Size	Small - Large
Team	Social Cohesion	Low, Medium, High

Category	Concept/Property	Dimensions
Team	Social Engagement	Low, Medium, High
Team	Spread of Technological Skills	
Team	Sub Teams	
Team	Task Awareness	Poor, Average, Good
Team	Task Management	Poor, Average, Good
Team	Team Building	
Team	Team Contracts	
Team	Team Goal	
Team	Team Rules	
Team	Trust Level	Low, Medium, High
Team	Trust in Technology	
Team	Virtual Team Work Experience	Yes, No
Team	Work Setting	Face-To-Face, Distributed, Home
Team/Team Member	Distance to Work	Short, Medium, Long
Team/Team Member	Geographical Distance between Team Members	Short, Medium, Long
Team/Team Member	Effectiveness	
Team/Team Member	Satisfaction	
Team/Team Member	Technological Preferences	
Team/Team Member	Technological Skills	Low, Medium, High
Team/Team Member	Work Preference	Home, Office, Face-To-Face

Table 71 - Summarized Category TOOL

Category	Concept/Property	Dimensions
Tool	Access	No, Limited. Unlimited
Tool	Adaption	
Tool	Availability	No, Limited, Unlimited
Tool	Selection	
Tool	Combination	
Tool	Communication	Synchronous, Asynchronous
Tool	Integration	
Tool	Internet-Based	No, Yes
Tool	Keeping the Team on Board	
Tool	Licence	

Category	Concept/Property	Dimensions
Tool	Security Incident	
Tool	Sharing	
Tool	Technical Infrastructure	
Tool	Training	
Tool	Use	Never, Daily, Two to three times a week, At least once a week, At least once a month
Tool	User Account Management	Yes, No
Tool	Effort	
Tool	Task Tracking System	
Tool	Central Platform	Yes, No
Tool	Change	Yes, No
Tool	Document Sharing	
Tool/Acceptance	Frustration	Low, Medium, High
Tool/Acceptance	Maturity level	Low, Medium, High
Tool/Acceptance	Motivation	Low, Medium, High
Tool/Acceptance	Personal Preferences	
Tool/Acceptance	Professionalism	
Tool/Acceptance	Reliability	Low, Medium, High
Tool/Acceptance	Response Time	
Tool/Acceptance	Security Features	
Tool/Acceptance	Self-Explicatory	Yes, No
Tool/Acceptance	Speed	
Tool/Acceptance	User Management	
Tool/Acceptance	Usability	Low, Medium, High
Tool/ Chat-Tool		
Tool/Email		
Tool/MS Project		
Tool/Phone		
Tool/SMS		
Tool/Version Control		
Tool/Voice of IP		
Tool/Vula		

Category	Concept/Property	Dimensions
Tool/ Google Docs		
Tool/ Google Calendar		
Tool/ Google Groups		
Tool/ Shared Document Handling		
Tool/ Web-based Task Management		

All specific tools (Chat-tool, Email, Forum, MS Project, Phone, SMS, Version Control, Voice over IP, and Vula) have the following properties in common:

Table 72 - Summarized Sub-Category SPECIFIC TOOL

Property	Dimension
Communication related Usage	Yes, No
Information, Data, and Source Code Sharing Related Usage	Yes, No
Project Management Related Usage	Yes, No
Shared Document Handling	Yes, No
Usage Frequency	Never, Daily, Two to three times a week, At least once a week, At least once a month
Wiki	Yes, No

Table 73 - Summarized Category INTERNET

Category	Concept/Property	Dimensions
Internet	Availability	No, Limited, Unlimited
Internet	Bandwidth	Limited, Unlimited
Internet	Cost of Access	
Internet	Download Quota	
Internet	Mobile Access	

5.6.3 Matrices on Categories and Relationships in Theory building

Corbin and Strauss (2008) suggested techniques such as writing a story line, drawing diagrams, reviewing, and sorting through memos for integrating the main categories into a theory following the process model. Even though Urquhart (2001) critically discussed the limitations of the coding paradigm - as it is proposed by Strauss and Corbin (1990) - she emphasised on its use in

drawing distinctions in the data. As proposed by Urquhart (2001) I used the coding paradigm in the first step to classify the categories and relationships.

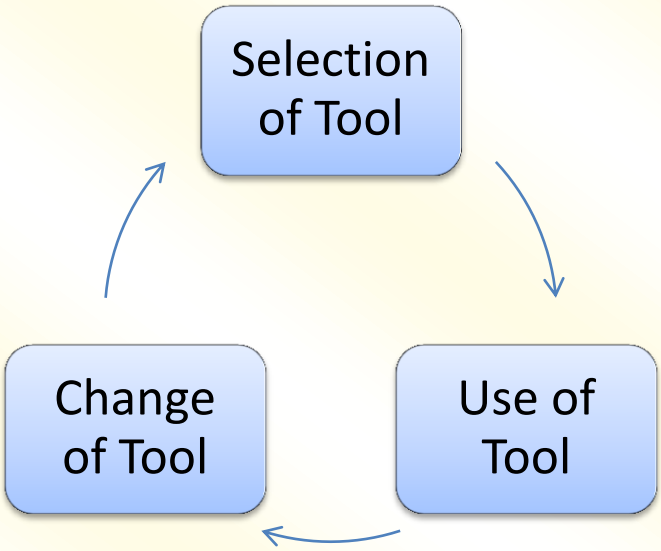
Table 74 shows the three interdependent steps: selection, use and change that are relevant for web-based tools in the context of Project, Team, and Team Member. Describing my theory in those three steps was inspired by Orlikowski's (1993) approach to describe the process of organizational change around CASE tools for incremental change in one diagram and for radical change in a second diagram. She explained both phenomena in different contexts. Analysing the different relationships (see Table 74) for the three actions highlights the necessity to consider Project, Team and Team Member´s context in the emergent theory.

Table 74 - Relationships over the three Interdependent Actions: Selection, Use and Change

Categories & Subcategories/ Activities	**Project**	**Team**	**Team Member**
Selection	R-UCT-2008/9-4 R-UCT-2008/9-7 R-UCT-2008/9-11 R-UCT-2008/9-16 R-UCT-2008/9-BHT-2009-2 R-UCT-2008/9-BHT-2009-4 R-UCT-2008/9-BHT-2009-10 R-UCT-2008/9-BHT-2009/10-6	R-UCT-2008-3 R-UCT-2008/9-8 R-UCT-2008/9-17 R-UCT-2008/9-18 R-UCT-2008/9-20 R-UCT-2008/9-BHT-2009-1 R-UCT-2008/9-BHT-2009-2 R-UCT-2008/9-BHT-2009-5 R-UCT-2008/9-BHT-2009-6 R-UCT-2008/9-BHT-2009-8 R-UCT-2008/9-BHT-2009/10-1 R-UCT-2008/9-BHT-2009/10-7	R-UCT-2008/9-17 R-UCT-2008/9-BHT-2009/10-3 R-UCT-2008/9-BHT-2009/10-4 R-UCT-2008/9-BHT-2009/10-5
Use	R-UCT-2008-2 R-UCT-2008-4 R-UCT-2008/9-6 R-UCT-2008/9-BHT-2009-5	R-UCT-2008-1 R-UCT-2008-5 R-UCT-2008/9-2 R-UCT-2008/9-3 R-UCT-2008/9-5 R-UCT-2008/9-9 R-UCT-2008/9-10 R-UCT-2008/9-12 R-UCT-2008/9-14 R-UCT-2008/9-15 R-UCT-2008/9-21 R-UCT-2008/9-BHT-2009-6 R-UCT-2008/9-BHT-2009-7 R-UCT-2008/9-BHT-2009-9 R-UCT-2008/9-BHT-2009-11	R-UCT-2008/9-1 R-UCT-2008/9-BHT-2009-13 R-UCT-2008/9-BHT-2009-14 R-UCT-2008/9-BHT-2009/10-5
Change	R-UCT-2008/9-19 R-UCT-2008/9-BHT-2009-3 R-UCT-2008/9-BHT-2009/10-2	R-UCT-2008/9-13 R-UCT-2008/9-BHT-2009-3 R-UCT-2008/9-BHT-2009-1 R-UCT-2008/9-BHT-2009-9 R-UCT-2008/9-BHT-2009-11 R-UCT-2008/9-BHT-2009-13 R-UCT-2008/9-BHT-2009/10-1 R-UCT-2008/9-BHT-2009/10-2	R-UCT-2008/9-BHT-2009/10-4

The following Figure 47 shows the process of selection, use and change as it emerged from the abstraction of categories and relationships applying the coding paradigm.

Figure 47 - The Selection-Use-Change Cycle for Internet-based Tool in Projects



5.6.3.1 **Selection of a Tool/Tool Combination**

The first step is the **Selection of a Tool/Tool Combination** to support the team with a certain degree of virtuality, in their specific project.

In this context, selection means deciding to use a tool or tool combination for the project, a project activity, or a project management activity. My theory does not highlight user requirements for the development or selection of a specific tool.

The relationships that influence this process are derived from the different propositions arising out of the different data cycles. Further relationships show the context of this selection process. Finally, relationships show the consequences of the selection and might cause further activities. In Table 75 the relationships and the related concepts/categories are listed.

Table 75 - Relationships influencing the Selection of a Tool/Tool Combination in Virtual Teams

	Tool/Combination	Project/Face-to-Face meetings	Team/Effectiveness	Team/Team Member/Satisfaction	Tool/ Selection
Internet/Availability	R-UCT-2008-5				R-UCT-2008/9-18
Internet/Bandwidth	R-UCT-2008-3				R-UCT-2008/9-18
Tool/Central Platform			R-UCT-2008/9-BHT-2009-8		
Project/Face-To-Face Meetings					R-UCT-2008/9-4
Project/Phase			R-UCT-2008/9-15 R-UCT-2008/9-BHT-2009-2		R-UCT-2008/9-15 R-UCT-2008/9-17
Project/Stage					R-UCT-2008/9-5
Team/Team Member/Work Preferences					R-UCT-2008/9-7
Team/Geographical Distance					R-UCT-2008/9-17
Team/Leadership(-concept)		R-UCT-2008/9-BHT-2009-10			R-UCT-2008/9-BHT-2009-9
Team/Social Cohesion					R-UCT-2008/9-9 R-UCT-2008/9-17
Project/Project Activity	R-UCT-2008-3		R-UCT-2008/9-15		R-UCT-2008-2 R-UCT-2008/9-5 R-UCT-2008/9-7 R-UCT-2008/9-17
Project/ Task Management	R-UCT-2008/9-18				R-UCT-2008/9-18

	Tool/Combination	Project/Face-to-Face meetings	Team/Effectiveness	Team/Team Member/Satisfaction	Tool/ Selection
Tool/Acceptance/Security Features					R-UCT-2008/9-BHT-2009/10-1
Team/Team Members' Preferences			R-UCT-2008/9-BHT-2009/10-3	R-UCT-2008/9-BHT-2009/10-4	
Team/Size					R-UCT-2008/9-BHT-2009-1
Virtual Team Work Experience					R-UCT-2008/9-BHT-2009/10-5

5.6.3.2 **Use of the Tool/Tool combination**

The second action is the **Use of the Tool/Tool combination** in the project. There are causal conditions influencing the use of a tool in a specific context. The context of Team, Project, and Team Member has consequences for Effectiveness, Trust, Team cohesion, Satisfaction, and/or Success. Intervening conditions influence the use of the tool or tool combination and might have consequences for Effectiveness, Trust, Satisfaction, and/or Success. These intervening conditions might also influence the use of a tool or even make a change of tool necessary. The described relationships are listed in Table 76.

Table 76 - Conditions and Consequences for the Use of a Tool/Tool Combination in Virtual Teams

	Trust level	Performance Level	Training	Team Cohesion	Learning	Team member Satisfaction	Work Setting	Communication Intensity	Effectiveness	Use of Tools
Limited Internet Availability		R-UCT-2008-5			R-UCT-2008/9-2 R-UCT-2008/9-10				R-UCT-2008-4	R-UCT-2008-3 R-UCT-2008/9-19
Limited Internet Bandwidth		R-UCT-2008-5			R-UCT-2008/9-2				R-UCT-2008-4	R-UCT-2008-3 R-UCT-2008/9-19
Team/Work Setting								R-UCT-2008/9-4	R-UCT-2008/9-5	R-UCT-2008/9-7
Face-To-Face Meetings	R-UCT-2008-1						R-UCT-2008/9-BHT-2009-4			
Project Stage										R-UCT-2008/9-6
Team Members ' Preferences						R-UCT-2008/9-BHT-2009/10-4			R-UCT-2008/9-BHT-2009/10-4	
Project/Task Management	R-UCT-2008/9-BHT-2009-7						R-UCT-2008/9-7		R-UCT-2008-2 R-UCT-2008/9-5	R-UCT-2008-2 R-UCT-2008/9-6 R-UCT 2008/9-11
Shared Document Handling									R-UCT-2008/9-BHT-	R-UCT-2008/9-BHT-2009-6

									2009-5	
Document Sharing									R-UCT-2008/9-BHT-2009-6	R-UCT-2008/9-BHT-2009-6
Information Exchange	R-UCT-2008/9-BHT-2009-7									
Trust level		R-UCT-2008/9-1					R-UCT-2008/9--21			
Project Phase								R-UCT-2008/9-3		R-UCT-2008/9-18
Face-to Face-Meeting	R-UCT-2008/9--20							R-UCT-2008/9-4		
Task Management	R-UCT-2008/9-BHT-2009-7					R-UCT-2008/9-BHT-2009-7	R-UCT-2008/9-8	R-UCT-2008/9-BHT-2009-12		R-UCT-2008/9-18 R-UCT-2008/9-19
Size							R-UCT-2008/9-8		R-UCT-2008/9-BHT-2009-1	
Central Platform									R-UCT-2008/9-9 R-UCT-2008/9-BHT-2009-8	
Usability									R-UCT-2008/9-14 R-UCT-2008/9-BHT-2009-1	R-UCT-2008/9-12 R-UCT-2008/9-BHT-2009-9

User friendliness			R-UCT-2008/9-BHT-2009-13							R-UCT-2008/9-BHT-2009-9
Maturity									R-UCT-2008/9-BHT-2009-11	
Training										R-UCT-2008/9-13
Integration of Functionality				R-UCT-2008/9-15					R-UCT-2008/9-14 R-UCT-2008/9-BHT-2009-1	
Security Incident									R-UCT-2008/9-BHT-2009/10-1	
Friendship										R-UCT-2008/9-BHT-2009/10-5
Asynchronous Tool										R-UCT-2008/9-BHT-2009/10-6

5.6.3.3 **Change of a Tool/Tool Combination**

The above mentioned **Change of a Tool/Tool Combination** is the third action that is important for virtual project teams. Specific conditions can lead to the change of a tool. Depending on the PROJECT, TEAM, and TEAM MEMBER context, this will have consequences for EFFECTIVENESS, SUCCESS, TRUST, and SATISFACTION. The relevant relationships are shown in Table 77.

