COLLABORATIVE DISTANCE

Investigating Issues Related to Distance Factors Affecting Collaboration Performance.

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ABSTRACT

Both organisations and individuals are using more collaborative work, across geographic, disciplinary and organisational boundaries, leading to increased demand for Information and Communication Technologies (ICT) to support a more effective and efficient distributed collaboration. This thesis presents an empirical study exploring various aspects related to collaborative distance in the context of innovation projects. It focuses on the investigation of issues related to distance factors that affect collaboration effectiveness and efficiency.

A total of 14 focus group interviews, undertaken with 75 participants in a comparative study of 14 project cases, revealed sufficient evidence on distance factors in the context of mixed (face-to-face and online or virtual) collocation modes. The results confirmed the positive role of collaboration technology for compressing geographical and temporal types of distance; other distance types were also bridged, however, other distance types were created.

This empirical study aims to enlarge the academic understanding of distance factors by disambiguating their description and deciphering their role in the collaboration process, and clarifying the reasons for the use and improvement of collaboration technology for overcoming collaborative distances. It also confirms that distance factors raise collaboration barriers, and reveals that they disturb the collaboration mechanics by hindering knowledge workers' capacity to reach a mutual understanding. Such findings have deep implications for the future enhancement of collaboration technology to fill the current gaps in distributed collaboration, also called e-Collaboration.

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GLOSSARY

Abbreviations	Descriptions
AR	Augmented Reality
BSCW	Basic Support for Collaborative Work
CD	Collaborative Distance
CDF	Collaborative Distance Framework
CE	Concurrent Engineering
CMC	Computer Mediated Communication
CoI	Community of Interest
CoP	Community of Practice
CSCW	Computer Support for Cooperative Work
CWE	Collaborative Working Environment or Web Environment
DKM	Distributed Knowledge Management
EA	Expectation Awareness
EN	Events Notification
FEI	Front-End Innovation (also called Fuzzy Front End)
FFE	Fuzzy Front End (also called Front-End Innovation)
FGI	Focus Group Interview
GDSS	Group Decision Support Systems
GDT	Geographic Dispersion in Teams
HCI	Human-Computer Interaction
ICT	Information and Communication Technology
IDEF0	Integrated Definition for Functional Modelling, version 0
IEC	Inter-Enterprise Collaboration
IM	Instant Messaging
IOC	Inter-Organisational Collaboration
IP	Intellectual Property
IPO	Input-Process-Output
IPR	Intellectual Property Rights
IST	Information Society Technology
ISTAG	IST (Information Society Technology) Advisory Group
KM	Knowledge Management

Abbreviations	Descriptions
MR	Mixed Reality
MWC	Mobile Wearable Computing
NPD	New Product Development
OBS	Organisational Breakdown Structure
PBS	Product Breakdown Structure
SADT	Structured Analysis and Design Technique for system description
SG	Serious Gaming
SN	Social Networking
SNA	Social Network Analysis
SW	Shared Workspace (also called Collaborative Web Environment)
VR	Virtual Reality
VT	Virtual Team
WBS	Work Breakdown Structure

PUBLICATIONS

Conference Papers

Main author

- Pallot, M., Bergmann, U., Kühnle, H., Pawar, K. S., Riedel, J. CKH (2010), Collaborative Working Environments: Distance Factors Affecting Collaboration. In: Proceedings of the 16th International Conference on Concurrent Enterprising, ICE'2010 "Collaborative Environments for Sustainable Innovation", Lugano, Switzerland, 21-23 June 2010, Centre for Concurrent Enterprise, University of Nottingham, Nottingham. ISBN 9780853582 700. www.ice-proceedings.org.
- Pallot, M., Richir, S., Samier H. (2008), Shared Workspace and Group Blogging Experimentation through a Living Lab approach. In: Thoben, K-D; Pawar, KS & Goncalves, R. (2008) Proceedings of the 14th International Conference on Concurrent Enterprising, ICE'2008 "A new wave of innovation in Collaborative Networks", Lisbon, Portugal, 23-25 June 2008, Centre for Concurrent Enterprise, University of Nottingham, ISBN 978 0 85358 244 1.
- Pallot, M., Ruland, R., Traykov, S., Kristensen, K. (2006), Integrating Shared Workspace, Wiki and Blog Technologies to Support Interpersonal Knowledge Connection. In: Thoben, K-D; Pawar, KS; Taisch, M; & Terzi, S. (2006) Proceedings of the 12th International Conference on Concurrent Enterprising, ICE'2006 Innovative Products and Services through Collaborative Networks – 26-28 June 2006, Milan, Italy, University of Nottingham, Nottingham. (ISBN 0 85358 228 9).
- Pallot, M., Prinz, W., Pawar K. (2006), Stimulating Creativity and Innovation through People-Concepts Connectivity within on-line Collaborative Workplaces. Proceedings of the IRMA 2006 conference, Washington, USA.
- Pallot, M., Prinz, W., Schaffers, H. (2005), Future Workplaces, towards the Collaborative Web. Proceedings of the AMI@Work Forum 2005 – Munich, June 2005.
- Pallot, M., Pawar, K., Salminen, V., Pillai, B. (2004), Business Semantics: The Magic Instrument Enabling Plug & Play Collaboration? In: Thoben, K-D; Pawar, K.S. & Weber, F. (Eds) (2004) Proceedings of the 10th International Conference on Concurrent Enterprising, ICE'2004 Adaptive Engineering for Sustainable Value Creation, 16-18 June 2003, Seville, Spain, University of Nottingham, Nottingham. (ISBN: 0 85358 128 2).

Co-author

- Prinz, W., Ruland, R., Peristeras, V., Pallot, M. (2008), Towards Shared Workspace Interoperability, ECOSPACE Newsletter Special Issue on Interoperability within Collaborative Environments, Published by the ECOSPACE Consortium.
- Martikainen, O., Pallot, M., Alasalmi, A. (2007), Collaboration Model based on Entity-Concepts Connectivity. In: Pawar, KS; Thoben, K-D & Pallot, M. (Eds) (2007) Proceedings of the 13th International Conference on Concurrent Enterprising, ICE'2007 Concurrent Innovation: an emerging paradigm for Collaboration & Competitiveness in the extended enterprise, 4-6 June 2007, Sophia-Antipolis, France, Centre for Concurrent Enterprise, University of Nottingham, ISBN 978 0 85358 2335.

- Antoniac, P., Pallot, M., Pulli P. (2006), Virtual and Augmented Reality Supporting Group Consciousness within Collaborative Working Environments. In: Thoben, K-D; Pawar, KS; Taisch, M; & Terzi, S. (2006) Proceedings of the 12th International Conference on Concurrent Enterprising, ICE'2006 Innovative Products and Services through Collaborative Networks – 26-28 June 2006, Milan, Italy, University of Nottingham, Nottingham. (ISBN 0 85358 228 9).
- Schaffers, H., Prinz, W., Pallot, M., Fernando, T. (2005) Mobile and collaborative workplaces: An agenda for innovation. Proceedings of the eChallenges conference e'2005 Innovation and the Knowledge Economy: issues, Applications, Case Studies - Ljubjana, Slovenia.

Newsletter Articles

- Pallot, M., Trousse, B., Senach, B., Richir, S., de Ruyter, B. Prinz, W. Rerolle, O., Katzy, B. (2008), Living Lab Research, ECOSPACE Newsletter Special Issue on Living Labs, Published by the ECOSPACE Consortium.
- Pallot, M. (2004), Towards Community based Collaborative Workplaces, article published in the MOSAIC Newsletter, July 2004.

Journal Articles

Main author

- Pallot, M. Martinez-Carerras, A., Prinz, W. (2010), Collaborative Distance: A Framework For Distance Factors Affecting The Performance Of Distributed Collaboration. *The International Journal of eCollaboration*, Special Issue on Collaborative Working Environments (CWE), 6(2), 1-32, April-June 2010.

Co-author

- Prinz, W., Martinez-Carerras, A., Pallot M. (2010), From Collaborative Tools To Collaborative Working Environments. *The International Journal of eCollaboration*, Special Issue on Collaborative Working Environments (CWE), 6(1), 1-13, January-March 2010.

Books & Chapters

Main author

- Pallot, M., Bergmann U. (2010), Collaborative Virtual Environments and Immersion in Distributed Engineering Contexts, Book Title: *Distributed Manufacturing: Paradigm, Concepts, Solutions and Examples*. Edited by H. Kühnle, Published by Springer-Verlag.

Co-author

- Schaffers, H., Brodt, T., Pallot, M., Prinz, W. (2006) The Future workspaces: perspectives on Mobile and Collaborative Working. The MOSAIC Consortium. Published by Telematica Instituut - The Netherlands - ISBN 90-75176-00-7.

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Chapter 1. Introduction

Somewhere, something incredible is waiting to be known. - Carl Sagan

This chapter describes the background and distinctive features of distributed collaboration. It also outlines the research scope and background, including motivation, research goal, significance, strategy, objectives and questions. The chapter concludes with a description of the thesis structure and an overall map of this empirical study on collaborative distance.

1.1 Motivation, Research Scope and Objectives

Increasing globalisation implies that more and more companies are outsourcing design and production activities around the world. This in turn means that there is a high level of inter-firm interaction within a multidisciplinary, multicultural, multilingual and multi-site context, often involving different continents and time zones. Within this kind of networked environment, a more effective collaboration amongst various stakeholders becomes essential, especially when innovative capability is at the heart of a firm's competitiveness. In parallel with this development, there is a trend within society for employers and employees to adopt more flexible working arrangements (Puybaraud, 2004, 2005).

The Internet is the prime driver for this 'new' way of working, alongside pressure from the wider society (Schaffers et al., 2006). This flexible and mobile way of working is gaining increased acceptability due to potential benefits for both parties (Vendramin & Valenduc, 1998). The workers involved, often labelled knowledge-workers (Tapscott & Anthony, 2006) or eProfessionals (Prinz et al., 2006), make extensive use of ICT and remain remotely in constant touch with other people through Internet technologies. Increasingly they require and rely on collaboration facilities or services such as on-line or virtual collaborative space. Arguably this space is the 'workplace' of many such knowledge workers or eProfessionals, and the relevant technology is currently undergoing considerable evolution and development (Schaffers et al., 2006).

Open Innovation (Chesbrough, 2003), another current trend, attempts to gather knowledge workers or eProfessionals within a 'community of practice' or 'knowledge community'. Organisations' boundaries become more permeable as they need to collaborate in adopting a widely distributed knowledge approach. Several organisations, such as InnoCentive[1] and NineSigma[2], already operate as open innovation intermediaries. Hence, New Product Development (NPD) and Front End Innovation (FEI) (Poskela et al., 2005) practices have slowly evolved from face-to-face collaboration towards online or distributed collaboration (also named eCollaboration).

Sharifi and Pawar (2001), in a paper exploring physically and virtually collocated teams in NPD, find that aspects such as trust, working relationship, integrity and common purpose are pivotal to team effectiveness. They note that this point is supported by Coutu's (1998) study of 29 virtual teams operating globally, which found that trust can and does exist in virtual teams but that it develops in a very different way than in physically collocated teams. Coutu found that the formation of trust in teams is similar to that in other social systems; the beginning is filled with uncertainty, unfamiliarity and fear of the unknown. As shown in one of Sharifi & Pawar's case studies, the initial face-to-face meeting thus becomes crucial to the gelling of the team. In their survey, respondents perceived physical collocation as a more appropriate context for building relationships.

Sharifi and Pawar (2001) also note that collocation of teams is often adopted as an ad hoc solution or means. This has implications for the performance of the team, and subsequently for the ways experiences can be shared and disseminated across the enterprise. The authors observe that a team matures and develops the coherence that is needed to fulfil its mission. They also find that collaboration is vital to the success of concurrent engineering (CE).

Prasad (1998) argues that 'traditional' organisational forms can inhibit teamwork, and suggests that integrative means such as technological and virtual concurrent teams can enhance interactions. Similarly, Pawar et al. (1999) present the importance of establishing 'concordance'

[1] http://www.innocentive.com/

[2] http://www.ninesigma.com/

within teams during the design and development of new products. Pawar and Sharifi (1997) argue that, in view of the existing diversity among team members in their understanding and interpretations of the 'design language', both intra- and inter-team communication become even more vital to the team performance. In their study, advanced telecommunication systems such as electronic mail and engineering databases were considered to facilitate a kind of virtual team collocation and to simulate face-to-face communication (Pawar & Sharifi, 1997).

However, Pawar and Sharifi (1997) also observed that distributed design teams (virtually collocated) encountered problems related to language barriers, technology incompatibility, different company practices, constraints in accessing information quickly, and geographical distribution and different time zones. The lack of informal exchanges and proximity were identified as leading to problems of motivation among team members, such as feelings of isolation and frustration. Sharifi and Pawar's study revealed that 'out of sight out of mind' syndrome may develop in the distributed design team context, which may cause low morale and consequently lead to decreased cohesiveness. Sharifi and Pawar (2002) conclude that:

> *the advent of telecommunication innovations has shortened distances and time to such an extent that geographic limits cease to exist and is truly seen as one of the major forces enabling economic globalisation. The Internet, E-mail, video conferencing, etc have changed the way business was done a decade earlier. However, it should be noted that having the advanced technology alone would not provide for an effective and efficient virtual co-location of design teams. On the contrary, selection of the appropriate technology and defining its use with relevance to the design needs to be seriously taken into consideration.*

The above issues highlight the motivation of this empirical study, in which the main objective is to provide a holistic model and increased understanding on the various distance factors that impede a necessary level of proximity among distributed group members, as stated by Sharifi and Pawar (2002). This empirical study further investigates the mechanics of collaboration and explores issues surrounding the role of mutual understanding in distributed collaboration through the use of online Shared Workspace technology. Hence, this is not another comparative study between collocated and distributed team models, but rather a holistic observation and exploration of distance factors affecting the collaboration mechanics and performance, whatever the working mode (e.g. collocated, distributed, mixed) in which a group uses collaboration technology.

In this context, project stakeholders, whatever their respective geographic location, need a Collaborative Working Environment (CWE) for sharing knowledge and reaching a mutual understanding that enables the creation of new knowledge (Pallot et al., 2005; Prinz et al., 2006). The CWE promotes the use of specific collaboration tools such as online Shared Workspace for sharing knowledge among project stakeholders. While there have been many studies related to proximity and distance factors, as stated by Boschma and Knoben and Oerlemans (Boschma, 2005; Knoben & Oerlemans, 2006), there is little understanding about distance factors and the role of mutual understanding within the collaboration mechanics. Unfortunately, the current research body lacks a holistic view and framework that captures all the dimensions of distributed collaboration and its related distance factors.

1.2 Research Questions

Main question: **How do eProfessionals collaborate within an appropriate level of performance regardless of their location (mixed mode of physical and virtual collocation)?**

E-professionals are people who do not necessarily work from a single location or for one single organisation, but rather as experts offering their experience to several organisations according to project demand in terms of requested competences and experience. They are members of at least one, but often several, communities of practice where they share and develop visions, roadmaps, ideas and practices. E-professionals have the capacity to collaborate from anywhere and at any time through the use of new Information and Communication Technologies (e.g. laptop, wireless broadband connection, mobile terminal, and Web applications such as Shared Workspace, wiki, and blogging).

Sub-questions:

1. **What are the distance factors that affect collaboration performance?**

   (Identify within the literature and business cases a list of distance factors affecting collaboration performance. Collaboration performance is composed of collaboration effectiveness[3], efficiency[4] and efficacy[5].)

   a) Are there different dimensions holding distance factors?

   b) Are there different types of distance factors?

   c) In which (positive or negative) ways do distance factors affect collaboration performance?

   d) Are distance factors related to one another?

2. **What is the role of the Shared Workspace technology within a collaborative context?**

   a) Does ICT contribute to overcome collaboration barriers raised by distance factors?

   b) Does ICT create even more distance factors?

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[3] Effectiveness: ability to bring about the result intended (everything necessary is in place for a high quality output).

[4] Efficiency: ability to perform duties well with a minimum resource level for a maximum output (high productivity level).

[5] Efficacy: ability to get things done (fulfil a request in due time).

3. **What are the issues surrounding mutual understanding and collaborative performance?**

    a) Is a generic collaboration process an appropriate model for situating the role of mutual understanding?

    b) Do distance factors affect the reaching of a mutual understanding?

    c) Is the extended Johari Window an appropriate model of social interaction for explaining the important role of mutual understanding?

4. **What are the elements comprising the mechanics of collaboration?**

    a) What are the generic activities comprising the mechanics of collaboration?

    b) Do distance factors affect the mechanics of collaboration?