Table 77 - Conditions and Consequences for the Change of a Tool/Tool Combination in Virtual Teams

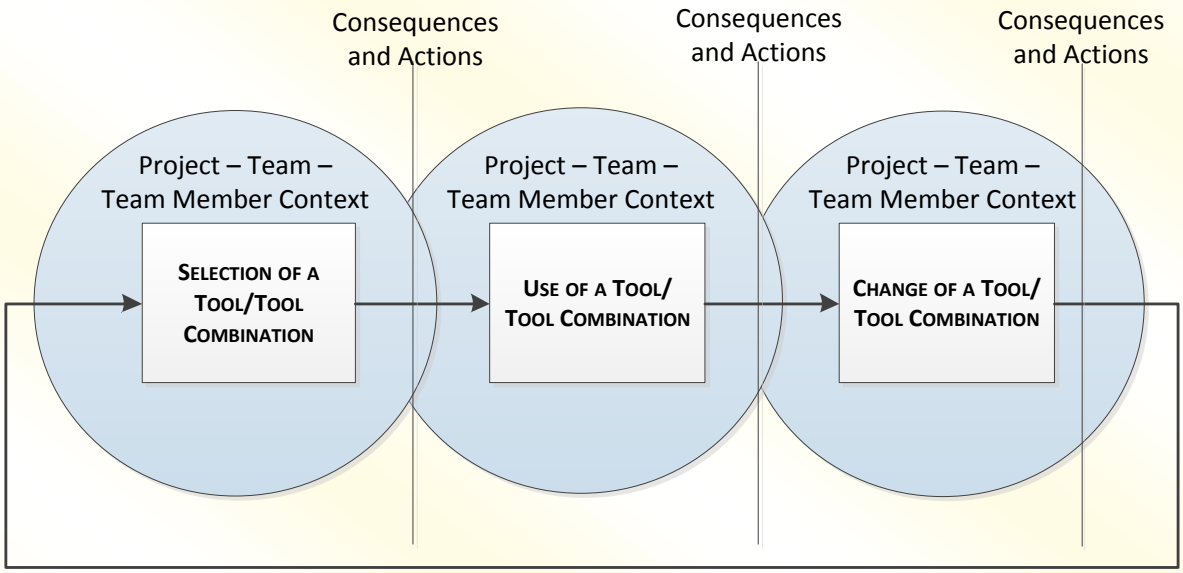
	Trust in Technology	Face-To-Face Meetings	Effectiveness	Success	Change of Tool
Internet Availability					
Internet Access					
Security Incident	R-UCT-2008/9-BHT-2009/10-2	R-UCT-2008/9-BHT-2009/10-2	R-UCT-2008/9-BHT-2009/10-1	R-UCT-2008/9-BHT-2009/10-2	R-UCT-2008/9-BHT-2009/10-1
Project Phase			R-UCT-2008/9-BHT-2009-3		R-UCT-2008/9-BHT-2009-3
Usability					R-UCT-2008/9-BHT-2009-9

6. Theory on the Selection, Use and Change of Tools in Virtual Teams

After being informed by 47 complex propositions including over 100 different relationships and related memos, I again analysed the data (interviews, surveys, observations and course results) and reorganized the concepts following the paradigm model in order to draw up my theory.

The use of information technology in project teams is essential for a team to perform in a distributed work setting (e.g., Lipnack & Stamps (2000), and Thomas & Bostrom (2010)). The application of Internet/web-based tools in such a setting is a process consisting of a number of actions. The three related main activities described in my theory are the **selection of a tool or tool combination**, the subsequent **use** of it, and the occasional occurrence of **change of a tool/tool combination** (see Figure 48).

Figure 48 - Process of Selection-Use-Change of a Tool/Tool Combination



The three actions occur over a period of time, starting at the beginning of the project and involving other activities such as training on the tool and adaptation of the tool. The complex context--including the team, the team members and the nature of the project--influences these three main activities. The theory is explained in detail for each activity. The potential consequences in terms of teams' effectiveness, team members' satisfaction, and project success are outlined for the different causal and intervening conditions. In addition, the actions and strategies in response to the conditions are defined.

Regarding the process and its complex contextual setting, Corbin and Strauss (2008, p. 97) state:

> Structure (context) and process are related because persons act in response to something or something being the issues, problems, situations, goals and events occurring in their lives. The relationship between structure and process is complex, leading to infinite variations in intensity, type, and timing of action/interaction/ emotional responses.

The following sections describe and underpin the emergent theory. They demonstrate the extent to which the theory both explains the selection of tools in different project contexts and shows the consequences of the tools usage. It also shows the circumstances requiring a change in the tool and the consequences of such a change for team, team member, and project. The change phase itself describes a period in the project following team's abandoning a tool and before a new one is selected.

I developed 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. This is in line with Gregor (2006) proposing that a theory in Information Systems can serve for explanation. Urquhart *et al.* (2010) pointed out that the grounded theory approach is capable of generating such a theory using these categories.

Figure 49 gives an overview of the resulting categories, sub-categories, and concepts relevant in the subsequently described theory.

In the interviews, the memos, and the survey data, the **TEAM** itself is a strong category incorporating many other emerging concepts. **SOCIAL COHESION, TRUST LEVEL, WORK SETTING,** and the **TEAM'S EFFECTIVENESS** are among other important concepts within the team's use of tools in their project work, as pointed out in the following quotation from UCT-Team-2009-1:

> [Question: What would have happened if we would have split up the team to work in Cape Town and Johannesburg (with the customer)?] Could we have kept using Vula? [Yes!] Then it would have worked out fine. It would have taken a lot more time by the end. [Question: Could you rely on each other also with the task management right from the beginning?] Yes. I was very confident working with my team mates and girls.

The most important sub-category in the **TEAM** is the individual **MEMBER,** with concepts like **PREFERENCES**, **SKILLS**, and **SATISFACTION** playing vital roles for my research field.

Figure 49 - Overview of the Main Categories with Concepts

Project

- **Activity**
  - Conflict Solving
  - Code Exchange
  - Documentation
  - Document Exchange
  - Face-To-Face-Meeting
  - Face-to-Face-Working
  - Knowledge Exchange
  - Learning
  - Problem Solving
  - Scheduling of Face-To-Face-Meeting
- Communication Intensity
- Deadline
- Phase
- Project Task
- Stage
- Success
- **Task Management**
  - Deliverables
  - Task Assignment
  - Task Complexity
  - Task Planning
  - Task Tracking
  - Task Transparency

Tools

- **Acceptance**
  - Availability
  - Maturity
  - Reliability
  - Security
  - Usability
- Central Platform
- Change
- **Chat**
- **Email**
- **Forum**
- Integration of Functionality
- Keeping the Team on Board
- **MS Project**
- **Phone**
- Selection
- Security Features
- Security Incident
- Sharing
- **SMS**
- Technical Problems
- Training
- User Management
- Use
- **Version Control**
- **Voice over IP**
- **Vula**
- **Web-based Task Tracking System**

Properties of the different tools (above in **bold**)

- Communication related Usage
- Information, Data and Source Code Sharing Related Usage
- Project Management Related Usage
- Frequency

Team

- Effectiveness
- Friendship between Team Members
- Leadership Concept
- **Member**
  - Geographical Distance between Members
  - Geographical Distance to Work
  - Preferences
  - Satisfaction
  - Technological Skills
  - Work Preferences
- Organisational Expertise
- Performance Level
- Social Cohesion
- Size
- Spread of Technological Skills
- Technical Expertise
- Task Awareness
- Team Rules
- Trust Level
- Trust in Technology
- Virtuality
- Virtual Teamwork Experience
- Work Setting

Internet

- Availability
- Bandwidth
- Cost of Access
- Download Quota
- Mobil Access

In the category **PROJECT**, many interviewees mentioned the importance of the different **ACTIVITIES** in the **PROJECT,** including **TASK MANAGEMENT**, in response to the research questions. For example, the relationship between the complexity of the **PROJECT TASK** and **FACE-TO-FACE MEETINGS** is 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.

This refers to complexity in the **PROJECT TASK** as well as in the single tasks derived from a project's work breakdown structure. **TASK MANAGEMENT** and **ACTIVITY** represent sub-categories in the main category **PROJECT**. The sub-category **Task Management** covers different steps taken during the

planning process of the project, such as **TASK PLANNING, TASK ASSIGNMENT,** and **TASK TRACKING**. For the **TEAM** and **TEAM MEMBER SATISFACTION,** of special importance are **TASK TRACKING** and **TASK TRANSPARENCY.**

Most of the sub-categories appear in the main category **TOOL**, and help to specify and explain tool specifics, use, and usage frequencies as well as the different functionalities needed by the teams for different project activities. Under the sub-category **ACCEPTANCE,** concepts are summarized that reflect those elements that the teams or team members think are important to work effectively with a tool. This covers factors such as **USABILITY,** as well as **SECURITY FEATURES** and **USER MANAGEMENT.**

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).

6.1 *Selection of a Tool/Tool Combination*

6.1.1 Description of the Phenomenon "Selection of a Tool/Tool Combination"

At the beginning of the project a team working on a project task in a distributed work setting has to select a tool or tool combination to support them in project management activities. Selection in this context means deciding to use a specific tool or tool combination either for the project, or for a specific project activity, or for a project management activity. This selection in the process of "selection, use, and change" depends on a number of conditions, is influenced by a complex context, and might result in different tool and tool combinations as demonstrated by the following three quotations:

> [Team leader:] From my point of view, the most important elements were email so that we can communicate and work time-independently, a shared file storage and a way to interconnect via phone (BHT-Team-2010-O-1).

> We used Vula extensively and we communicated with each user; we used our cellphones a lot also to phone with each other and to send SMSs (UCT-2009-6).

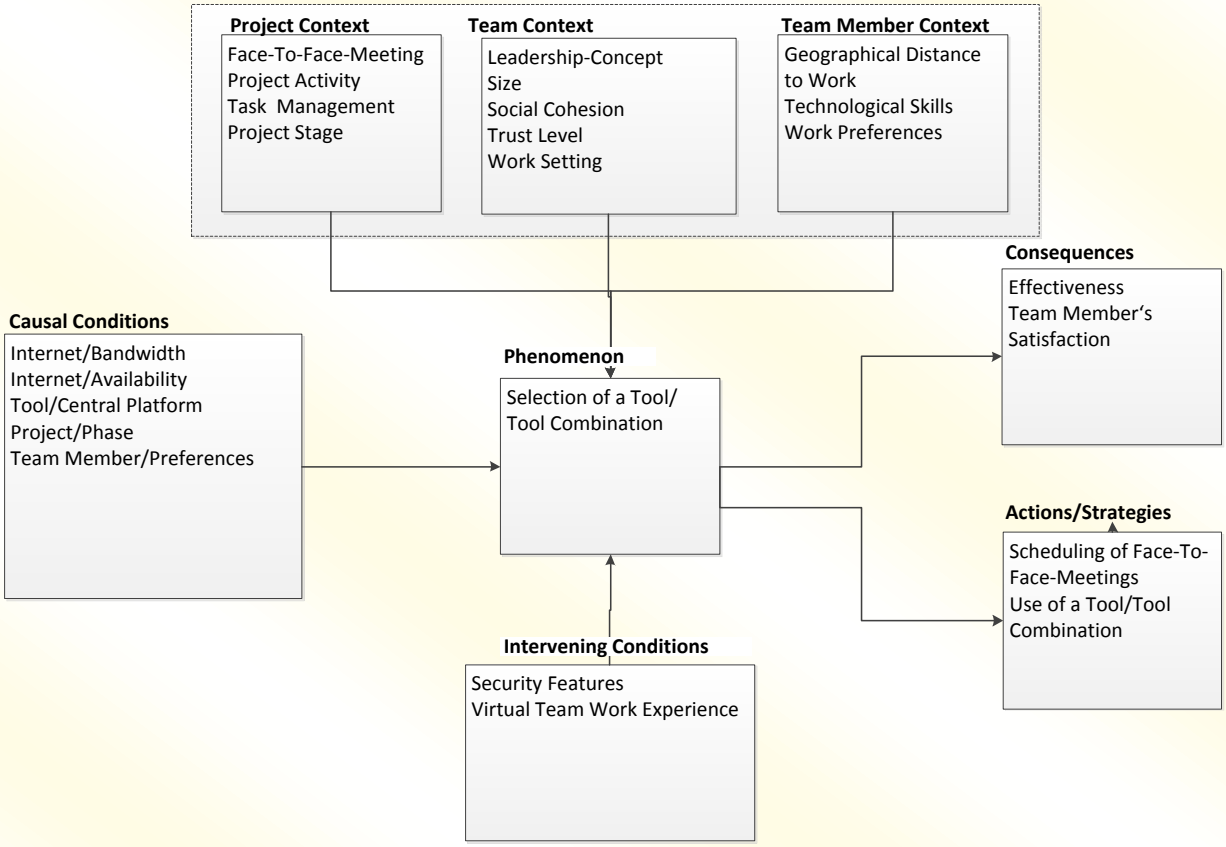
> [Team leader:] First of all we used Google Docs that was not so successful, but then we used the web-based task tracking system called Projectplace. This was very helpful. We accomplished everything with this tool. At the start I wrote a few more emails and we often phoned each other (BHT-team-2010-2).

Three teams used three different variations of tools to support their project work. In the following section I will explain the conditions relevant to the selection of tools and the context influencing the selection. In addition, I will specify the consequences and actions that can be deduced (see Figure 50). Further, my research study shows that email is fundamental in project work. The different surveys provide proof that most of the teams from UCT and BHT used email on a daily basis. In the actual project work, it is not a matter of whether or not to use it, but how to use email effectively (e.g., by reducing the number of emails), as pointed out by the following quotation:

> Email was all-important, in particular to transfer the reports and minutes in the team (BHT-Team-2009-5).

This task list and the work results from the different team members were uploaded into Google Groups. By this means we avoided being flooded with emails (BHT-Team-2009-3).

Figure 50 - Conditions, Context and Consequences in the Selection of a Tool/Tool Combination



6.1.2 Causal Conditions and resulting Consequences/Actions for the Selection of Tool/Tool Combinations

There are a number of causal conditions influencing the selection of tools that have consequences in terms on effectiveness and the process of using the tool or tool combination, as shown in Figure 50.

The conditions that exert a great influence on the choice of tools relate naturally to **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH**. The role of the Internet as a conditional factor is most apparent where **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH** are limited. Teams choose a specific **TOOL** or **TOOL COMBINATION** in order to overcome limited **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH** as such

limitations are likely to reduce the **EFFECTIVENESS** of the certain **PROJECT ACTIVITIES** and **TASK MANAGEMENT** activities.

This restriction especially seems to prohibit the use of web-based 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.

Another quotation demonstrates this causal condition for the BHT teams, who generally had excellent access to the Internet due to the good infrastructure in Germany:

> Ocan had only limited access to the Internet; therefore we used email and phone (BHT-Team-2009-4).

In one of the teams, a single team member had limited access to the Internet and this therefore restricted the team in its selection of tools to support their project work; this in turn influenced the team's effectiveness.

The importance of the **CENTRAL PLATFORM**, as a virtual place for communication, information sharing, and task management only emerged when I interviewed the BHT-Teams. At the beginning of the project there was no central tool prescribed for these teams.. This contrasted with the situation at UCT where Vula that was used by all teams to support their project work. Therefore, most of the BHT teams selected a tool that had a central role in their exchange of information, data, minutes or tasks and their discussion of project relevant issues. Those that failed to do so often had a lower performance level.

The **TEAM'S SELECTION** of a **CENTRAL PLATFORM** influences the **TEAM'S EFFECTIVENESS**.

The following quotations underpin this relationship:

> What we up to now had not experienced in project work, was that not everybody would ask: 'Have you already done this?' or 'Is this already finished?' The program [myinterval] provided a nice transparency which made these questions unnecessary. Everybody knew what he had to do. This is my task and this is my deadline. At last the tool we were using also contributed to our good results (BHT-Team-2009-1).

The central platform for all UCT Teams was Vula. The following words outline its central role:

> We used Vula a lot. It is so easy. We all log on. There is a chat room for us. We leave messages for each other. We can post an announcement if there is something really important for us. We upload all the documents of the project and all the resources that are important for the project. It is reliable in most of the time. We are used to the tool. We used the chat real-time. We wrote tens of thousands of messages. Me and Brad we used it a lot. If there is something to discuss that takes a long time to talk about, we chatted about it (UCT-Team-2009-1).

Another causal condition is related to the **PROJECT PHASE**: The **TEAM'S EFFECTIVENESS** is strongly influenced by the **TOOL SELECTION** taking place at the beginning of the project (**PROJECT PHASE**) to support the different **PROJECT ACTIVITIES** and **TASK MANAGEMENT** activities.

This relationship suggests that the team's effectiveness depends on the 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 honours 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).

> [Question: How would you rate eGroupware[38] for the project planning and task tracking?] [Team member:] If we had had this tool from the start, then it would have helped the project a lot. We would have needed an introduction phase to the tool and then additional time to adjust the tool to the project requirements (BHT-Team-2010-O-1).

TEAM MEMBERS PREFERENCES include the way he or she likes to work (from distributed or face-to-face) as well his preferences in technology. **TEAM MEMBERS PREFERENCES** have a strong impact on

[38] eGroupware is a *web-based task tracking system*, a specific type of issue tracking system that manages and maintains a list of tasks as needed by the project.

their **SATISFACTION** and the **TEAM'S SATISFACTION.** It also influences the **TEAM'S EFFECTIVENESS**. The following quotation supports this claim:

> [Team member:] The choice of the medium for the communication also depends on the person; I am, for example, somebody who prefers to write an email. Phoning always costs too much time. [Project manager:] Yes, this is right; from you I have always got written comments (BHT-Team-2010-1).

The following quotation demonstrates the influence on **TEAM MEMBER'S SATISFACTION** and on the **TEAM'S EFFECTIVENESS**.

> [Team Member:] If we had had to come together, say, at fixed times in one place, we would not have been able to provide the same performance. [Another Team member:] The virtual work gives a certain individual freedom. If you work together in one place, conflicts can more easily arise between team members. With the virtual team setting you keep at a distance from your team members and at the same time you are close to the project through the phone conferences (BHT-Team-2010-O-1).

If **TEAM MEMBERS** have a strong **PREFERENCE** for working face-to-face, this also influences the **SELECTION OF THE TOOL**. Therefore the **TEAM MEMBERS PREFERENCES** relate to the number of scheduled **FACE-TO-FACE MEETINGS**.

6.1.3 Influence of the Project Context on the Selection of Tool/Tool Combination

One of the most important issues in virtual team work is the **FACE-TO-FACE MEETING**, starting from the frequency of meetings up to their scheduling to make sure that everyone can participate. The possibility for **FACE-TO-FACE MEETINGS** influences the **SELECTION OF TOOLS** and the **TOOL COMBINATION**. This also relates to the **WORK SETTING** of the **TEAM**. The BHT 2010 online teams knew that they had fewer opportunities to meet face-to-face and therefore decided on tools that enabled video- and phone-conferences.

TOOLS are selected to support different **TASK MANAGEMENT** activities. In various **PROJECT PHASES** of the **TASK MANAGEMENT,** different **TOOLS** are preferred by the **TEAMS.** The following quotations give examples of tool selections for various **TASK MANAGEMENT** activities (**TASK PLANNING, TASK ASSIGNMENT, AND TASK TRACKING**):

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

> The allocation and assignment of the tasks was done via the minutes and emails (BHT-Team-2009-6).
>
> A wiki for the task management [task tracking] but mostly a paper-based list with the items that need to be done to visualize the progress and what needs to be done (UCT-Team-2009-5).
>
> 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).

TOOLS are selected to support different **PROJECT ACTIVITIES,** such selection preferably to take place at the beginning of the **PROJECT**. The different **PROJECT ACTIVITIES** are related either to communication or to sharing activities. **TEAMS** want to share information, documents or code.

The **PROJECT STAGE** is normally characterized by **COMMUNICATION INTENSITY**. Such **INTENSITY** varies according to the different **STAGES** of a **PROJECT**. If the **COMMUNICATION INTENSITY** in the **PROJECT** is high, then **FACE-TO-FACE MEETINGS** are more appropriate than a distributed **WORK SETTING**. The distributed **WORK SETTING** is only possible with the **SELECTION OF A TOOL/TOOL COMBINATION** that supports the different **PROJECT ACTIVITIES** and **TASK MANAGEMENT** activities.

There are certain time periods in a project where the need for intensive communication is high and other times when less communication is needed to perform a project task in the project. There seems to be a difference between stage and phase, with stages applying to a certain time period in a project when either more or less communication is necessary. Sometimes a stage can take place during a certain phase of the project, such as the start or end phase of a project. This also might depend on how much the team members know each other (see section 6.1.4).

6.1.4 Influence of the Team Context on the Selection of Tool/Tool Combination

TOOL SELECTION is influenced by the **TEAM'S SOCIAL COHESION** and the **GEOGRAPHICAL DISTANCE** of the **TEAM MEMBERS** from home[39] and work. This relationship is well illustrated by the specific situation

[39] Even though this is a specific student situation the distance between home and workplace is relevant for the tool selection.

of UCT-Team-2009-4, who preferred to work together face-to-face because they lived close to each other and in addition had good team cohesion:

> We didn't use Virtual server. We didn't need it. We live a few minutes from each other. Take a flash drive and that's it.

The next quotation shows the importance of the cohesion of the team in the selection and use of a tool. The UCT-Team-2009-1 was confident that they could work together using Vula in a distributed work setting. Again the **COHESION** of the **TEAM** as well as its **TRUST LEVEL** played an important role.

> [Question: What would have happened if we would have split up the team to work in Cape Town and Johannesburg (with the customer)?] Could we have kept using Vula? [Yes!] Then it would have worked out fine. It would have taken a lot more time by the end. [Question: Could you rely on each other also with the task management right from the beginning?] Yes. I was very confident with my team mates and girls.

TRUST and **WORK SETTING** are, therefore, two more concepts influencing the **TOOL SELECTION** from the **TEAM'S** perspective.

TEAM LEADERSHIP CONCEPT and **PROJECT PHASE/PROJECT STAGE** influence the **SELECTION OF TOOLS** and the frequency of **FACE-TO-FACE MEETINGS** in a **PROJECT**. Teams with high communication intensity (in the early phase of the project, specific stage of a project, or in a democratic leadership structure (e.g., student teams)) need more synchronous group communication functionality or face-to-face meetings. The following statement endorses this relationship:

> I have thought about it, why myintervals was developed like that, and why there is no communication functionality. It became clear to me that one assumes in myintervals that there is a clear hierarchy and a project manager who distributes and assigns the tasks. Though we chose a project manager in each sub-team, we are all at the same hierarchical level and, hence, there is a fair amount of discussion about the assigning of the tasks. There is no single person who makes the decisions. Hence, the missing communication component in myintervals is comprehensible from the developer's point of view but crucial for our decision on Google Groups and myintervals (BHT-Team-2009-1).

The larger the **SIZE** of the **TEAM,** the more tool support is need for **TASK MANAGEMENT** and the different **PROJECT ACTIVITIES**. This is especially true in a distributed **WORK SETTING**.

While the UCT teams pointed out that the size of the team strongly influences the selection and use of tools especially for task planning in a distributed work setting ("If we were a bigger group we would have used more tools. More coordination needed." (UCT-Team-2009-7)), most of the BHT teams selected two or more tools to support them in their task management and project activities in their distributed work setting. This was closely related to their larger size and their higher degree of virtuality as explained in Section 5.1.

6.1.5 Influence of the Team Members Context on Tool Selection

The **SELECTION OF A TOOL** OR **TOOL COMBINATION** is influenced by the **TEAM MEMBER'S GEOGRAPHICAL DISTANCE-TO-WORK, WORK PREFERENCES,** and his/her **TECHNOLOGICAL SKILLS**. The first 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 (in the 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 (from the team's perspective). 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).

6.1.6 Interventions on the Selection of a Tool/Tool Combination

A security incident forced two teams to change the web-based tool supporting the project management and information exchange in their teams. Both teams were using the same platform but only realized a few weeks later that the security features did not prevent the other team from accessing project data. In consequence, the teams lost trust in web-based tools, encrypted their documents, and manually exchanged documents. In turn, both teams were less effective and less successful. The interviews revealed the consequences of tool change and the security incident on the team's performance and their trust in technology, as supported by the following quotation:

> [Question: How did the data exchange take place?] Via email. At first we used Wikispaces until we found out that everybody had access to our data. As a result, we exchanged data during our face-to-face meetings (BHT-Team-2010-3).

After a security incident the selection of a new tool or tool combination will be different from the initial selection.

The **SECURITY FEATURES** of a **TOOL** strongly influence the **SELECTION OF A TOOL,** if the **TEAM** is affected by a **SECURITY INCIDENT** and decides to **CHANGE the TOOL/TOOL COMBINATION**. In addition the **TEAM** might have lost **CONFIDENCE IN TECHNOLOGY.** This might cause a reduction in the **TEAM'S EFFECTIVENESS.** In addition the team might need to **SCHEDULE ADDITIONAL FACE-TO-FACE MEETINGS** for the **PROJECT ACTIVITIES** and **TASK MANAGEMENT** that otherwise could be done more efficiently with a **SPECIFIC TOOL**.

TEAMS where **TEAM MEMBER** know each other well or are friends and have **VIRTUAL TEAM WORK EXPERIENCE** seem to prefer to use 'leaner' **TOOLS**.

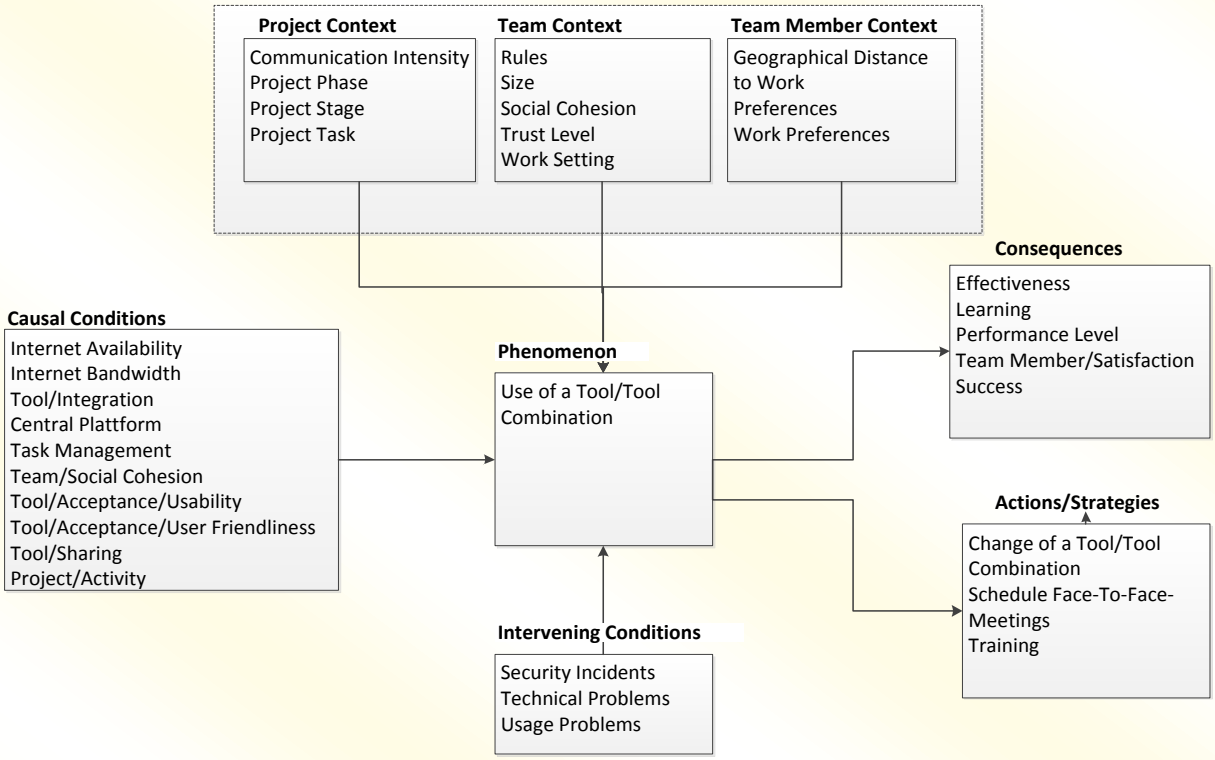
It seems that teams and team member regularly using different tools in the Internet prefer to use **leaner** tools. In both teams of the online course the members favoured using Skype or Adobe Connect without the video functionality. Such choices are related to the friendships in the team and to the fact that the team members have worked together before and therefore team cohesion has developed.

6.2 *Use of a Tool/Tool Combination*

6.2.1 Description of the Phenomenon "Use of a Tool/Tool Combination"

The following sub-sections describe the part of the theory related to the **USE** of Web-Based **TOOL/TOOL COMBINATIONS**. This part of the theory explains and illustrates the consequences of the use of various tools in different project, team, and team member contexts. It aims to develop an understanding of when, why, and for what purpose a specific tool is used (or why it hasn't been used) as well as when it is preferable or more appropriate for team members to meet face-to-face.