1.3 Research Goal, Significance and Strategy

Although the immense and diverse body of literature on collaboration and distance (or proximity) factors continues to uncover an increasingly complex phenomenon of social interaction, there is still little understanding of the generic process and mechanics of collaboration, especially the role of mutual understanding. Despite its continuing growth, research on distributed team performance is still in its infancy and there have been few attempts to undertake robust academic research on the performance effectiveness of virtual teams (Saunders, 2000; Powel et al., 2004; Egea, 2006; Gaudes et al., 2007). However, it should be noted that group effectiveness performance has been investigated by prominent authors such as Hackman and Morris (1975), who adapted the work of McGrath (1964) to develop the famous 'Input-Process-Output' model for evaluating the performance effectiveness of a group. This model probably inspired Lipnack & Stamps' (1997) description of 'A System of Virtual Team Principles', illustrated by a matrix composed of 'Inputs-Processes-Outputs' on one side and

‘People-Purpose-Links’ on the other. According to Lipnack & Stamps (1997), ‘The principles of people, purpose and links forms a simple systems model of inputs, processes and outputs.’

In addition to the investigation of various distance types and related issues, the main goal of this empirical study is to develop a holistic model of collaborative distance that can be used to categorise, disambiguate and disentangle distance factors. The categorisation scheme is later used to classify, compare and make sense of recorded data from activities in comparative cases, the findings of the focus group interviews, and the survey results.

The formulated research questions and propositions led to the design of a triangulated research approach comprising both qualitative and quantitative methods as the best means to investigate distance factors that raise barriers in complex tasks of project teams. These methods comprise a survey on collaboration barriers, 14 comparative cases of corresponding collaboration projects with their related log data, and 14 focus group interviews (FGI). The implemented Shared Workspace platform (BSCW) acts as a Collaborative Working Environment (CWE) supporting the 14 collaboration project teams. This ICT platform is also used as a log platform for extracting data generated by the 14 project cases.

The major advantage of this approach is that it allows the researcher to study the development of mutual understanding and exchange of knowledge during real tasks by combining the advantages of all three methods outlined in the research method chapter. The combination of the three methods provides insights, information and data contributing to a broad understanding of the ‘sharedness’ of a CWE. Nevertheless, the main focus is on the analysis and correlation of the observational data, as this shows how real contributions are made by project team members, giving hints to the corresponding collaborative activities conducted. The qualitative part is also intended to support the observation of distance factors affecting collaboration performance with 14 comparative cases and the corresponding focus group interviews. The quantitative part is intended to provide indications as to survey respondents' perceptions of distance factors.

The 14 comparative cases implemented the SADT (Structured Analysis and Design Technique) (Ross & Schoman, 1976) structured analysis approach and the IDEF0 (Integrated Definition for Function Modelling) (Ross, 1985; 1989) functional activity modelling instrument, used by project participants to define and agree to their respective project processes. This part of the research included a team building (purpose, people, process and place), relationship and leadership experiment throughout the project life-cycle of five consecutive months. In terms of shared techniques and methods enforcing a shared understanding of their projects, in addition to the already mentioned use of SADT and IDEF0, all project teams used WBS (Work Breakdown Structure) and OBS (Organisation Breakdown Structure) techniques for the structuration of their respective projects. The BSCW platform log data, together with the level of interaction and usage, is also intended to provide insights on the various collaborative activities conducted by each team, such as shared models, common classification, shared structuration, team communication and shared spaces. In terms of team performance, log data is also intended to provide figures on the level of team productivity compared to the level of interaction and number of project stakeholders.

One of the main objectives of the research is to explore interrelated collaboration models. First, a holistic model of collaborative distance (CD) illustrates and explains the relationships between distance factors, collaboration barriers, distance types, collaboration tools and distributed teams. This holistic model of CD is complemented by a holistic view of all CD types and related factors within four dimensions, namely 'Structural', 'Social', 'Technical' and 'Legal & Ethical'. Second, a social interaction model, based on an extension of the Johari Window Model (Luft & Ingham, 1955), explains how to enlarge the area of mutual understanding that determines the level of interpersonal productivity, creativity and innovativeness. Third, a generic collaboration process model is used to describe the interrelated layers of activities. Fourth, a logical model of the collaboration mechanics is used to articulate the role of awareness, responsiveness, sense-making and understanding. Fifth, there is a model integrating the generic collaboration process activities with the mechanics of collaboration. Finally, a model introducing distance factors into the knowledge creation process is used to decipher the role of mutual understanding in collaboration performance, and the way this is impacted by distance factors.

1.4 Thesis Structure

This empirical study aims to improve understanding of factors related to collaborative distance and the role of shared or mutual understanding in the collaboration performance among knowledge workers or eProfessionals, especially during innovation and creativity activities (see Figure 1.1 for an overall view of the thesis structure). To this end, a holistic literature review surveys published papers that discuss either proximity or distance factors, in order to gather all the factors identified so far. The literature review also surveys published papers discussing shared, common or mutual understanding. Then, there is an analysis of gaps in the existing literature, followed by a discussion and presentation of the selected research methodology. Next, findings of the survey, comparative cases and focus group interviews are presented, followed by three separate analyses and subsequent discussion using a triangulated interpretation of the comparative cases, focus groups and survey. Finally, a conclusion is drawn and future research plans are introduced.

Chapter 1 introduces the current trends in the domain of collaboration amongst knowledge workers or eProfessionals and explores previously encountered problems within distributed groups or virtual teams. It presents the main research question and related sub-questions and objectives, gives a summary of the chapters and then addresses conclusions.

Chapter 2 presents the literature review on collaboration topics, focusing specifically on collaboration proximity and collaboration distance as well as mutual, shared or common understanding. It specifies the various distance related factors affecting collaboration performance identified during the literature review. Finally, it discusses the gaps in the existing literature and provides a conclusion.

Chapter 3 discusses the rationale behind the choice of the research approach and methods used in this empirical study, as well as some constructs and artefacts employed in the course of the present research for elaborating the mechanics of collaboration where distance factors are integrated in a systematic approach.

Chapter 4 introduces the findings through a survey on collaboration barriers, 14 comparative cases and related focus groups, presented in terms of collected data sources.

Chapter 5 presents the analysis and discussion of the survey on collaboration barriers, the 14 project cases and related focus group interviews.

Chapter 6 concludes the study by responding to the research questions and propositions. It outlines the contribution of this research to the existing body of knowledge, states the lessons learned and presents recommendations. Finally it discusses the limitations and need for future research.

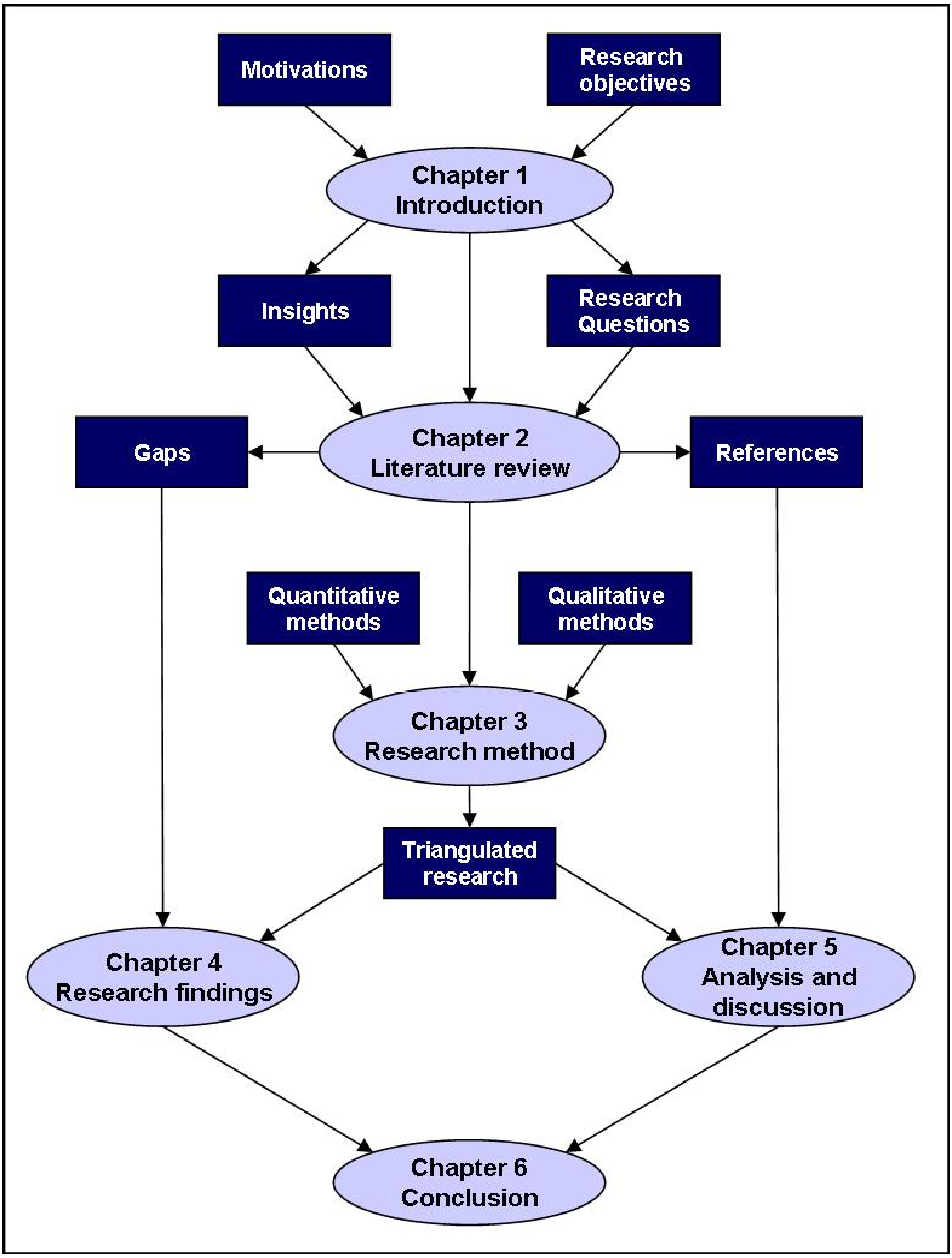


Figure 1.1: Thesis Structure

1.5 Summary

Today, Geographic Dispersion in Teams (GDT) appears to be only one of the problems faced by knowledge workers or eProfessionals during collaboration activities. There are many other distance or proximity factors affecting collaboration effectiveness and efficiency. Enterprises are facing a sort of collaboration paradox. While they need to have a proper level of diversity to ensure a high level of creativity and innovation, more distance factors affect the overall collaboration performance.

One major and well-known factor is conceptual ambiguity, called 'conceptual distance' in this study, which affects interpersonal communication and mutual understanding among collaborating stakeholders. According to Kock and Nosek (2005):

> *In spite of nearly 30 years of research, many phenomena related to e-Collaboration still remain obscure and in need of clarification through empirical and theoretical research.*

They argue that this could be explained by the fragmentation of the e-Collaboration research community and dispersion in particular collaboration issues, as well as the many different publication streams. Their argument is confirmed in this study by the numerous research areas considered during the literature review (see Chapter 2 for the list of research areas).

In order to reach a broader understanding of collaborative distance factors and the role of mutual understanding in collaboration performance, this empirical study focuses on a comparative analysis of 14 project cases, using an online Shared Workspace (SW) platform operating over the Internet, named BSCW (Basic Services for Cooperative Work). An overall view of the empirical study on Collaborative distance is presented in the Figure 1.2, where appear the instruments of the triangulated approach, namely: the survey on collaboration barriers, the 14 project cases for the comparative case study, the related 14 focus group interviews and finally, the collaboration technology that was used for carrying-out the 14 project cases, which produces the log-data. Knowledge workers or e-Professionals express themselves through the use of various concepts, and jointly develop artefacts in their collaborative or shared workspaces. As a result of collective contributions, those concepts are constantly evolving, even while potential new concepts emerge during creative sessions and other innovation activities. In this study, it is believed that a mutual understanding, often called 'common understanding' or 'shared understanding', among project stakeholders enables a more effective and efficient collaboration. This assertion is supported by Luft and Ingham's (1955) argument that the larger the arena (space of interpersonal interaction conditioned by the level of mutual understanding), the more productive the interpersonal relationship. There are several such issues related to collaborative distance, mutual understanding and collaboration technology that deserve to be investigated during this empirical study.

As stated earlier, there are diverse factors affecting collaboration, which we propose to group into a holistic model (see Figure 2.6) and Collaborative Distance Framework (CDF). This empirical study does not re-investigate the case where individuals collaborate only in the same physical space, since numerous empirical studies have found that face-to-face collocation is more suitable for team performance (Sakiroglu et al., 2002; Nardi & Whittaker, 2002). However, it should be noted that face-to-face collocation no longer fits with the current business challenges and requirements imposed by global competitiveness. While this empirical study attempts to categorise, disambiguate and disentangle distance factors into a holistic view (see Figure 2.7) in order to reach a broader understanding of their impact on collaboration performance, it concurrently investigates the way in which distance factors are bridged or compressed by collaboration technology and tools. This research is also intended to elaborate and explore complementary models to foresee the impact of distance factors on reaching a mutual understanding.

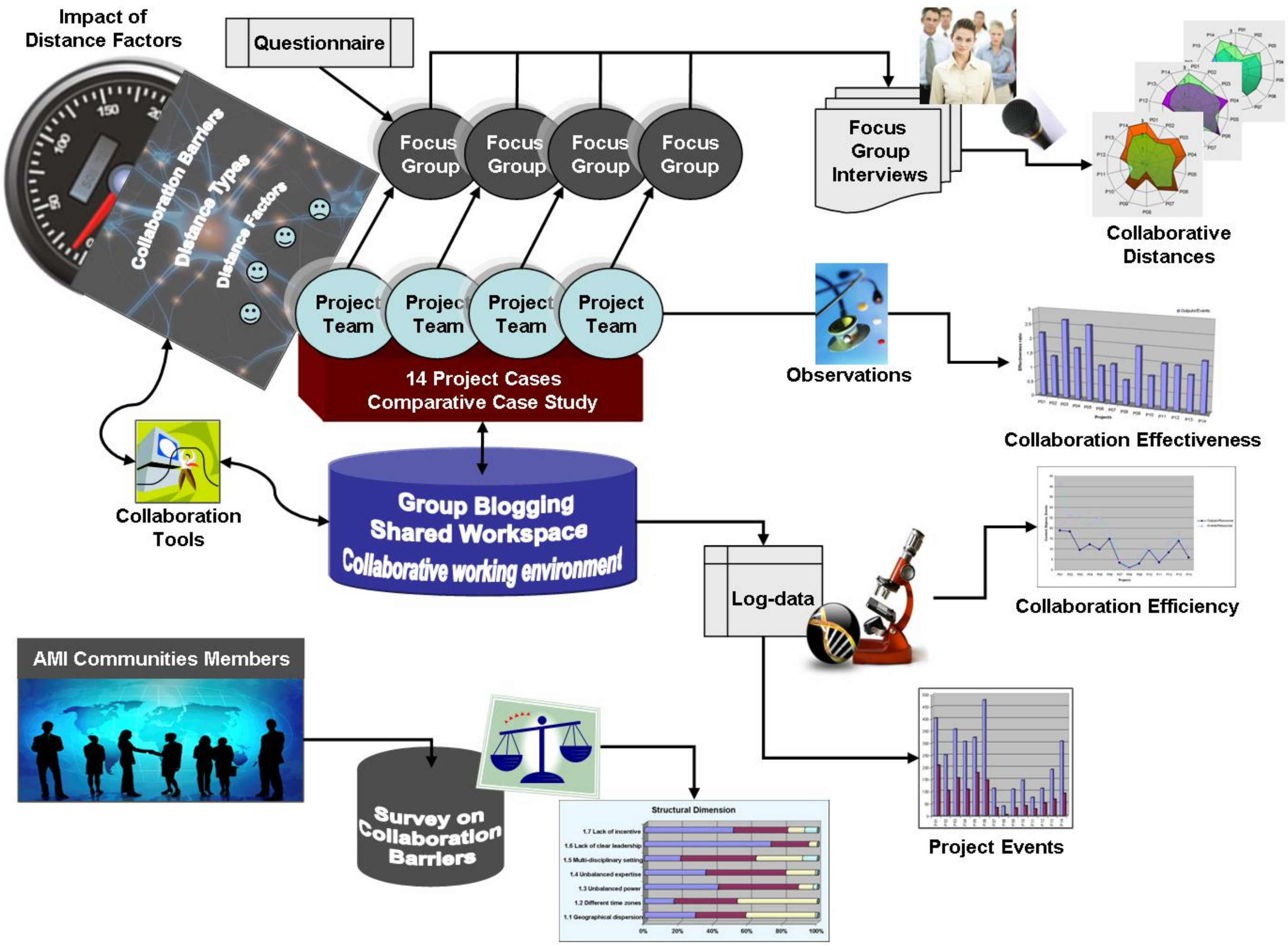


Figure 1.2: Overall View of the Empirical Study on Collaborative Distance

Chapter 2. Literature Review

Every path to a new understanding begins in confusion. - Mason Cooley

This chapter presents the literature review conducted on collaboration issues such as proximity and distance in collaboration, mutual understanding, social interaction model, collaboration process and the mechanics of collaboration. It describes the different types of distance mentioned in the literature and discusses the use of collaboration technology in virtual collocation to bridge or compress the various types of distance. The chapter identifies existing gaps in the literature, and points to several models that emerge as potential artefacts to fill these gaps. Finally, a number of propositions are introduced.