Figure 51 - Conditions, Context and Consequences in the Use of a Tool/Tool Combination



6.2.2 Causal Conditions and resulting Consequences/Actions for the Use of a Tool/Tool Combination

The conditions that exert the greatest influence on the use of tools relate to **INTERNET AVAILABILITY, INTERNET BANDWIDTH, TOOL INTEGRATION, CENTRAL PLATFORM, TASK MANAGEMENT, SHARING, TEAM COHESION, ACCEPTANCE,** and **PROJECT ACTIVITY** as shown in Figure 51.

The role of the Internet as a conditional factor is most apparent where Internet access is limited. Teams choose and use specific tool combinations in order to overcome limited **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH** which are likely to reduce the effectiveness of certain project activities. This restriction especially seems to prohibit the use of 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 the use of Internet-based tools 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 Availability and Internet Bandwidth encounter obstacles in accessing information that would help them learn to use new tools and technology. An example of this is underlined by a 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 **INTERNET BANDWIDTH** contribute to a reduced **EFFECTIVENESS** in the project work in general. The limited **INTERNET AVAILABILITY** and Internet **BANDWIDTH** specifically constrain the **USE OF INTERNET/WEB-BASED TOOLS** in virtual project work and reduce the **EFFECTIVENESS** of the **TEAM**.

The support of various **PROJECT ACTIVITIES** via different tools is related either to communication or to sharing. **TEAMS** wish to share information, documents or code. **SHARING** is a key issue of the web-based tools and tool combinations that support teams, especially in a distributed work setting. Some tools support these **PROJECT ACTIVITIES** better than other tools. This better support relates to the **INTEGRATION OF FUNCTIONALITY**, **CENTRAL PLATFORM**, **USABILITY,** and **USER FRIENDLINESS**.

TOOLS with a high **INTEGRATION OF FUNCTIONALITY** increase the **TEAM'S EFFECTIVENESS**.

This 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 a project server where you have to update the Gant charts all the time. And it

> also takes time to do the updates. It is a bit of a hassle to do those things with MS Project. It would be fine to have it all on 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 were causing 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. 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 chatroom, and MS Project. We met a lot but I am sorry to say that most of meetings were useless. They were really a waste of time. We came there and often waited for everybody to show up and then sat there for an hour for no reason at all. Towards the end, the Version Control and Vula chatroom was very effective in the way we did it. How would it been if we would have done it differently right from the beginning? Instead of waiting for hours and having long discussions.

The integration of functionality as well as the use of a central platform was also a key issue for the BHT teams, as can be seen in the following statement from BHT-Team-2009-1:

> In the beginning we used a number of different tools, but we stopped that rather quickly and replaced them with Google Groups. By means of Google Groups, communication and exchange of files was centralized. There was no necessity to look at different places and gather information on the project from different places. If you wanted to know something about the project, you logged onto Google Groups and everything accomplished so far was documented there.

The **USE** of a **CENTRAL PLATFORM** influences the **TEAM'S EFFECTIVENESS**.

Most of the BHT teams 2009 selected a tool that had a central role in their exchange of information, data, minutes or tasks and in the discussion of project relevant issues. The team's tool choice on a central platform influences the team's effectiveness. Vula was the prescribed and therefore central platform for the UCT teams. The concept and the influence of a central platform on the team's effectiveness only emerged in the data analysis of the BHT teams. For these teams no platform was prescribed and the failure to select a central workplace at the beginning of the project caused a decrease in the relevant team's effectiveness.

USABILITY and **USER FRIENDLINESS** influence the **TOOL'S ACCEPTANCE** und the **USAGE FREQUENCY** of a **TOOL**. As pointed out, the data from the UCT teams as well as from the BHT teams reveal that usability and user friendliness have a strong impact on the acceptance and the usage frequency of tools.

Some **TOOLS** have a low **USAGE FREQUENCY** because the **TEAMS** feel that they need more **TRAINING** to be able to use them effectively. A low **TOOL MATURITY LEVEL** also influences the **TOOL'S ACCEPTANCE** and reduces the **TEAM'S EFFECTIVENESS**.

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 at UCT and BHT with poor task management showed a high performance level. For good task management, it is essential to make the tasks progress transparent, for instance, by means of a tool.

TOOLS that support **TASK TRANSPARENCY** in the **TASK MANAGEMENT** increase the **TEAM MEMBERS' SATISFACTION** with the **PROJECT**.

For team members in the UCT teams as well as in the BHT teams, 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 two quotations from the interviews of the BHT teams:

> The timer [in myintervals] is a good function to keep track of how much time you have consumed on a task, but this foregrounds the fact that everybody wants to take part and make his performance transparent (BHT-Team-2009-1).

> We needed Aplan[40] to make sure that we did not lose our thread. To see what we needed to do next. It helped us a lot in this way (BHT-Team-2009-3).

TEAM COHESION plays an in important role in the **USE OF A TOOL OR TOOL COMBINATION.** On the one hand, **TEAM COHESION** is supported by **TEAM RULES** and the **INTEGRATION OF FUNCTIONALITY**. But, on

[40] Aplan is a web-based task tracking system, a specific type of issue-tracking system that manages and maintains a list of tasks as needed by the project.

the other hand, it is **TEAM COHESION** that enables **TEAMS** to use even leaner **TOOLS** to work effectively together in a distributed **WORK SETTING.**

This is supported by the following quotation from BHT-Team-2010-O-1:

> [Question: Did you use Skype as a video conference or phone conference tool?] [Team Leader:] For phone conferencing; because Thomas, Rafael, and I already know each other quite well, so no problems came up just because we used a leaner communication medium.

TEAM COHESION and as well as the **TEAM'S TRUST LEVEL** are two concepts important for using a **TOOL/TOOL COMBINATION** effectively. **TEAM COHESION** and as well as the **TEAM'S TRUST LEVEL** are two concepts important to use a **TOOL/TOOL COMBINATION** effectively.

Communication is at the heart of project work in general, but besides this, sharing via web-based tools has a major influence on a virtual team's effectiveness.

Web-based **TOOLS** that support **TEAMS** in **SHARING** items such as documents, information, program code, and any other digital source relevant for the **PROJECT ACTIVITIES** will increase the **EFFECTIVENESS** of **TEAMS** in a distributed **WORK SETTING**. Furthermore, the **TEAM'S EFFECTIVENESS** is increased by the **SHARED DOCUMENT HANDLING** in a **TOOL** introduced at the beginning of the **PROJECT**.

This will be explained by a couple of examples, because sharing is important in several project activities. The rise in the team's effectiveness through achieving shared document handling can be supported by a quotation from BHT-Team-2009-2:

> We started with Google Groups and I found the free file sharing great, and then also the automatic email notification after changes in the documents. This helped in the team's cooperation and made work easier.

An example of the decrease in effectiveness that results where shared document handling has not been applied follows:

> Tibor and I have not inter-coordinated on one work item. Anne uploaded a template file for the technical report. Tibor downloaded it and started to work on the file. I also downloaded the file and entered my texts. In the meantime, Anne updated the template file. Finally we had to assemble all the bit and pieces into one document with much more effort than necessary (BHT-Team-2009-3).

The **TEAM'S EFFECTIVENESS** is increased by the **SHARED DOCUMENT HANDLING** or the **DOCUMENT SHARING** via a **TOOL** because the number of project related **EMAILS** is decreased.

The proposed relationships might be one explanation for the increase in the project team's effectiveness using certain features of a tool: this may be grounded in the following quotation:

> We first discussed in the team the allocation of the tasks and then wrote it down with names and dates. This task list and work results from the different team members were uploaded into Google Groups. By this means we avoided being flooded with emails (BHT-Team-2009-3).

The support of certain **PROJECT ACTIVITIES,** such as **INFORMATION EXCHANGE** via a **TOOL,** has a positive influence on the **TRUST LEVEL** in a **TEAM**.

Trust is not just a precondition for successful team work with tools in a virtual work setting. The use of tools to support activities like information sharing and task tracking also has a positive influence on the trust in the team itself, as explained in the following quotation from BHT-Team-2009-3:

> [Question: How was the trust in the team? Did the tools affect the trust?] With the use of tools you create at least a baseline for trust, because at least everybody has the information about what is going on in the project. If everybody is going to perform without such a tool, some members may not know what is going on.

6.2.3 Influence of the Project Context on the Use of a Tool/Tool Combination

The four concepts influencing the use of a tool/tool combination from the project context point of view are the **PROJECT STAGE**, the **COMMUNICATION INTENSITY**, the **PROJECT PHASE**, and the **PROJECT TASK**.

The **FREQUENCY** of the **USE OF A TOOL** varies according to the **STAGE** of the **PROJECT**. There are certain time periods in a project where the need for intensive communication is high, and other times when less communication is needed to perform a project task in the project.

The **COMMUNICATION INTENSITY** varies according to different **STAGES of a PROJECT.** In certain project stages it is effective for teams to work distributed on a task. If a **PROJECT ACTIVITY** needs several **TEAM MEMBERS** working quasi-simultaneously on it, a distributed **WORK SETTING** can hinder accomplishing the **PROJECT ACTIVITY** effectively.

The complexity of the **PROJECT TASK** set for the project team also plays a role in how much work can be done in a distributed work setting.

The **PROJECT PHASE** is an important contextual element in many relationships regarding the **USE OF A TOOL/TOOL COMBINATION**: **SHARED DOCUMENT HANDLING,** for instance, should be introduced at the beginning phase of a project. The use of different tools for **TASK MANAGEMENT** depends on the **PROJECT PHASE**. The scheduling of **FACE-TO-FACE MEETINGS** instead of using a tool can be important at the beginning of a project as well as at the end of project ("deadline").

6.2.4 Influence of the Team Context on the Use of a Tool/Tool Combination

There are a number of issues in the team context that influence the use of a tool or tool combination: **WORK SETTING, SOCIAL COHESION, TRUST LEVEL, SIZE,** and **TEAM RULES**.

The most important factor is the **TEAM'S WORK SETTING** as mentioned in several causal conditions. This concept is in many cases related to the **TEAM'S SOCIAL COHESION** and **TRUST LEVEL**. **TEAMS** with high **SOCIAL COHESION** and **TRUST LEVEL** are confident about managing a **PROJECT** in a distributed **WORK SETTING** successfully, if they have the right **TOOL.**

Task transparency in task management via a tool especially requires a certain trust level in the team, as underlined by the following quotation from a team with a low trust level:

> Via a tool it is possible to check the status of working packages before the deadline, but the status is not always fully transparent. In a personal conversation I can better handle the fears of the project leader or team member that the work will not be completed in time. With a tool it is also easier to pretend a degree of completion than in a face-to-face meeting (BHT-Team-2009-4).

In the selection and the use of a tool or tool combination the team's size plays an important role. The larger the **SIZE** of the **TEAM,** the more **TASK MANAGEMENT** is needed, especially in a distributed **WORK SETTING** supported by a **TOOL**. Often the teams pointed out that the size of the team strongly influenced the need for and importance of **TASK MANAGEMENT** sustained by a specific tool. The relationships with the **INTEGRATION OF FUNCTIONALITY** and **CENTRAL PLATFORM** also are connected with the context of the **TEAM'S SIZE.** The larger a **TEAM** is, the more an integrated and central **TOOL** is needed.

In many areas it became clear that certain **TEAM RULES** on the right use of a tool, as set up by the team members either at the beginning of the project or in the course of the project, define a

framework for the effective use of the tools. The following relationship is a good example of this framework. The **USE** of asynchronous **TOOLS** might cause **MISUNDERSTANDINGS**. It is therefore necessary to **USE** those **TOOLS** together with synchronous **TOOLS** in the **PROJECT,** or to schedule regular **FACE-TO-FACE MEETINGS** to define rules for when and for which activities a specific tool is to be used.

Email has a high incidence of causing misunderstandings in virtual team work. Consequently, it is helpful to have a combination of synchronous communication tools (like Skype) and asynchronous communication tools, or to schedule regular face to-face meetings to resolve/avoid misunderstandings. This claim is supported by the following quotation:

> Yes, we had a number of problems with emails. That we found out by ourselves, and therefore it was so important that we meet in person or have these weekly virtual project meetings, where you could then see what each team member's attitude is, and could ask the team members what they meant with a specific email. These misunderstandings only occurred with email and not with Skype (BHT-Team-2010-O-1).

6.2.5 Influence of the Team Members Context on the Use of a Tool/Tool Combination

The use of a tool is influenced by the **TEAM MEMBERS' PREFERENCES** regarding tools, as well as their **WORK PREFERENCES** and their **GEOGRAPHICAL DISTANCE TO WORK**. This is supported by the following quotation:

> Everyone can work at times that suits him/her best, and which personally are the most effective times. It can also tie in better with other work items or the individual daily work schedule. If we would have had to come together, say at fixed times at one place, we wouldn't have been able to provide the same performance (BHT-Team-2010-O-1).

6.2.6 Interventions on the Use of a Tool/Tool Combination

Three concepts intervene with the effective **USE OF A TOOL/TOOL COMBINATION** in a **PROJECT: SECURITY INCIDENTS, USAGE PROBLEMS,** and **TECHNICAL PROBLEMS.**

A **SECURITY INCIDENT** can reduce the Team's **TRUST IN TECHNOLOGY** and, in turn, reduce its **EFFECTIVENESS**. In a distributed **WORK SETTING** reduced trust increases the number of **FACE-TO-FACE MEETINGS** because the **TOOL/TOOL COMBINATION** cannot be used as planned by the team and this endangers the **SUCCESS** of the **PROJECT**.

USAGE PROBLEMS can force a **TEAM** to **CHANGE A TOOL** because the use of this specific **TOOL OR TOOL COMBINATION IS** reducing the **EFFECTIVENESS** of the **TEAMS.**

In case of **USAGE PROBLEMS** that relate to missing **USER FRIENDLINESS,** and that cause a decrease in the **TOOL'S USAGE FREQUENCY** of individual team members, it might be necessary to schedule tool **TRAINING** activities to avoid a **CHANGE** of the **TOOL**.

A **USAGE PROBLEM** could, for example, be: a lack of sharing options or of no version management; difficult folder management for the documents; difficult or no user administration; and low maturity level of the tool. BHT-Team-2009-1 experienced low maturity level in a tool:

> [Team Member:] It was absolutely strenuous that in Google Groups there are no folders and that one could not login properly. [Team Member:] The tools have not matured yet. We had 71 documents at the end. It was just confusing. [Team Member:] In particular, after someone has worked with it for several weeks, it becomes absolutely confusing. [Team Member:] From my point of view, Google Groups is not that bad, but it has not matured yet, because of the repeated uploading of a document, the problems with the login and the unpredictable email messages. Further, there are the missing structuring possibilities and missing overview in the document handling.

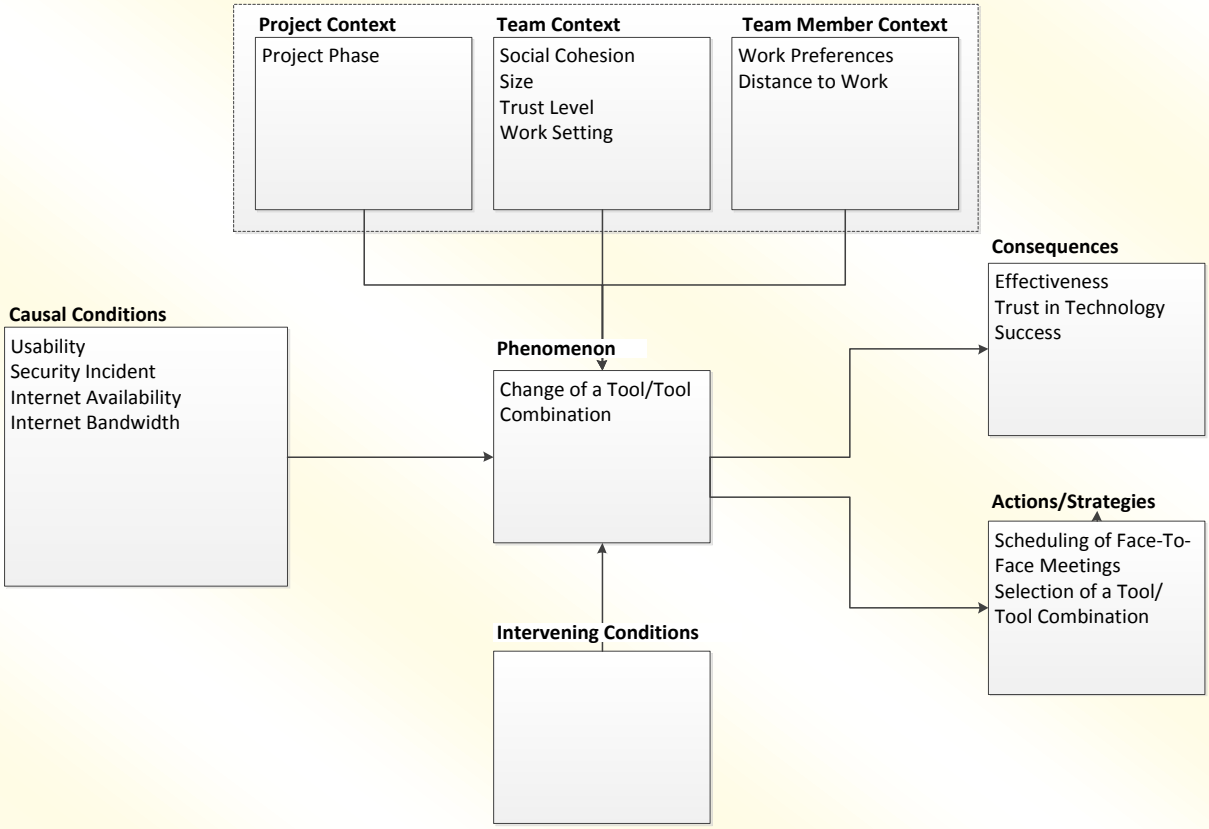
TECHNICAL PROBLEMS not covered under the above topic are, for example, all problems regarding the **AVAILABILITY AND BANDWIDTH OF THE INTERNET**. As mentioned before, the **AVAILABILITY OF THE INTERNET AND BANDWIDTH** are major causal conditions for the **USE OF A TOOL/TOOL COMBINATION** in project teams working in a distributed work setting**.**

6.3 *Change of a Tool/Tool Combination*

6.3.1 Description of the Phenomenon "Change of a Tool/Tool Combination"

The following sub-sections describe the part of the theory related to the **CHANGE of Web-Based TOOL/TOOL COMBINATIONS.** The change refers to the transition phase from one Tool/Tool Combination to another. The theory explains and illustrates the consequences of the change of various tools in different project, team, and team member contexts. It aims to develop an understanding of when, why, and for what reason a specific tool has been changed (or why it is not being used any longer) and the consequent effects on effectiveness, trust in technology, and project success. The theory describes the consequences for the selection process of a new tool, and explains why additional face-to-face meetings are necessary in this phase.

Figure 52 - Conditions, Context and Consequences During the Change of a Tool/Tool Combination



6.3.2 Causal Conditions and resulting Consequences/Actions for the Change of a Tool/Tool Combination

USABILITY, A SECURITY INCIDENT as well as **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH** are conditions that may cause a team to change the tool and to go into a transition phase from one supporting tool set into another.

If **TEAMS** have selected the wrong tool and realize this, then the **TEAMS** go into a phase of **CHANGE**. This phase of change affects the **TEAM'S EFFECTIVENESS**, **TRUST IN TECHNOLOGY,** and even the **PROJECT'S SUCCESS**.

In the transition from one tool another tool (**CHANGE**) caused by inadequate **USABILITY** and therefore lack of **TOOL ACCEPTANCE** by the **TEAM MEMBERS**, the **TEAM'S EFFECTIVENESS** is reduced and the **TEAM** needs to **SCHEDULE ADDITIONAL FACE-TO-FACE MEETINGS**.

During the **CHANGE** phase caused by a **SECURITY INCIDENT**, the **TEAM'S EFFECTIVENESS** is diminished, the **PROJECT SUCCESS** is endangered and the team needs to **SCHEDULE ADDITIONAL FACE-TO-FACE MEETINGS**. In addition the team might have lost **TRUST IN TECHNOLOGY** which could cause an additional decrease in the **TEAM'S EFFECTIVENESS**.

During the **CHANGE** phase caused by limited **INTERNET AVAILABILITY** and **INTERNET BANDWIDTH**, the **TEAM'S EFFECTIVENESS** is reduced and the **TEAM** needs to **SCHEDULE ADDITIONAL FACE-TO-FACE MEETINGS**.

Of prime importance in the change phase is the influence of the various conditions on the frequency of Face-To-Face Meetings. If teams are forced to **CHANGE** their **TOOLS,** they have to schedule additional **FACE-TO-FACE MEETINGS**. Depending on the context (**PROJECT, TEAM, AND TEAM MEMBER**) this has more or less of an impact on the **TEAM'S EFFECTIVENESS**.

The selection of tools seems to be crucial for a virtual team. The decision takes place at the beginning of a project and influences the team's effectiveness. Two teams with low project results changed their tools during the project:

> [Question: Explain the role of Vula to manage your project?] [Team Member:] Specific adaptation of Vula (for a weekly breakdown of tasks) for the tasking, exchange of documents, and chatting. At the beginning, also code sharing, later via Subversion (UCT-Team-2008-2).

> [Team Member:] The choice fell at the beginning of the project on Google Groups because it was available and easy to handle, free of charge and offered the functionality we thought that we would need. At the beginning of the project documents were wildly sent by email and nobody knew what the latest version of a document was. We therefore needed to organize ourselves as fast as possible. After we got to know myintervals, we asked ourselves whether we wouldn't start the project differently next time (BHT-Team-2009-1).

The following quotation from BHT-Team-2010-6 supports the need for training in the way that they highlight the cost of changing to another tool. This also shows the consequences in terms of effectiveness in changing the tools:

> Maybe one could have done it better but the training into another tool would have cost us too much time.

6.3.3 Influence of the Project Context on the Change of the Tool/Tool Combination

The **PROJECT PHASE** has a strong influence on the **SELECTION AND CHANGE OF TOOLS** during a **PROJECT**. The decision for a tool should take place at the beginning of a project.

A late **SELECTION OF THE TOOL/TOOL COMBINATION** or a **CHANGE OF THE TOOL/TOOL COMBINATION** in a later **PROJECT PHASE** both influence the **TEAM'S EFFECTIVENESS**. Two teams with low project results changed their tools in the middle of the project and had to schedule additional face-to-face meetings, find new ways to share data and information, and make the task management transparent. How the change in the tools in a later project phase influenced the team's effectiveness is shown in a quotation from BHT-Team-2010-4:

> For the assignment and allocation of the tasks we used a mixed approach. First I wrote down the tasks, then printed them out and handed them over personally. Later on, I sent them via email. In the beginning we uploaded them onto our unprotected platform.

6.3.4 Influence of the Team Context on the Change of the Tool/Tool Combination

SIZE, TRUST LEVEL, TEAM COHESION, and **WORK SETTING** all have an influence on the Teams' Effectiveness and the frequency of Face-Face-Meetings during the phase of changing from one tool to another.

The larger the **SIZE OF A TEAM,** the bigger is the influence of change in tool on the **TEAM'S EFFECTIVENESS**. The **TEAM SIZE** also affects the **TEAM'S EFFECTIVENESS** during the change phase from one tool to another. In **TEAMS** with a low **TRUST LEVEL** and weak **TEAM COHESION** the change phase lasts longer. These teams need more **FACE-TO-FACE MEETINGS**. In the **CHANGE** phase, the distributed **WORK SETTING** strongly influences the **EFFECTIVENESS OF A TEAM**, the frequency of additional **FACE-TO-FACE MEETINGS,** and the **SUCCESS OF THE PROJECT**.

The above relationships are very clear if one looks at BHT-Team-2010-4. This team had a medium technical skill level and good task awareness, but only a medium to low trust level. Due to a security incident they were forced to change their tool. In addition, they met relatively rarely even during the change phase and as a result worked with reduced effectiveness to the extent that they almost failed the project. The following quotation elucidates the above explanations:

> [Question: Why didn't your project team perform in the beginning?] Because most of our activities took place via the platform, the platform was causing problems, and in addition we seldom met face-to-face (BHT-Team-2010-4).

6.3.5 Influence of the Team Member's Context on the Change of the Tool/Tool Combination

TEAM MEMBERS' WORK PREFERENCES and their **GEOGRAPHICAL DISTANCE FROM WORK** often go hand in hand and they influence the **CHANGE** phase. During this phase, teams should schedule additional face-to-face meetings and select a new tool; both activities have an impact on the individual team members.

7. Discussion

The purpose of my research was, firstly, to explore the selection and use of web-based/Internet tools in the underlying project management processes of virtual teams, and, secondly, to understand their impact on team effectiveness and performance, project success, as well as team member's satisfaction. The investigation of these issues led to the development of a framework of relevant variables that helps researcher to explain the selection, use and change of tools/tool combinations for virtual teams. The emergent theory gives a holistic explanation of how single aspects contribute to the team's performance and the team member's satisfaction in a virtual work setting when selecting and using Internet/web-based tools. The theory shows the dependencies in action of the three phases: selection, use, and change. From the contextual aspect, it seems to be important to consider individual (team member), team, and organizational issues (the project). Furthermore my 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: limited Internet availability and bandwidth; lack of training for certain tools; the wrong selection and use of tools that are either not integrated/do not support adequate sharing among team members/do not help to manage tasks and promote transparency about progress made. Definite areas emerged where tool selection and use, or lack of use of appropriate tools, affect performance.

When adopting a grounded theory approach, it is especially important to revisit the related research literature to compare and to discuss critically the developed theory (e.g., Pandit (1996)). According to Martin (2006), the appropriate use of literature in a grounded theory approach is a matter of phasing. It is acceptable for researchers (e.g., Dey (1999), and Andrews (2006)) to conduct a pre-study literature research to uncover the research problem, as a long as this is done in such a way that it does not influence the researcher in developing his theory on basis of the data (Seldén, 2005). The first phase should be noncommittal, with literature helping the researcher to find his problem. The second phase is integrative, with the researcher comparing, discussing, and integrating his/her emerging theory with existing theories so as to

> render the new theory in the context of existing knowledge and thus making the theory more valuable (Urquhart & Fernandez, 2006, p. 461).

In their analysis of the use of technology in virtual team research, Schiller and Mandviwalla (2007) scanned virtual team articles from 18 top journals and identified 25 theories relevant to virtual teams. I refer in the following discussion to those four theories among these 25 theories that are relevant to my research question and developed theory:

- Media Richness Theory (MRT) (Daft & Lengel, 1984)
- Media Synchronicity Theory (MST) (Dennis & Kinney (1998), Dennis & Valacich (1999), and Dennis, Fuller, & Valacich (2008))
- Swift Trust Theory (Jarvenpaa, Knoll, & Leidner (1998), and Coppola, Hiltz, & Rotter (2004))
- Task-Media Fit Theory (Hollingshead, McGrath, & O'Connor, 1993)

There are, in addition, two more theories I will discuss with regard to my theory:

- Media Naturalness Theory (Kock, 2004)
- Vital signs for management intervention in virtual teams (Thomas & Bostrom, 2010)

Furthermore, I debate my research findings in relation to research in the fields of Computer Supported Cooperative Work (CSCW), Computer Mediated Collaboration (CMC), and Group Support System (GSS). Culture and diversity are further research issues for virtual teams that I wish to relate to my findings.

7.1 *The Emergent Theory and ICT Inadequacy*

My emergent theory underpins the vital signs for virtual teams proposed by Bjørn and Ngwenyama (2010) in the area of ICT inadequacy, trust, and team relationships. The lack of attention to technology in the research into virtual teams is a symptom of a general weakness in IS research: Orlikowski and Iacono (2001) pointed out that technology is an active element and not a stable and independent factor and therefore has to be considered as such in research studies.

According to my theory, limited access to the Internet has a strong impact on the available media richness and hence on the communication processes within project teams; limited access to the Internet also affects the collaboration and task management in the team via web-based tools; as a result, virtual project teams with limited Internet access are less effective than other teams.

The environment within which a project team functions is a crucial element contributing to effective teamwork. As pointed out by Bjørn and Ngwenyama (2010), the alignment of task, technology, and team is often neglected in the research of virtual teams. Because communication

and collaboration play a vital role in any project team, including traditional teams, they should be included when making such alignment. In my resultant theory, team issues such as trust, social cohesion, work setting, and leadership concept as well as project issues such as project activity, complexity of project task, and task management influence the selection and use of (web-based) technology. In addition, my analysis revealed that the team members' preferences, technological skills and distance from work are as important in the alignment process, a factor also highlighted by Thomas and Bostrom (2010) (see section 7.2.).

7.2 *The Emergent Theory and Vital Signs of Virtual Teams*

Thomas and Bostrom (2010) 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 (e.g., time schedule/scope change and upper management intervention), internal constraints (e.g., team size), information and communication technology inadequacy (e.g., not operating or a feature/tool missing), ICT knowledge, skills, and abilities inadequacy (e.g., lack of ICT knowledge), as well as trust and relationship (e.g., trust failure).