2.1 Introduction

Despite several decades of continuous research effort on collaborative work, seeking to understand the mechanics of collaboration and the role of sense-making, shared meanings and mutual understanding, as well as the impact of distance factors, this remains an interesting field of empirical study. Due to the fragmentation of the e-Collaboration research community and the many different publication streams, as already stated by Kock and Nosek (2005), published papers selected for the literature review belong to diverse research streams (see Figure 2.1) such as Computer Mediated Communication (CMC), Computer Support for Collaborative Work (CSCW), Front-End Innovation (FEI), Geographic Dispersion in Teams (GDT), Group Decision Support Systems (GDSS), Groupware, Human Computer Interaction (HCI), Inter-Enterprise Collaboration (IEC), Inter-Organisational Collaboration (IOC), Distributed Knowledge Management (DKM), New Product Development (NPD) and Virtual Team (VT).

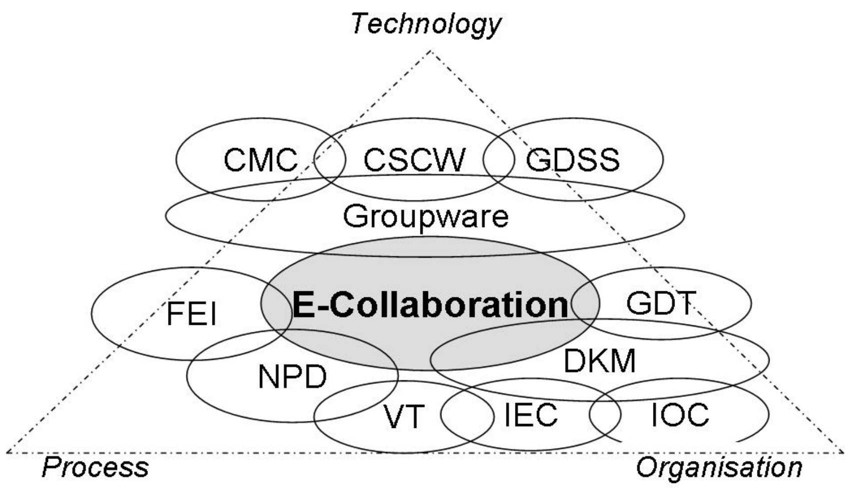


Figure 2.1: Scientific streams composing the e-Collaboration domain

The selected papers are related to several collaborative distance issues, as shown in the figure below (see Figure 2.2). Each displayed tag corresponds to a potential distance type or factor, which groups several published papers. The number of selected papers is indicated within parentheses.

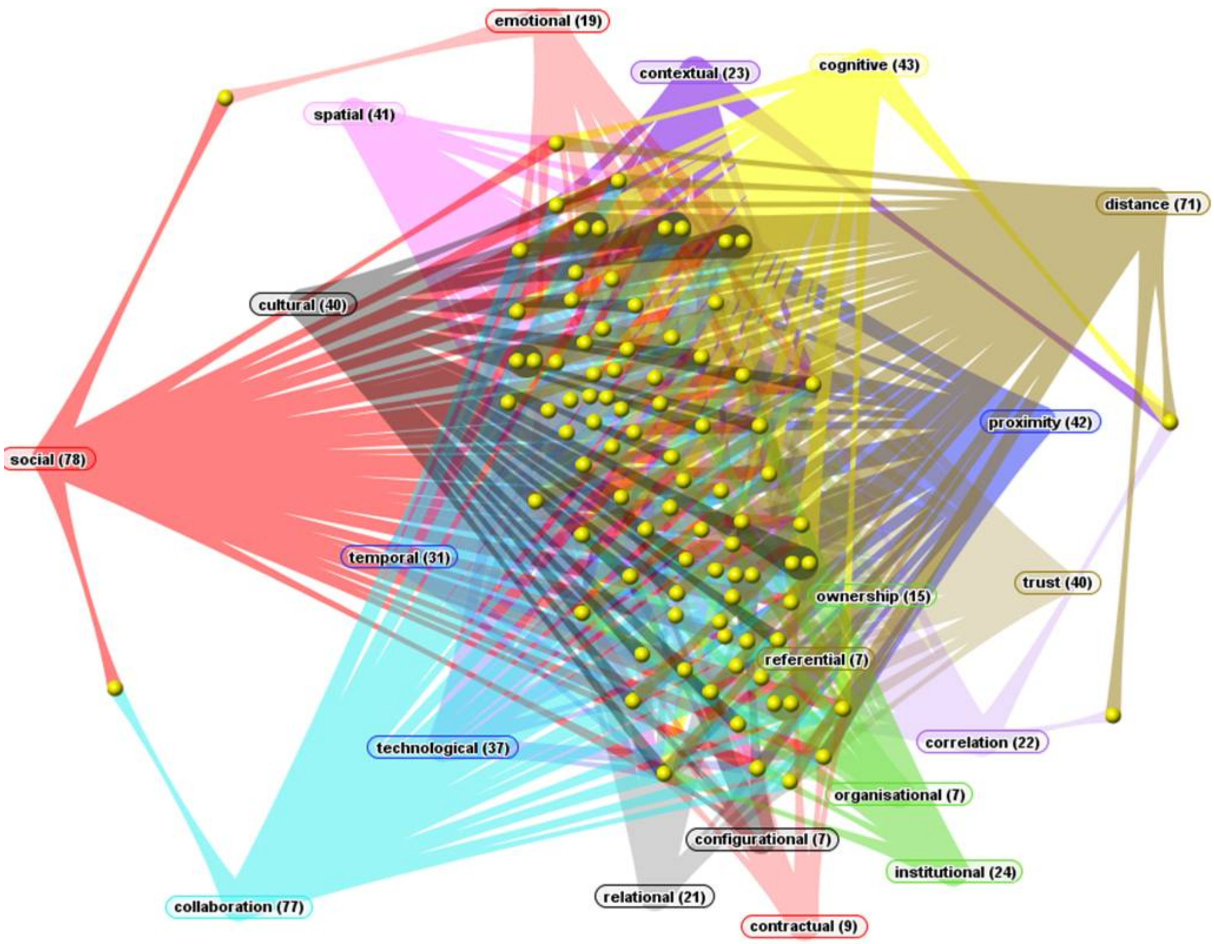


Figure 2.2: Cluster view of selected papers and related tagged distance types or factors

The yellow dots in the above cluster view each represent a group of published papers all containing the words ‘collaboration’, ‘distance’ and/or ‘proximity’, and one or several words representing various distance factors, such as ‘spatial’ or ‘temporal’. This example of cluster view provides an indication of the most frequent distance factors in the literature.

2.2 Context

Today, working patterns are extremely complex, due to the wide range of collaborative activities and the large number of involved stakeholders, most of them having a specific discipline and expertise, and also due to the virtualisation of the workplace (Pallot et al., 2005). As business becomes more global and broadband connections more widely available, more and more individuals are embracing flexible working and benefiting from its multiple advantages (Puybaraud, 2004, 2005). A study on the future of work, carried out by Morello and Burton (2006), highlights a clear trend towards a decrease in 'working alone' and team working within 'same time and same place' configurations. Simultaneously, there is an increase in team working within 'different place and different time' and 'same time and different place' configurations.

Lu and colleagues state that both globalisation effect and the availability of advanced information technologies foster the trend of globally organised work, which in turn promotes geographically dispersed teams as the main configuration style within many organisations (Lu et al., 2005). They argue that geographical distance implies differences in time, language, culture and organisational processes which negatively impact team coherence and work practices. They mention virtual work crossing space, time, organisation, culture and media as characterised by the notion of discontinuity (Watson-Manheim et al., 2002).

When discussing collaborative activities, it appears that distance between collaborating individuals is the most important aspect to be considered. While nearness or proximity can facilitate communication and social interaction, greater distance can act as an impediment. This is also confirmed by proxemics, the social use of space (Hall, 1966): when individuals operate more than 30 meters away from each other they are not likely to collaborate as often (Kiesler & Cummings, 2002; Kraut et al., 2002; Bradner & Mark, 2002; Armstrong & Cole, 2002; Olson & Olson, 2001; Moon, 1999; Lipnack & Stamps, 1997; Allen, 1977; Latané et al., 1995). Meanwhile, others claim that technologies compress geographical distance (Child et al., 2002);

that is, the perception of distance becomes more subjective as long as people stay connected. A decade ago, the Information and Communication Technology (ICT) revolution was heralded as bringing about the death of distance (Cairncross, 1997), while subsequently others have claimed that distance still matters in international business (Ghemawat, 2001; Goodall & Roberts, 2003). Although the persistence of distance has been openly questioned, as technology makes it possible for firms to do business even from abroad (Nachum & Zaheer, 2005), a number of issues still require additional attention in order to identify and overcome all distance factors.