The emergent theory emphasises in particular the importance of ICT adequacy and trust in project teams (e.g., Thomas & Bostrom (2010), and Daim, *et al.* (2011)). Limited access to the Internet reduces the availability of web-based tools and has a negative impact on the communication processes as well the sharing of data, information, documents, and code. As a result, project teams with limited Internet access generally perform on a lower level than other teams. According to my research results, they are less effective. In addition, the task management processes are restricted. This has an impact on the team's effectiveness and on the satisfaction of team members, as explained in my theory. The various research results on ICT inadequacy, team leader interventions, and technology adaptation (e.g., Bjørn & Ngwenyama (2010), Daim, *et al*. (2011), and Thomas & Bostrom (2010)) support the necessity and relevance of the change phase in my theory.

In the emergent theory a security incident triggered the change of the tool. With regard to ICT adequacy from Thomas and Bostrom (2010) the missing security features might well be part of a larger category of tool weaknesses or failures, which almost certainly would cause tool choices to be reevaluated in the selection phase. Research results from Lu, Watson-Manheim, Chudoba, and Wynn (2006) support my finding on the impact of tool change on the team's effectiveness. They state that the loss of information and knowledge due to the switch of tools and the change of processes is

evident and has consequences for the team's effectiveness. Lu *et al.* (2006) also revealed in their case study that integrating information from different tools was a problem in virtual work setting, which support my findings regarding the effect of integration on team effectiveness.

Virtual teams are more fragile and vulnerable to breakdowns than face-to-face teams (Hinds & Mortensen, 2005). The beginning of a project is a crucial phase (e.g., Huysman, *et al.* (2003), and Jarvenpaa & Leidner (1999)) and it is important that the right tools are selected during this phase to avoid discontinuities in the project work. This is supported by my research results and part of my theory. If the selection of the correct tool does not take place at the beginning of the project, effectiveness is reduced.

Discontinuities may take the form of gaps or of a lack of coherence in work such as task, culture, technologies or working rules (Watson-Manheim, Chudoba, & Crowston, 2002). This is in line with my research results.

7.3 *The Emergent Theory and Media/Tool/Technology Selection Theories*

Flammia, Cleary and Slattery (2010) pointed out that the use of 'lean' media such as chat or text messaging have a strong influence in developing team cohesion, trust, and member satisfaction. My research has revealed that an even more important factor affecting team member satisfaction and team effectiveness is to ensure that the team's choice of tools is aligned with the team members' individual needs and preferences.

7.3.1 Team Leaders Choice on Technology

Previous research (Sivunen & Valo, 2006) has focused on the team leader's choice of technology and has described and explained the choice in terms of accessibility, social distance, idea sharing and informing. My view of this choice includes the different contexts of team, project, and team member, and thus recognises individual preferences. This approach is supported by Goodhue and Thompson's (1995) task technology fit model, which proposes that to have a positive impact on the user's individual performance, the suitability of technologies to the task and context must be taken into account. Goodhue and Thompson (1995) suggest in their task-technology fit model that technology has to acknowledge the utilization for the tasks and the good fit, so as to have a positive impact on the users' individual performance. Hertel *et al.* (2004) propose management by objectives as the preferred leadership concept for remote work situations. 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 behaviour on relatively whole tasks" (see Cohen & Ledford (1994), and Goodman, Devadas, & Hughson (1988)). These research results emphasise the role of the individual within a team and are in line with my view of how team members influence tool selection and use.

7.3.2 Media Richness Theory

The Media Richness Theory (MRT) is based on the work of Daft and Lengel (1984 and 1986) and Daft *et al.* (1987). MRT is a theory that can be used to describe the ability of communication media to transfer information. MRT suggests that media vary in the levels of richness they provide. MRT further proposes that task performance will be improved when task-information processing requirements are matched to a medium's ability to provide that information richness. Daft and Lengel (1984) specifically concluded that written media are preferred for unequivocal messages while face-to-face media are preferred for messages containing equivocality.

My research results and the developed theory do not support the MRT in virtual project teams. Like other researchers (e.g., Carlson & Zmud (1999), Majchrzak, Malhotra, & John (2005), and Markus (1994)), I question the value of the MRT, specifically for explaining how team members select and use tools effectively in virtual project teams. My research results regarding this point are endorsed by Dubé and Robey (2008).

According to my theory, in specific contexts teams might select a leaner medium especially if they know each other well and have experience in virtual team work. This is in line with research results from Alge, Wiethoff and Klein (2003), who revealed that experienced virtual teams that have worked together in the past communicate as effectively through different media as via face-to-face. Further, according to my theory, the selection and use of a tool also depends on the team members' preferences.

7.3.3 Task-Media Fit Theory

The Task-Media Fit Theory (Hollingshead, McGrath, & O'Connor, 1993) was developed on the basis of MRT. This theory argues that for each type of communication task, a well-fitting medium should be selected. In comparison to my theory, I have the same arguments as for MRT as to the reasons that my theory does not support this theory for use among virtual project teams. First, in a specific context, a team might select a leaner medium especially if the team members know each

other well and have worked together before. In addition, according to my theory, the selection and use of a medium also depends on the team members' preferences.

7.3.4 Media Synchronicity Theory

Media Synchronicity Theory (MST) (see Dennis & Kinney (1998), and Dennis & Valacich (1999)) distinguishes the communication tasks in terms of whether they are conveyance tasks or convergence tasks. MST proposes that, for conveyance communication processes, low media synchronicity will be more effective and that, for convergence communication process, high media synchronicity is recommended. Based on MST, a better match of media synchronicity with the team's communication processes will lead to improved performance of the team members (Schiller & Mandviwalla, 2007). According to Dennis, Fuller and Valacich (2008), for most tasks the use of one medium alone is not sufficient to achieve ideal communication performance. The reason for this is that many tasks require both conveyance and convergence.

Several research results (e.g., DeLuca & Valacich (2006), and Niinimäki, Piri, Lassenius, & Paasivaara (2011)) on virtual teams support the MST. DeLuca and Valacich (2006) point out that team members felt as comfortable with their colleagues using less synchronicity if they were a more established team. This is also partly supported by my research results and theory on the selection and use of web-based tools. Teams that know each other well and have worked together before prefer to use leaner tools, although not necessarily tools with less synchronicity.

On the other hand, MST suggests the use of multiple communication media to accomplish a task. This is supported by my research results, in that teams select different media/tools in their work on a project task. MST 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.

According to DeLuca and Valacich (2006), media with high synchronicity (e.g., face-to-face or phone) are preferred for complex problem-solving tasks in virtual teams so as to ensure convergence on a shared meaning. In my 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 my theory supports the idea that the integration of functionality (different media) also increases the team's effectiveness. This is supported by Watson-Manheim and Belanger (2007, pp. 287-288) whose research results indicated that

> . . individuals faced with multiple choices of communication media actually make use of a repertoire of communication media rather than making discrete media choices, and develop norms of media usage over time.

Niinimäki, *et al*. (2010) pointed out that the concepts in media synchronicity "are useful and applicable for globally distributed software development" (2010, p.11), even though in the projects they studied the tool selection and use "were not always similar as suggested by media synchronicity theory" (2010, p11). This is in line with my findings, as explained above. Further, Niinimäki *et al.* (2011) underline the effective use of communication media with high reprocess ability for the sharing of information (both complex tasks and simple). According to my findings, sharing is a major issue in the use of tools and therefore tools that support sharing increase the team's effectiveness.

As pointed out by DeLuca & Valacich (2006), certain tasks in teams can be performed with communication media that have low synchronicity (e.g., chat and SMS) and other tasks with communication media with high synchronicity (e.g., Skype). According to my resultant theory, just as important as the synchronicity of a medium/tool is how the tool is integrated into the project's processes. Also according to my theory, teams like to have a central point of contact or a central platform/workplace. This central platform/tool would ideally provide access to different media.

7.3.5 Media Naturalness Theory

Kock (2004) developed the media naturalness theory to understand the user's behaviour towards communication media. My findings support Kock's Media Naturalness Theory (2004) that team member adapt to technology. For the two teams studying in an online degree it was more natural to work with technology and even leaner technology than for the other 26 teams. Zack (1994), for example, found that initial face-to-face meetings support the team processes but later in the project when team members become more familiar with one another, mediated communication does not hinder the team processes. But a main point influencing technology choice and use was again the individual preference and team members' personal situation (for example distance to work).

7.4 *The Emergent Theory and Diversity*

According to Shachaf (2008), specific technology, such as e-mail or teleconferencing, serves to reduce the negative impact of intercultural communication and to have a positive impact on decision-making; cultural diversity therefore may influence the selection of communication media.

This was not supported by my research because cultural diversity had no significant influence on the team work of the selected student project teams. There are several possible explanations for this finding. One explanation is the increasing overlapping and merging taking place within multi-cultural societies such as in South Africa and Germany.

This explanation is partly supported by Erez and Gati (2004), in the dynamic of their multi-level cultural model. A quotation from UCT-Team-2009-5 suggests how cultural diversity is being accepted:

> People are aware of the cultural differences and accept them. What puts them together is being proud to be South Africans.

In addition, specifically for the BHT Teams, Ancona (1987) finds that even when team members belong to a specific national culture they are influenced by the context (team or organization) in which they are living or working. This might also explain why the different cultural background did not affect the use and selection of tools within my research study.

Results from different researcher (e.g., Baba, Gluesing, Ratner, & Wagner (2004), and Jarvenpaa, Knoll, & Leidner (1998)) pointed out that the influence of cultural background becomes less relevant for certain areas of virtual team's processes and outcomes. Jarvenpaa *et al.* (1998) stated that in a situation where swift trust has developed, culture is less relevant for the team's effectiveness. This swift trust theory could also explain why no specific influence of culture on the selection, use, and change of web-based tools was observed in the teams of my research study.

7.5 *The Emergent Theory and Usability/Task Awareness from the CSCW Research Field*

Usability and user-friendliness sum up a couple of criteria in my theory on the acceptance of a tool in virtual teams. According to Green and Pearson (2011), usability can be defined in different ways, and, regarding web-based tools, Lee and Kozar (2011) identified 10 website usability factors. Many researchers (e.g., Daim, *et al.* (2011)) state that the use of tools and technology are central for the success and effectiveness of virtual teams but little is written about the role of the acceptance of tools in a virtual team setting. Based on my analyses and the developed theory missing tool acceptance reduces the usage frequencies and might decrease the team's effectiveness.

For the evaluation of technology acceptance Information Systems theory provides a number of approaches such as the Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989) or the Collaboration Usability Analysis (CUA) (Pinelle, Gutwin, & Greenberg, 2003). Even though in

the analyses of the interviews a number of issues emerged that explained why a specific tool was not accepted by a team and therefore was less frequently used or even abandoned, I did not evaluate usability and acceptance of tools in virtual teams in my research. The TTF-Model (Goodhue & Thompson, 1995) could be an interesting approach to follow regarding usability, tools and technology.

One of the concepts in my theory that strongly influenced the team members' satisfaction was the transparency of the work progress in the task management. Transparency of the work progress in the task management is closely related to one key research issue in the CSCW field: awareness[41]. According to Schmidt (2002), awareness describes the need of team members to monitor and support the mutually dependent team activities that enable the work progress. Ngwenyama and Bjørn (2008) 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, in my theory, 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 (Prinz, 1999).

While the team members' satisfaction caused by task awareness in virtual teams is supported by different researchers (e.g., Geister, Konradt, & Hertel (2006)), the antecedent of a certain trust level to achieve this satisfaction, as is described in my theory, needs be emphasized. It is, again, trust that plays an essential role in the virtual team, as pointed out by many researchers (e.g., Jarvenpaa & Leidner (1999), Kirkman, Rosen, Tesluk, & Gibson (2004), and Bos, Olson, Gergle, Olson, & Wright (2002)). There are some activities supported by tools, such as sharing knowledge and information that help to build up trust (e.g., Plotnick, Hiltz, & Ocker (2010)). There are other activities, like task awareness facilitated by tools, where trust is needed beforehand. My theory elucidates the different roles of trust in the selection, use, and change of tools to assist virtual teams and summarizes and backs up research findings on single aspects on trust in virtual teams.

[41] According to the Webster dictionary the noun awareness generally has two broad meanings: *(1) consciousness, cognizance, knowingness* and *(2) sentience.* Interestingly there is no counterpart in German, French or the Scandinavian languages as pointed out by Schmidt (2002). This might explain the use of "task transparency" in the interviews of the German teams.

7.6 *Theoretical Integration of Key Issue in the Emergent Theory*

The following table summarizes the key issues of the emergent theory on the selection, use and change of tools/tool combinations in virtual teams, as it was discussed in the previous sections, and relates them to factors from an updated systematic literature review as well as to factors from broader literature. The emergent theory extends the key issues in Table 78 in single aspects but most important integrates them into an explanatory holistic framework.

Table 78 - Theoretical Integration of Key Issue of the Emergent Theory on the Selection, Use and Change of Tools in Virtual Teams

Key issue in the selection, use and change of tools in virtual teams	Relates to Factors from Systematic Review	Relates to Factors from Broader Literature
Tool Selection	Team, team leader (Sivunen & Valo, 2006), project, and team member (Goodhue & Thompson, 1995), especially his individual preferences (e.g. (Rutkowski, Saunders, Vogel, & van Genuchten, 2007) and (Watson-Manheim & Belanger, 2007)) influence the decision on tools and technology. Previous work experience in the teams influence tool selection (DeLuca & Valacich, 2006)	Technology/media choice (Daft & Lengel, 1984), (Daft & Lengel, 1986) (Daft, Lengel, & Trevino, 1987), (Dennis & Kinney, 1998); (Hantula, Kock, D'Arcy, & DeRosa, 2011); (McGrath & Hollingshead, 1994) Technology adaption and organization (Majchrzak, Rice, Malhotra, King, & Ba, 2000)
Change of Tools	ICT inadequacy (Bjørn & Ngwenyama, 2010); Reduced performance and loss of information/knowledge (Lu, Watson-Manheim, Chudoba, & Wynn, 2006)	Five trigger model for technology adaption (Thomas & Bostrom, 2010)
Team Member Context – Work Preferences	Tool repertoire (Watson-Manheim & Belanger, 2007); (Dennis, Fuller, & Valacich, 2008)	Development of collaboration Know How (Majchrzak, Malhotra, & John, 2005);
Team Member Context – Preferences	Influence on team member satisfaction (Flammia, Cleary, & Slattery, 2010)	Team member adapt to technology (Kock, 2004) Media adaption of groups (Zhang & Poole, 2007) Individual competency (Wang & Haggerty, 2009)
Internet Access and Availability	Reduced effectiveness	ICT inadequacy (Bjørn & Ngwenyama, 2010); (Thomas & Bostrom, 2010)
Tool Integration	Increases effectiveness and team member satisfaction (Watson-Manheim & Belanger, 2007); (Dennis,	Technology acceptance (Davis, Bagozzi, & Warshaw, 1989); (Pinelle, Gutwin, & Greenberg, 2003);

Key issue in the selection, use and change of tools in virtual teams	Relates to Factors from Systematic Review	Relates to Factors from Broader Literature
	Fuller, & Valacich, 2008); (Lu, Watson-Manheim, Chudoba, & Wynn, 2006) Ease of use of technology (Munkvolk & Zigurs, 2007)	(Goodhue & Thompson, 1995)
Sharing via Tools	Builds up trust and increases team member satisfaction (Plotnick, Hiltz, & Ocker, 2010); (Kanawattanachai & Yoo, 2007); (Staples & Webster, 2007)	Role of trust in virtual teams (Jarvenpaa & Leidner, 1999); (Kirkman, Rosen, Tesluk, & Gibson, 2004); (Bos, Olson, Gergle, Olson, & Wright, 2002); (Baskerville & Nandhakumar, 2007) Sharing Information and Knowledge (Malhotra, Majchrzak, Carmen, & Lott, 2001)
Security in Tools	Security problems decrease effectiveness and tool acceptance/use	Five trigger model for technology adaption (Thomas & Bostrom, 2010) Technology acceptance (Davis, Bagozzi, & Warshaw, 1989); (Pinelle, Gutwin, & Greenberg, 2003); (Goodhue & Thompson, 1995)
Task/Work Transparency	Increased team member satisfaction (Ngwenyama & Bjørn, 2008); (Geister, Konradt, & Hertel, 2006) Team member preferences (Leinonen, Järvelä, & Häkkinen, 2005)	Awareness (Schmidt, 2002); (Prinz, 1999)

8. Conclusions

This PhD thesis presents research investigating how virtual project teams should use web-based tools in the processes of project management so as to improve the team's outcome and the team's affective outcome. This was reflected in the core research question of how Internet/web-based tools should be employed in the project management processes of virtual project teams by increasing the effectiveness of the processes, and improving the project outcome as well as the team affective outcome. In the last three years I observed, questioned, and interviewed a total of 28 project teams with 167 team members, in a series of prospective research studies. The sampling and analyses of these teams followed the grounded theory approach as described by Corbin and Strauss (2008) and as guided by experienced researchers in this field (e.g., Orlikowski (1993), Pandit (1996), Urquhart (2007), and Urquhart *et al.* (2010)). The investigation into the core research question led to the development of a framework of relevant variables that helps researcher to explain the selection, use and change of tools/tool combinations for virtual teams. The emergent theory helps to answer the following secondary research questions on the employment of Internet/web-based tools in virtual teams:

(1) How and when web-based tools are used in the different project management tasks?
(2) How does the task-technology fit influence team performance and team affective outcome?
(3) How does the use of a certain tool influence team dynamics and socio-emotional factors?
(4) How do team dynamics and socio-emotional factors influence the team performance and the team affective outcome?

The developed framework of variables gives explanation for all four secondary research questions, but specifically highlights the first secondary research question of how and when to select, use and change a tool for specific project management tasks. Even though the emergent theory gives a holistic explanation of how single aspects contribute to the team's performance and the team member's satisfaction in a virtual work setting when selecting and using Internet/web-based tools, it specifically addresses the secondary research questions 3 and 4, showing the dependencies in action of the three phases: selection, use, and change and highlighting the importance of individual (team member), team, and organizational issues (the project). Relating to the secondary research questions 1 and 2, differing performances of teams can in many cases be attributed to such conditions as:

limited Internet availability and bandwidth; lack of training for certain tools; the wrong selection and use of tools that are either not integrated or do not support adequate sharing among team members/do not help to manage tasks and promote transparency about progress made. Definite areas emerged where tool selection and use, or lack of use of appropriate tools, affect performance. Addressing team dynamics and socio-emotional factors and their influence on the team performance and team members' satisfaction (secondary research questions 3 and 4) the emergent theory elucidates the different roles played by trust in the selection, use and change of tools to assist virtual teams and thereby it summarizes and endorses research findings on single aspects of trust in virtual teams. Task awareness is a key issue that influences the team members' satisfaction. If a tool supports task management by making the task progress transparent to every team member then the task awareness is enhanced within a virtual team setting. Trust is, in reality, an antecedent to working in such a setting. Sharing of information using a tool, on the other hand, does not merely increase the team's effectiveness but also helps to build up trust within the virtual team.

8.1 Contributions of the Research to the field of IS

8.1.1 Practical Contributions

My research results contribute to practice by providing a number of guidelines for the management of virtual teams and the initial knowledge required by companies that want to launch projects with virtual teams.

From the six general leadership practices for virtual teams recommended by Malhotra, Majchrzak, and Rosen (2007, p. 60) four leadership practices are supported and explained in more detail based on my research results:

"1) establish and maintain trust through the use of communication technology;

. . .

4) monitor team progress using technology;

5) enhance visibility of virtual members within the team and outside in the organization; and

6) enable individual members of the virtual team to benefit from the team."

Differing performances of teams can in many cases be attributed to a set of conditions: limited Internet availability and bandwidth, lack of training for certain tools, as well as the wrong selection and use of tools that are not integrated or do not support adequate sharing among team

members and that, finally, do not 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. While communication is the heart of project teams, sharing is the soul of project teams that are virtual and that are using web-based tools. My theory elucidates the different roles played by trust in the selection, use, and change of tools to assist virtual teams. It summarizes and endorses research findings on specific aspects of trust in virtual teams.

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.

Furthermore, my theory emphasises 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 use of web-based tools in a distributed work setting.

8.1.2 Theoretical Contributions

As the major theoretical contribution, my research study provides a holistic theoretical framework for the effects of web-based tools on virtual project teams. The goal of my research was to develop a theory that will help to explain the selection and use of web-based tools by virtual teams operating in different contexts, and to illustrate the consequences of using different tool combinations to support their project management activities. This is in line with Gregor (2006) proposing that a theory in Information Systems can serve the function of explanation, while Urquhart *et al.* pointed out that the grounded theory approach is capable of generating such a theory.

The identification of an organized framework of relevant variables as shown in Figure 49 helps researchers in their work to explain the selection, use and change of tools/tool combinations for virtual teams. It categorizes the different factors influencing the selection-use-change cycle and emphasizes the concepts important for the selection and use of web-based tools by virtual teams operating in different contexts.

Theories like the Task Technology-Fit Model (Goodhue & Thompson, 1995), the Media Synchronicity Model (Dennis & Kinney, 1998), the Media Naturalness Theory (Kock, 2004), as well as Thomas and Bostroms' (2010) Five Trigger Model describe single aspects of the role of technology to

support virtual teams. My theory gives a holistic explanation of how these single aspects contribute to the team's performance and the team member's satisfaction in a virtual work setting when selecting and using Internet/web-based tools. The theory shows the dependencies in action of the three phases: selection, use, and change. From the contextual aspect, it seems to be important to consider individual (team member), team, and organizational issues (the project).

8.1.3 Methodological Contributions

This research is expected to make a methodological contribution to the debate concerning the use of grounded theory in the analysis of virtual project teams, using the Straussian coding paradigm to investigate individual as well as organizational issues. I was able to demonstrate how theoretical sampling could be done over several slices of data in a series of studies. After comparing Strauss (1990) and Glaser's (1992) differing approaches on applying the Grounded theory, I decided to follow the Straussian approach, because my research is located on the micro-sociological level and the coding paradigm seemed to better meet the requirements of my phenomena under investigation.

8.2 *Limitations of my Research*

Some of my limitations are related to the educational environment of my research setting. I, as the researcher, coordinator, and participating lecturer, formed part of the research setting at BHT and influenced the setting. There are ethical issues involved in conducting research in an educational setting where the marks can influence whether a student passes or fails a course module. I was not, therefore, a completely independent observer; however, I separated my research activities from tasks performed as course convener at BHT. In addition, the marking of the projects at BHT was done by a different participating lecturer. At UCT I was neither participating lecturer nor coordinator.

Another limitation of my research is related to the realistic nature of the project and the assessment of project success and performance in an educational environment. This is a general concern because, according to Martins, Gilson and Maynard (2004), much of the empirical research on virtual teams has been conducted in laboratory settings, using student teams working on short-term tasks. On the other hand, using new technology like the web-based project management tools in a real-world project situation is a difficult undertaking, especially if you wish to analyze a larger number of project teams.

The context of student groups, furthermore, frees my research from certain power relations within the typically hierarchical power structure of companies and therefore it serves to endorse my research findings. The freedom from power relations was partly restricted with regard to the university norms on the teaching platforms Vula and Moodle. Besides this, it was left to the teams to select those tools that help them best to accomplish their project task. The technology does not determine the way in which the teams do their project work; instead, the teams decide on the technology that will support them in their projects. Nevertheless student knowledge or lack of knowledge of the available options strongly influenced the tool choices that the students made.

Further, researchers and practitioners 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 (Majchrzak, Rice, Malhotra, King, & Ba, 2000).

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 knowledge and experience. Projects at an undergraduate level are most likely a first-time experience for team members of developing a comprehensive information system. Thus these projects might not be of a sufficiently high standard to be implemented immediately in a business environment at a pre-determined hand-in date.

In the projects in my research setting, a comprehensive assessment strategy, implementing various instruments to accomplish formal summative assessment, formal continuous assessment, and informal formative assessment can greatly enhance the quality of projects and their chances of successful implementation (Scott & van der Merwe, 2003). It can therefore be argued that teams achieving low marks are more likely to deliver a project failure and teams with high marks are more likely to deliver a project success. Much of the data gathered for this study was from the students' perceptions of their project success, through interviews with the students, questionnaires on the lessons learned, and the peer evaluations of the teams.

One major aspect of virtual teams is that there is a geographical distance between team members. In the projects at UCT and BHT, team members were not spread across each country or the world. But they provided many characteristics typical for virtual teams in major organizations through 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 factors such as travel expenses, involvement in different courses, and employment while studying. All these factors helped to ensure a setting for the virtual teams focussed on in this study that is not dissimilar

to that to be found in major organizations. According to Fiol and O'Connor (2005) as well as Kraut *et al.* (2002), the effects of proximity among team members fall off rapidly with even very small distances. Therefore, even team members who reside near each other but who never meet may experience very similar dynamics to those who interact across large distances.

8.3 *Suggestions for Future Research on the Emergent Theory*

Many limitations of my research relate to the fact that teams were set up in an educational environment. Therefore future research on the emergent theory should be proving its applicability in 'real world' projects. For example, researcher 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 (Majchrzak, Rice, Malhotra, King, & Ba, 2000).

Further in the emergent theory a security incident triggered the change of the tool. With regard to ICT adequacy from Thomas and Bostrom (2010) the missing security features might be part of a larger category of tool weaknesses or failures, which almost certainly would cause tool choices to be reevaluated in the selection phase. Therefore, this could be proven as an interesting area for future research and to amend my framework of relevant variables for explaining the change of tools/tool combinations in virtual teams.

Even though in the analyses of the interviews a number of issues emerged that explained why a specific tool was not accepted by a team and therefore was less frequently used or even abandoned, I did not evaluate usability and acceptance of tools in virtual teams in my research. Therefore in future research the TTF-Model (Goodhue & Thompson, 1995) could be an interesting approach to follow up and look for usability, tools and technology in virtual teams.

8.4 *Evaluation of Contribution*

8.4.1 Evaluation According to the Guidelines for Grounded Theory Studies in Information Systems

Urquhart *et al.* (2010) revisited the matter of the application of grounded theory in Information Systems and suggested a number of guidelines for grounded theory studies in this field. In their article they applied their guidelines to analyses of three grounded theory studies.

In a form of self-assessment, I applied the guidelines from Urquhart *et al.* (2010, p. 13) to my grounded theory study, using the same criteria to evaluate and to explain what I had done to take these guidelines into account.

Table 79 - Applied Guidelines in my Grounded Theory Research Study

Guideline	Description	Research in my thesis
Constant Comparison	"Constant comparison is the process of constantly comparing instances of data labelled as a particular category with other instances of data in the same category. Constant comparison contributes to the development of theory by exposing the analytic properties of the codes and categories to rigorous scrutiny. This guideline for data analysis encourages researchers to be both rigorous and theoretical (Charmaz, 2006)."	Constant comparison had been applied as explicitly mentioned at different places in my thesis. Within every data slice I compared the data of the new interviews with the concepts and categories coded into the tool NVivo. For every new data slice I coded the concepts into the tool and compared them with the coded data so far. My drafted relationships were revised on the basis of new, upcoming data. New properties were added to the concepts. Concepts, categories, and relationship were underpinned within this thesis with selected quotations from different data slices NVivo helped to keep track of which concept was coded on the basis of which interviews.
Iterative Conceptualization	"This guideline suggests that researchers should increase the level of abstraction and relate categories to each other through a process of iterative conceptualization. In grounded theory, this is done using theoretical coding. The relationships between categories can be of many different types, not just causal. Theoretical coding contributes to an understanding of relationships between the concepts or factors of a theory. Theoretical memos are also very important to the development of theoretical coding and the whole process of iterative conceptualization."	I iteratively drew my concept and categories, as well as relationships, out of different data slices and applied the Strauss and Corbin (1990) coding paradigm. This served to identify patterns in the selection, use, and change of web-based tools in the virtual teams.
Theoretical Sampling	"This guideline stresses the importance of deciding on analytic grounds where to sample from next in the study. Theoretical sampling helps to ensure the comprehensive nature of the theory, and	I started with convenience sampling as this method is often used at the beginning of a research study (Morse, 2007). After the analysis of my first interviews, I pursued the principle of

Guideline	Description	Research in my thesis
	ensures that the developing theory is truly grounded in the data."	theoretical sampling with regard to concepts that seemed relevant to the problem and came up during the previous interviews (e.g. team size, tool restrictions, Internet access, security, experience in virtual team work, project type, and project sponsor). The boundaries of my theoretical sampling go in line with the limitations of my research (e.g. student teams, organisational restrictions of the universities, team and project experience, and degree of virtuality). For every new data slice the applied theoretical sampling was described at the beginning of the section. I explicitly pointed out the differences and I explained the reasons in detail.
Scaling up	"This guideline suggests how a researcher might counter what is said to be a common problem in grounded theory viz. the production of a low level theory, which is then hard to relate to the broader literature. Scaling up is the process of grouping higher-level categories into broader themes. Scaling up contributes to the generalizability of the theory."	In the emergent theory are four categories and a limited number of sub-categories. These categories build the basis of the theory. In the development of my theory I mapped the relevant concepts and relationships following the process paradigm. Additional concepts and relationships that revealed interesting findings but were not part of my theory I discussed separately.
Theoretical integration	"This guideline helps the researcher deal with what we think is an obligation of the grounded theorist – theoretical integration. Theoretical integration means relating the theory to other theories in the same or similar field. It is the process of comparing the substantive theory generated with other, previously developed, theories. This principle contributes to theoretical integration in the discipline and could help in the generation of formal theories."	In their analysis of the use of technology in the virtual team research Schiller and Mandviwalla (2007) scanned articles on virtual teams from 18 top journals and identified 25 relevant virtual team theories. My theory on the selection, use, and change of Internet-based tools was discussed in detail as it related to different theories relevant for my field, in particular, the Media Richness Theory, Media Synchronicity Theory, Swift Trust Theory, Task Technology Fit Model, Task Media Fit Theory, and Media Naturalness Theory.