International collaboration projects bring in positive effects, such as higher levels of creativity and innovativeness due to a larger diversity of expertise, as well as reduced costs and lead-time in optimising solutions based on partners' specific knowledge and core competencies (Pallot & Sandoval, 1998). In contrast, it is argued that increasing the number of partners systematically leads to an exponential increase in management and integration overhead, which impedes the global collaboration performance (Pallot & Hof, 1999), an effect described as a collaboration paradox. Trade-off and decisions are often delayed because several partners are involved in the same business process, while their infrastructures are neither compatible nor interoperable (Pallot et al., 2000). Furthermore, critical factors such as security, confidentiality, trust and confidence lead to the 'black-box' effect of operating solely within the group (Jones et al., 1999).

In a study on multidisciplinary collaborations, Cummings and Kiesler (2003) demonstrate that geographically distributed collaboration has a negative impact on both effectiveness and efficiency, due to difficulties in communication and coordination. They raise the interesting question: 'What do we know about distance factors?' This could be turned into: 'What do we know about distributed collaboration performance affected by distance factors?'

The latter question is probably the right one to ask in order to understand the implications for collaboration technology (Kraut et al., 2002) before exploring new ICT artefacts that could help to achieve a higher performance during distributed, or online, collaboration. Unfortunately, the current research body lacks a holistic view, and there is no universal Collaborative Distance Framework (CDF) that captures all the dimensions of distributed collaboration and its related distance factors. This kind of framework would prove useful for reducing conceptual ambiguity, helping to disentangle relationships among distance factors and consolidating the results of empirical studies to facilitate further research in this area and to develop a better understanding of the implications of distance factors. In fact, new ICT artefacts might either create more distance, or conversely help to bridge or compress distance factors, hence having a positive impact on distributed collaboration performance.

2.3 Discussion of Concepts

Distributed Group versus Virtual Team

One could argue that the concepts of ‘distributed group’ and ‘virtual team’ are identical. A virtual team is defined by Lipnack and Stamps (1997) as a group of people interacting through interdependent tasks guided by a common purpose. They argue that virtual teams operate across space, time and organisational boundaries, exactly like distributed teams and unlike collocated teams, through the use of links augmented by webs of communication technologies.

Face-to-Face Collaboration versus eCollaboration

‘Collaboration’ is defined by Noble and Letsky (2003) as the mental aspects of joint problem-solving for the purpose of achieving a shared understanding, making a decision, or creating a product. Hurley and Hult (1998) describe collaboration as the degree to which team members actively help one another in their work.

According to Marinez-Moyano (2006) collaboration is defined as a recursive and creative process where two or more people work together through collective activities such as sharing knowledge, learning and building consensus, toward the achievement of a common goal. In his book *Shared Minds*, Schrage (1990) defines collaboration as a process of shared creation where two or more individuals with complementary skills interact to create a shared or mutual understanding that none had previously possessed. We can synthesise these definitions to say that collaboration is a social interaction based process where stakeholders share knowledge and progressively build a mutual understanding that enables the creation of new knowledge.

'Electronic collaboration' or 'eCollaboration' is described by Kock and D'Arcy (2002) as collaboration amongst several individuals whose goal is to accomplish a task together using electronic technologies. As Kock & Nosek (2005) point out, e-Collaboration is not limited to Computer Mediated Communication (CMC) or Computer Supported Cooperative Work (CSCW). Their study identifies 'online collaboration' among professionals in diverse types of organisation, regardless of location or which electronic devices and networks they use. These 'eProfessionals' make extensive use of electronic means (fixed and mobile phones, Web devices, Wifi) to support their collaborative activities. Where online collaboration is not restricted to Web devices connected via the Internet, it is equivalent to eCollaboration. Fortunately, since 1996 the term 'online' has had a standardised definition[6] which encompasses telecommunication and computer technology. One might anticipate a convergence among telecommunication, media, computing and Web technologies whereby everything will be connected to the Internet and online collaboration will encompass collaboration among agents both human and non-human (e.g. robots).

Finally, 'mass collaboration' (Kriplean et al., 2007; Richardson & Domingos, 2003) or 'massively distributed collaboration' emerged with the extensive use of wiki, where content is created by thousands of widely distributed individuals. This represents a radical new modality of content creation (Kapor, 2005).

[6] Telecommunications: Glossary of Telecommunication Terms, Federal Standard 1037C

Collaboration Styles

Collaboration involves groups of participants. These may be teams, often referred to in the literature as small groups, or communities, referred to as large or very large groups. Teams tend to be characterised by a structured collaboration with planned outcomes, while communities resemble an unstructured collaboration with unplanned outcomes. One needs to be aware that distance factors might have different impacts, depending on the nature of the observed collaboration style. This could range from the well-known symbiotic collaboration style (Birnholtz, 2005; Dana et al., 2001) to the more surprising stigmergic (Elliott, 2006) (e.g. Wikipedia, Open Source Software, Second Life) and opportunistic collaboration (Chatzkel, 2003; Zhang et al., 2006) to the improbable webergic collaboration style (Pallot, 2007). The first embeds a strategy in which participants bring their own specificities to obtain individual benefits. The second has a strategy to benefit the community (e.g. ant colony, online community) while the third, according to Jianwei Zhang, has an adaptive strategy where groups form, break up and recombine for the benefit of an emerging process which leads to a higher level of collective responsibility within more pervasive and flexible distributed collaborations (Zhang et al., 2006). Finally, the fourth style is a Mother Nature strategy of open and self-organised sustainable systems displaying emergent properties or behaviours which result in unplanned and unpredictable outcomes (e.g. evolution, the Internet and the Web, virtual worlds). Stigmergic, opportunistic and webergic collaboration styles are related to 'mass collaboration' or 'massively distributed collaboration' (Tapscott & Anthony, 2006), and to the promise of Reed's 'Group Forming Networks' law, whereby 'networks that support the construction of communicating groups create value that scales exponentially with network size' (Reed, 1999).

Effectiveness, Efficiency and Efficacy

According to Drucker (2006), a simple way to distinguish among effectiveness, efficacy, and efficiency is to consider that: 'Efficiency is about doing things right, efficacy is about getting things done, while effectiveness is about doing right things.'

'E^2', a model of design performance developed by O'Donnell and Duffy (2001a, 2001b), distinguishes between efficiency and effectiveness in design performance. O'Donnell and Duffy argue that efficiency is related to input, output and resources, while effectiveness is determined by the relationship between output and goals. Input (I), Output (O), Resources (R) and Goals (G) are represented within the E^2 design performance model, providing a functional representation (IDEF0) of activity performance through the combination of efficiency and effectiveness (see Figure 2.3).

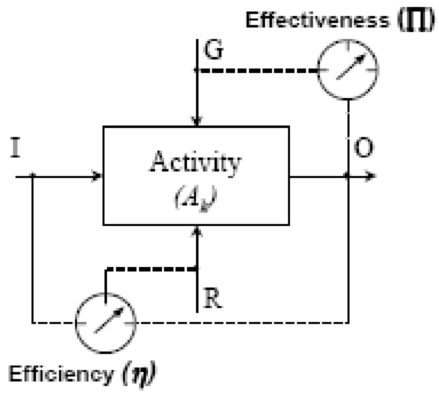


Figure 2.3: Design Performance E^2 model

(O'Donnell and Duffy, 2001a; 2001b)

Individual Productivity versus Interpersonal Productivity

An examination of the literature leads to the conclusion that very little research has been done in the area of interpersonal productivity, probably because individual productivity is, paradoxically, still considered a holy grail by business organisations, despite plentiful evidence that social interaction is the source of knowledge creation (Nonaka, 1994; Nonaka & Takeuchi, 1995; Nonaka & Konno, 1998). However, a number of research studies have been carried out on factors affecting group, team and collective efficacy (Parker, 1994; Staples et al., 1999; Gibson, 1999; Gibson et al., 2000; Zellars et al., 2001; Baker, 2001; Pescosolido, 2001; Gully et al., 2002; Jung & Sosik, 2003; Whiteoak et al., 2004; Carroll et al., 2005; Katz-Navon & Erez, 2005; Fuller et al., 2006; Hardin et al., 2006, 2007) or effectiveness (Prussia & Kinicki, 1996; Furst et al., 1999; Bal & Foster, 2000; Broom, 2002; Kayworth & Leidner, 2002; Noble & Letsky, 2003; Piccoli et al., 2004; Maznevski & Chudoba, 2000). Noble and Letsky proposed an interesting four categories of collaboration metrics, namely understandings, information interactions, task performance and products, based on a combination of Cognition-Behaviour-Product and Transactive Memory models. These models feature team cognitive behaviour and products. They also provide the corresponding metrics for each category, from product up to understandings, and claim that the cognitive-focused collaboration metrics not only measure team effectiveness, but also provide insights into the reasons for this effectiveness.

Proximity versus Distance

As mentioned in previous literature reviews (Knoben & Oerlemans, 2006; Hyypiä & Kautonen 2005; Cummings & Kiesler, 2003; Bradner & Mark, 2002; Kiesler & Cummings, 2002; Kraut et al., 2002, Nova, 2003; Olson & Olson, 2001; Torre & Gilly, 2000), there are several research studies on distance or proximity factors affecting collaboration performance within geographically distributed groups. In these literature reviews, proximity or nearness represents collocated collaboration, while distance represents distributed collaboration. In an empirical study, Kiesler and Cummings (2002) demonstrate the positive role of proximity on relationships and group interaction, hence on collaboration performance. Torre and Gilly claim that nearness or proximity provides a high level of information richness (Daft & Lengel, 1984, 1986, 1987) during interaction and therefore facilitates the sharing of both explicit and tacit knowledge. Knoben and Oerlemans conclude that the greater the distance among group members, the more difficult is the transfer of tacit knowledge. According to Nova, conversation is much easier when individuals are in the same physical setting. Kock's Media-Naturalness theory argues that a decrease in the degree of naturalness of communication (where face-to-face communication is the reference) decreases the quality of interaction, due to increased cognitive effort and communication ambiguity, as well as decreased physiological arousal (Kock, 2005). Nearness or proximity increases the frequency of communication and the likelihood of chance encounters. It also facilitates transitions from encounters to communication, fosters informal conversations and helps maintain task and group awareness (Nova, 2003), which Eriksson refers to as social translucence (Eriksson & Kellogg, 2000; Eriksson et al., 2004, 2006; Eriksson 2008). Howells argues that spatial proximity and tacit knowledge are also often necessary for interpreting explicit knowledge (Howells, 2002).

Due to the antonymic relationship between the concepts of distance and proximity, one might infer that distance necessarily has a negative impact on group interaction, hence on collaboration performance. This is confirmed by Bradner and Mark (2002), who conclude that CSCW should develop technologies for bridging social distance, not only geographic distance. Distributed collaboration has its own specific advantages, such as creating emotional distance during negotiation activities, which should not necessarily be removed through technologies mimicking face-to-face situations (Schunn et al., 2002).

However, others have used proximity technology artefacts as a means to compress distance factors; for example, social proxy tools provide a certain level of social translucence. Due to the domain complexity of distributed collaboration, and to the impressive number of studies published within different scientific fields, the full range of proximity or distance factors and their inter-relationships is not immediately obvious. Therefore, it is difficult to foresee the emergence of a holistic view and framework which would allow a sound classification of all published studies and results in this area.

In addition to the frequently studied geographical or spatial distance, there are many other types of distance affecting collaboration. Most, if not all, collaboration barriers generate various distance types, including organisational, institutional and cultural obstacles to name just a few.

2.4 Factors affecting Collaboration

Knoben and Oerlemans (2006), in their literature review on proximity and inter-organisational collaboration, clearly illustrate the overlap and ambiguity of proximity concepts used in the literature. They selected 80 papers collected within three different areas where proximity is studied: innovation and organisation, proximity and regional economic development, and proximity, network(s) and inter-firm collaboration. They condensed various labels of proximity dimensions found during the literature review into seven dimensions: geographical, organisational, cultural, technological, cognitive, institutional, and social. Finally, they proposed grouping those seven dimensions into only three, in order to reduce conceptual ambiguity, hence making the studies' findings more comparable and allowing more cumulative knowledge development. They recognised that proximity dimensions can interact over time, strengthening or weakening their respective effects, as they are heavily correlated. They also regretted the lack of published longitudinal research including several dimensions, instead of looking at a single one in isolation.

Rather than focusing on a specific research area such as inter-organisational collaboration, this study introduces a necessary holistic view and framework, clustering various distance dimensions and related factors appearing in the course of distributed or distant collaboration. The relevant research areas selected include Community of Practice (CoP), Computer Mediated Communication (CMC), Computer Support for Collaborative Work (CSCW), Front-End Innovation (FEI), Geographic Dispersion in Teams (GDT), Group Decision Support Systems (GDSS), Groupware, Human Computer Interaction (HCI), Inter-Enterprise Collaboration (IEC), Inter-Organisational Collaboration (IOC), Distributed Knowledge Management (DKM), New Product Development (NPD) and Virtual Team (VT). This has resulted in a broader set of published studies on distance or proximity factors, whatever the studied field.

We have named the framework 'Collaborative Distance' rather than 'Collaborative Proximity', because we look at the effect of distance factors that are generated during distributed collaboration. These distance factors then need to be overcome by creating some sort of proximity. This might be achieved by, for example, using temporary collocation to create geographical proximity, enforcing identical project management structures to create organisational proximity, involving project participants in social activities to create relational proximity, or applying the same collaboration tools or standards to enable interoperability among tools and applications to create technological proximity. These examples of creating proximity and bridging various types of distance are not necessarily built from the use of ICT. Using a Web-conferencing tool to create virtual proximity through online collocation is an example of the use of ICT to compress geographical distance, while providing an element of face-to-face interaction.

A holistic view and framework of distance factors would be useful for the scientific community, allowing easy identification of previous relevant studies (i.e. benchmarking) once they are properly categorised. This would allow a consolidation and comparison of the resulting knowledge.

The concept of collaborative distance (CD) is a research area in which a universal framework (CDF) is derived from observations on distance factors affecting collaboration performance within distributed groups. This study does not use the concept of 'collaboration distance' because it has previously been defined as the distance between two collaborating individuals that are nodes in a collaboration graph (Odda, 1979; Harary, 1979). This is also known as the Erdos number (Batagelj & Mrvar, 2000), which is the distance between mathematicians collaborating with Erdos, or the Bacon number for actors collaborating with Bacon. Another example of collaboration distance among individuals, explored during the ECOSPACE project (Prinz et al., 2006), considers all events (e.g. create, read, edit) generated by group members on all content objects uploaded within a shared workspace. The resulting figure is a hyperGraph comprising individuals, content objects and relationships, which are valued to measure the collaboration distance among group members (Pallot et al., 2006).

Distance is mentioned in the literature as having strong general effects and significant implications for both collaborative work and supporting technologies (Kiesler & Cummings 2002; Olson & Olson 2001). In this context, distance or proximity (Kiesler & Cummings, 2002; Knoben & Oerlemans, 2006; Oerlemans et al., 2000; O'Leary & Cummings, 2002; Torre & Rallet, 2005; Watson-Manheim et al., 2002) appear in the literature either as the main factor (in the context of this literature, 'distance' means implicitly 'geographical distance') or as a composite concept grouping factors affecting collaboration performance among organisations or individuals. Distance may also appear as geographically distant collaboration, often described as distributed teams or groups (Kiesler & Cummings, 2002; Torre & Rallet, 2005), as physical distance (Watson-Manheim et al., 2002) or even as distant linkages (Oerlemans et al., 2000). However, in the context of distributed teams, distant collaboration simply means that collaborating individuals are operating from geographically dispersed sites.

Distance is a complex concept, composed of several dimensions corresponding to diverse 'aspects' or 'perspectives'. For example, Knoben & Oerlemans (2006) cite geographical, organisational and technological dimensions, while Hyypiä & Kautonen (2005) mention geographical, industrial, organisational, temporal, cultural, cognitive, social and institutional dimensions. Having three or eight dimensions, as expressed in the latter two examples, may appear quite incredible, but in fact depends on including distance classes or types in the model. Knoben and Oerlemans identify, in their literature review, six non spatial dimensions, one spatial dimension and nine dimensions that are synonyms. After interpreting proximity dimensions for the specific field of Inter-Organisational Collaboration (IOC) they propose that only organisational, technological and geographical dimensions are relevant, thus reducing the existing conceptual ambiguity. Fischer (2005b), in his consideration of different cultures as a source of diversity and not necessarily as a cultural distance, proposes four distance dimensions, namely physical, temporal, technological and conceptual. Fischer also considers distance and diversity factors as opportunities or sources of social creativity rather than exclusively as collaboration barriers (Fischer, 2004). Bonifacio and Molani (2003) argue the key role or richness of diversity in the process of knowledge creation.