8.4.2 Whetten's Model for Determining what Constitutes a Theoretical Contribution

Whetten's model (1989) for evaluating a theoretical contribution provides seven questions that should be asked about the findings of a research study. These questions are as follows: *What is new? So what? Why so? Well done? Done well? Why now? Who cares?* These questions guide the evaluator to come up with a holistic and objective evaluation of the theoretical contribution to knowledge of a particular study. This section has some overlap with the previous sections where I have described my contributions and assessed my methodological approach, but Whetten's model highlights my contributions from a different angle, which might justify these overlaps.

8.4.2.1 What is new? Does the research make a significant value-added contribution the current thinking?

The emergent theory explains how the selection, use, and change of web- based tools in projects with a varying degree of virtuality influence the team's effectiveness and the satisfaction of both the team and its members. It shows the different causal conditions and explains them in the context of team, project, and the individual team member.

My research results show how the different technological environments of a developed and a developing country influence the selection and use of technology. Limited access to the Internet has a strong impact on the available media richness, hence on the communication processes within project teams: as a result, virtual project teams with limited Internet access are less effective than those with unlimited access.

However, there emerged clear areas where tool selection and use--or lack thereof--influenced the effectiveness of the team and team members' satisfaction. As mentioned above, while communication is the heart of project teams, is the soul of project teams that are virtual and that are using web-based tools.

The emergent theory elucidates the different roles of trust in the selection, use, and change of tools to assist virtual teams; the theory also summarizes and supports research findings on specific aspects on trust in virtual teams. Transparency in task management via awareness of tools or of task is a key issue that influences the team members' satisfaction in a virtual team setting. Here, trust is an antecedent for making use of task transparency. Sharing of information by using a tool on the other hand, does not merely increase team's effectiveness; it also helps to build up trust in the team.

In addition, the emergent theory highlights the fact that, besides the project and team contexts, the team members' individual preferences and personal distance from work play an important role in the selection and use of web-based tools in a distributed work setting.

In the course of this research, I finalized a number of conference and journal papers relating to my research field; this enabled me to discuss my results with other researchers and to share ideas about research approaches and research topics in the following areas: project management and virtual teams, project management in the educational environment, and virtual teams and tools:

- Weimann, P., Pollock, M., & Scott, E. C., (2011) Comparing Team Virtualness: A study of German and South African student project teams, Australasian Journal of Information Systems, submitted
- Scott, E., Weimann, P., & van der Merwe, N., (2011) The role of the lecturer as teacher, researcher and mentor in a project-based approach for IS/IT majors at three different academic institutions, European Conference on Information Management and Evaluation, Italy
- Weimann, P., Hinz, C., Scott, E. C., & Pollock, M. , (2010). Changing the Communication Culture of Distributed Teams in a World Where Communication is Neither Perfect nor Complete. *The Electronic Journal Information Systems Evaluation, 13 (2),* pp. 187-96
- van der Merwe, N., Scott, E. C., & Weimann, P., (2010). Can a project-based approach enable IS/IT graduaters to add the F to IT, International Conference on Information Management and Evaluation, University of Cape Town, South Africa on 25th & 26th March 2010
- Weimann, P., Hinz, C.R., Scott, E. C., & Pollock, M., (2010). Communication Technology and Culture in Distributed Teams of a Large German Manufacturer, International Conference on Information Management and Evaluation, University of Cape Town, South Africa on 25th & 26th March 2010
- Scott, E. C., Brown, R., Pearce, J., & Weimann, P., (2009). Ensuring Success and Quality through the Use of Standards in Team Projects: Students' Perceptions. (Eds. Tatnall & A Jones) Education and Technology for a Better World, New York: Springer
- Weimann, P., Scott, E. C., & Pollock, M., (2009). How the Virtualness of Project Teams effects their Performance, Proceedings of the IX IRNOP Conference on "Organizing by Projects" Berlin, Germany, October 11–13, 2009
- Weimann, P., & Kschonsak, F., (2008). Managing Projects via the Internet, Conference Proceeding ZAWWW 08

Based on this thesis two more journal articles are submitted or drafted for 2012:

- Weimann, P., Pollock, M., Scott, E. C. & Brown, I., (2012). The Impact of Tools and Technology on Team Effectiveness when Managing a Project, IEEE Transactions on Professional Communication, under revision
- Weimann, P.; Pollock, M., Scott, E.C. & Brown, I., (2012). An Organizational Framework for the Use of Web-Based Tools in "Virtual" Project Teams, drafted

8.4.2.2 So What? Will the theory likely change the practice of Information system research?

The developed theory underpins the vital signs for virtual teams as proposed by Bjørn and Ngwenyama (2010) in the area of ICT inadequacy, trust, and team member relationships. The alignment of tools, team's trust, and social cohesion as well as team members' individual technology and work preferences is an important research matter warranting further research.

The emergent theory provides a holistic view and shows that existing selection theories, such as MST, MNT and TTF, are able to explain only single aspects in the selection and use of tools in virtual project teams.

My research study demonstrates that cultural diversity is difficult to assess in the national environments of multi-cultural societies such as those of South Africa and Germany. This is partially supported by Erez and Gati (2004), in the dynamic of their multi-level cultural model, and by Ancona's (1987) findings that even when team members belong to a specific national culture they will be influenced by the context (team or organization) in which they are living or working.

Further, my findings underline the necessity to investigate usability and acceptance of web-based tools in virtual project teams; this is because usability and acceptance are relevant in the use of web-based tools, and they influence the team's effectiveness and the satisfaction of team members in a virtual work setting.

8.4.2.3 Why so? Are the underlying logic and supporting evidence compelling?

In the last three years I observed, questioned, and interviewed, in total, 28 project teams with 167 team members. I followed the grounded theory approach as described by Corbin and Strauss (2008) and as guided by experienced researchers in this field (e.g., Orlikowski (1993), Pandit (1996), Urquhart (2007), and Urquhart, *et al.* (2010)) in the sampling and analyses of these teams, and I have aimed at development of a resultant theory. Studying the use of web-based tools in a

"virtual" work setting, I took an interpretative research stance (Klein & Myers, 1999) on project teams in an educational environment. I collected data from these project teams via direct observation, questionnaires, documentation, and--as main data source--through semi-structured interviews. Urquhart *et al.* (2010) revisited and re-examined the application of grounded theory in Information Systems. This led to their suggesting a number of guidelines for grounded theory studies in Information Systems. In their articles they applied their guidelines to analysis of three grounded theory studies. I followed those guidelines in my research study. In a form of self-assessment, I evaluated my research using the criteria from Urquhart *et al.* (2010, p. 13) for my grounded theory study and I explained what I have done to take these guidelines into account (see Table 79).

8.4.2.4 Done well and well done? Is the thesis well written? Does the thesis reflect seasoned thinking?

The goal of this research was to develop a theory that will help to explain the selection and use of web-based tools by virtual teams operating in different contexts, and to illustrate the consequences of using different tool combinations to support project management activities. This is in line with Gregor (2006) proposing that a theory in Information Systems can serve for explanation. Urquhart *et al.* (2010) pointed out that the grounded theory approach is capable of generating such a theory. I decided to follow the Straussian approach, because my research is located on the micro-sociological level and the coding paradigm seemed to better meet the requirements of my phenomena under investigation. The Strauss and Corbin (1990) approach has been successfully applied to similar problems in related areas in Information Systems research. It has been applied by Orlikowski (1993) to understand Information Systems as they are used in the organizational environments. Sarker *et al.* (2000) used it for developing a process model for collaboration in virtual teams, Maznevski & Chudoba (2000) made use of it for studying global virtual team dynamics, as well as Pauleen (2003) for leadership-initiated relationship building within virtual teams.

According to Martin (2006), the appropriate use of literature following the grounded theory approach is a matter of phasing. It is accepted among researchers (e.g., Andrews (2006), Dey (1999), and Martin (2006)) using the grounded theory approach, that a pre-study literature research should be conducted to find the research problem, as long as it is done in such a way that it does not influence the researcher in developing his theory on basis of his data. In a first phase of my literature review I studied the literature to find and justify my problem. In the second phase, I compared and contrasted the developed theory on 'Selection, Use and Change of Tool/Tool Combination in

"Virtual" Project Teams' with the related research literature, and discussed the findings critically. This approach of weaving in the literature into the findings and by not performing an extensive literature review upfront has been pursued before for example by Strong and Volkoff (2010).

For every new data slice, the applied theoretical sampling was described at the beginning of the section. I explicitly pointed out the differences in the new sampling and I explained the reasons for the sampling in detail. Further, I made my research results transparent in documenting the results of the analyses of each data slice.

In addition, my theory on the selection, use, and change of Internet-based tools was discussed in detail in relation to different theories relevant to my field, in particular, the Media Richness Theory, Media Synchronicity Theory, Swift Trust Theory, Task Technology Fit Model, Task Media Fit Theory, and Media Naturalness Theory. I included in the discussion the latest articles on relevant issues such as virtual teams, CSCW, teams and technology, and project management, in the leading journals (e.g., *MIS Quarterly*, *Information Systems Research*, and *European Journal of Information Systems*) important to my research context.

8.4.2.5 Why now? Is the topic of contemporary interest to scholars in this area?

Nunamaker *et al.* (2009) highlight as drivers for the emergence of virtual teams among other the ubiquitous Internet technologies, the rapidly changing competitive environment, and the trends towards outsourcing and strategic alliances.

The environment within which a project team functions is a crucial element contributing to effective teamwork. As pointed out by Bjørn and Ngwenyama (2010), the alignment of task, technology, and team is often neglected in research into virtual teams. The lack of attention towards technology in the research of virtual teams is a symptom of a general weakness in IS research, as has been emphasized by Orlikowski and Iacono (2001). 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 at the workplace of the individual team members.

8.4.2.6 Who cares? What percentage of academic readers are interested in this topic?

My theory addresses the academic reader involved in virtual team research and the evaluation of different theories (e.g., MST, MNT, and TTF) for technology selection and use to explain team behaviour and team process outcomes (e.g., effectiveness, project success, and team member

satisfaction). The academic reader interested in the application of grounded theory to explain behaviour following the Straussian strand, is another target group, especially relating to how such theory can be applied to study individual and organizational issues. Yet another target group is composed of professionals interested in setting up virtual project teams in their organization. My theory helps them to build up their specific supporting framework to ensure success, effectiveness, and team member satisfaction of their project teams. Finally, my research might be interesting for policy makers and entrepreneurs as it underlines the importance of a technological infrastructure so as to be able to compete on the global market.

8.5 *Concluding Remarks*

In summary I evaluated my 'Theory on the Selection, Use, and Change of Web-based tools' with three approaches. First of all, I used guidelines from Urquhart *et al.* (2010) to show the appropriate application of the grounded theory approach and I assessed the methodological correctness. The evaluation showed that the grounded theory approach complied with the criteria provided. Then I discussed and related my theory as it relates to other theories in the field, and I showed its theoretical relevance. Finally, I provided an evaluation of the current research according to Whetten (1989) and explained the relevance of my findings to researchers as well as to practitioners.

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10. Attachments

10.1 *Ethics Committee Approval*

UNIVERSITY OF CAPE TOWN

Faculty of Commerce
Ethics in Research Committee

Courier: Room 2.21 Leslie Commerce Building Upper Campus University of Cape Town
Post: University of Cape Town • Private Bag • Rondebosch 7701
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Fax No.: +27 21 689-7570

28 July 2009

Mr Peter Weimann
Department of Information Studies
University of Cape Town
hans.weimann@uct.ac.za

Dear Peter

Project title: An organizational framework for the use of web-based tools in "virtual" project teams

This letter serves to confirm that the project entitled **An organizational framework for the use of web-based tools in "virtual" project teams,** as described in your final submitted protocol dated 12 May 2009, has been approved subject to final confirmation by the Commerce Faculty Ethics in Research Committee. You may proceed with the research.

Please note that if you make any substantial change in your research procedure that could affect the experiences of the participants, you must submit a revised protocol to the Committee for approval.

Best wishes for great success with your research.

Regards

JJ BAGRAIM

A/Prof Jeff Bagraim
Chair: Commerce Faculty Ethics in Research Committee

"OUR MISSION is to be outstanding teaching and research university, educating for life and addressing the challenges facing our society."

10.2 *Survey Questionnaire UCT 2008/2009*

Project Team Name/Number:_____

This questionnaire should take you a maximum of 15 minutes to complete. Please answer the questions honestly. Your identity will remain anonymous. No effort will be made to identify you and the answers provided will have no impact on your project mark. However, in our research, we need to investigate the opinions of each project group and therefore need to identify which team you are in.

Communication and information technology plays an important role in the management of projects. Therefore we would like to know how frequently you used the different tools to handle project management issues like:

1. setting up a team meeting via email,
2. planning and controlling your project tasks via a web-based issue handling system,
3. cooperating via wiki-website or forum,
4. sharing information and knowledge via a website,
5. or even meeting in a specific chat room, or
6. sharing information via SMS.

	Daily	Two- three times per week	At least once per week	At least once per month	Less than once per week	Never	Not available
Face to face team meeting							
Net-Meeting/Skype							
Phone							
MS Project Web Access/T							
Web-based task tracking							
Web-based time sheet management							
Team calendar (e.g. google calendar)							
UCT elearning platform Vula							
E- Mail							
Chat							
Text messaging							
Other:							

Describe the technological or organisational issue that could improve the management of your project!

10.3 *Survey Questionnaire BHT 2009/2010*

Project Team Name/Number:_____

This questionnaire should take you a maximum of 15 minutes to complete. Please answer the questions honestly. Your identity will remain anonymous. No effort will be made to identify you and the answers provided will have no impact on your project mark. However, in our research, we need to investigate the opinions of each project group and therefore need to identify which team you are in.

Communication and information technology plays an important role in the management of projects. Therefore we would like to know how frequently you used the different tools to handle project management issues like:

7. setting up a team meeting via email,
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9. cooperating via wiki-website or forum,
10. sharing information and knowledge via a website,
11. or even meeting in a specific chat room, or
12. sharing information via SMS.

	Daily	Two- three times per week	At least once per week	At least once per month	Less than once per week	Never	Not available
Face to face team meeting							
Net-Meeting/skype							
Phone							
Web-based task tracking							
Web-based time sheet management							
Team calendar (e.g. google calendar)							
Moodle							
E- Mail							
Chat							
Text messaging							
Other:							

Describe the technological or organisational issue that could improve the management of your project!