A systematic literature review has revealed eighteen types of distances, after removing those which appear to be synonymous (see Table 2.1). All the types of distance listed in the table are mentioned in the literature as affecting collaboration among group members in various ways.

2.5 Collaborative Distance

Introduction

The idea of developing a framework that would provide a holistic view of factors to collect, consolidate and share accumulated knowledge based on previous empirical studies in the area of knowledge management has already been proposed (Vaidyanathan, 2006). According to Schunn, Crowley and Okada, the main concern is to study distant or distributed collaboration rather than physical proximity or collocated collaboration. They consider collaboration from a geographical distance point of view (Schunn et al., 2002), as the trend is towards collaboration within different places at the same or different times (Morello & Burton, 2006), implying the extensive use of online or electronic collaboration. Hence, such a framework is named 'Collaborative Distance'.

In this study, we use two types of factor to overcome distance barriers. These were previously defined by Child and are termed 'distance-compressing' and 'distance-bridging' factors. Child et al. (2002) also named the type of factor creating barriers as 'distance-creating'.

As pointed out by Damian (2002), in some specific cases creating distance might be valuable (e.g. emotional distance). According to Schunn et al. (2002), this realisation raises the second important practical implication of the findings for distant collaboration. In order to decide when to bring in supporting technologies and which technologies to use, we need to know more about why distance might help or hinder collaborative activities. Research has provided the first clues that it might help, but further study is needed to determine why and under what circumstances it might help.

It is also necessary to take note that collaboration does not occur only in collocated situations (physical project workspaces) or in distant situations (virtual or online workspaces), but may also occur in mixed or hybrid situations (partly distributed), where several individuals are collocated and others are remotely engaged in collaborative activities. This kind of distributed-collocated collaboration is termed 'Physual Designing' (Kristensen, 2003; Kristensen & Røyrvik, 2004; Kristensen et al., 2005).

Various case studies illustrate the problems faced by individuals collaborating in a specific domain when there are conceptual ambiguities which hinder collaboration performance (Koen et al., 2001; Perttula & Sääskilahti, 2004). It is widely recognised that shared, mutual or common understanding is the main ingredient of collaboration among individuals (Fischer, 2005a).

Dimensions of Collaborative Distance

Knoben and Oerlemans (2006) propose geographical, organisational and technological dimensions to reduce the ambiguity of the proximity concept as used in the literature. However, the geographical dimension includes only one factor, corresponding to physical distance. The technological dimension also has only one factor, which is related to technology knowledge. While there is no mention of the legal dimension, it plays a major role in enabling or disabling collaboration and even more so in the case of distributed collaboration. The authors group cultural and social factors into the organisational dimension, while geographical factors are excluded.

Wilson et al. (2005) introduce the relativity notion, arguing that there are two categories of distance factors. The first, ‘objective distance’, concerns spatial, temporal and configurational elements (O’Leary & Cummings, 2002), which capture the pattern or arrangement of team members across various sites independently of the spatial-temporal distances among them. The second, ‘subjective distance’, mitigates physical distance or dispersion, and is driven by a wide variety of factors. Subjectivity in distance is related to the effect perceived by people through different sorts of feelings, such as the obvious example of emotional distance.

O’Leary and Cummings discuss the necessity of developing a dedicated framework and measure to characterise the spatial, temporal, and configurational aspects of geographic dispersion in teams. Watson-Manheim et al. (2005) argue that people in virtual work environments encounter numerous boundaries in their work lives that may not be present to the same extent in more conventional work settings. Others examine in depth five boundaries observed in five separate research studies of field-based teams: geographical, functional, temporal, organisational, and identity-team membership (Espinosa et al., 2003). They explain that these boundaries are especially salient in examinations of virtual work. Orlikowski (2002) found boundaries to be particularly important in understanding how work was conducted in a geographically dispersed high tech organisation. He identified seven boundaries routinely met by the organisation's members in their daily activities: temporal, geographical, social, cultural, historical, technical, and political.

These previous studies reveal that the conceptual ambiguity of proximity/distance and the complexity of interlaced factors in the context of collaborative activities, virtual teams or geographic dispersion in teams is even wider than previously demonstrated by Knoben and Oerlemans (2006).

This study takes a different approach, in that the multi-disciplinary literature review, surveying all existing types of distance and proximity previously studied, has allowed the grouping of all types of distance into four logical dimensions of distributed collaboration among knowledge workers or eProfessionals: structural, social, technical and legal & ethical (see Figure 2.4). This holistic research approach to distance factors in distributed collaboration is tentatively named 'Collaborative Distance'; it allows a balanced observation of any distributed collaboration case along those four dimensions, providing a kind of reference framework, including a holistic view of factors affecting collaboration performance. Categorising types of distance allows the researcher to make various measurements that could eventually be combined into a single overall indicator of collaborative distance.

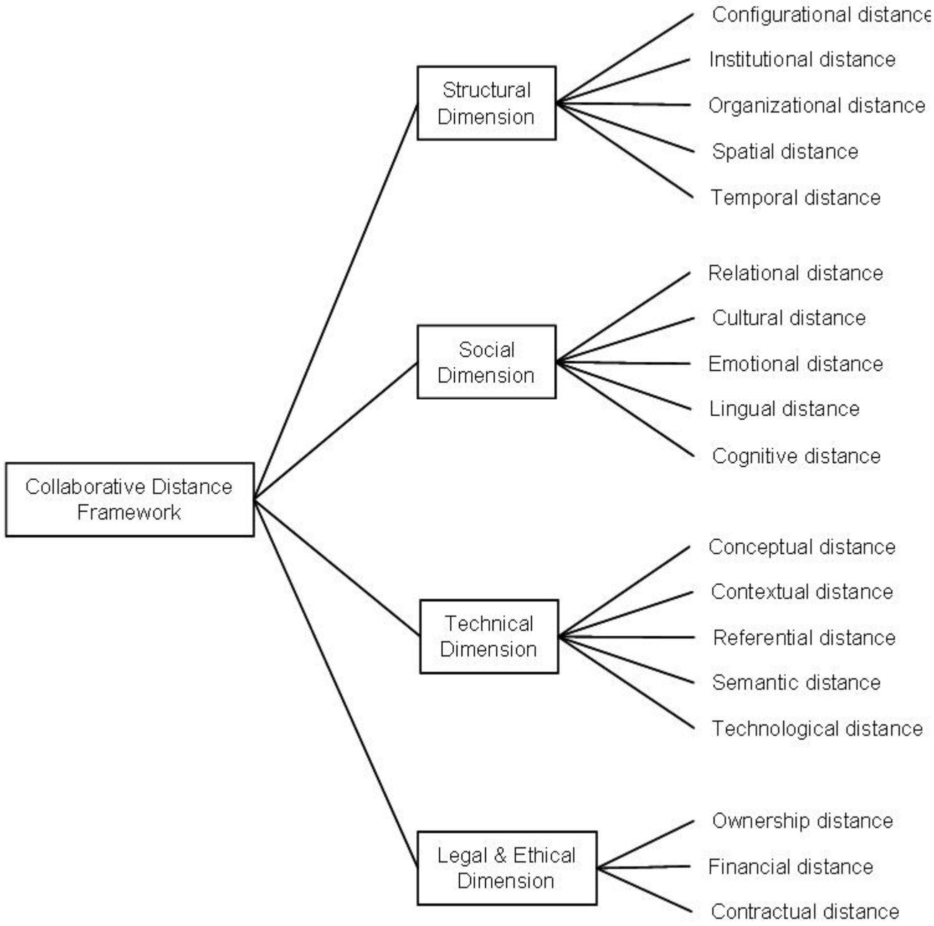


Figure 2.4: Tree Structure of Collaborative Distance

This work resulted in a list of distance factors that raise collaboration barriers, grouped into corresponding dimension and collaborative distance types (see Table 2.1). A more detailed table, which includes distance compressing and bridging factors, as well as a list of references, is available in Appendix A.

Distance types	Dim	Distance Factors
Configurational	Structural	Amount of participative and diverse expertise in the decision making; degree of team belonging (identity); degree of self-leadership; degree of self-organisation
Institutional		Degree of globalisation, incentives, enterprise policy, educational and environmental differences; political context
Organisational		Leadership capacity (task or relationship oriented); coordination capacity; degree of organisational structuration in a multi-disciplinary setting; degree of team cohesiveness (shared vision, purpose); degree of organisational interoperability
Spatial		Degree of spatial dispersion (different rooms, floors, buildings, sites); degree of isolation feeling (no sight, no thought); capacity to interact electronically (synchronous and asynchronous modes)
Temporal		Degree of time dispersion (time zones, time shifts); degree of isolation feeling (no sight, no thought); capacity to interact electronically (asynchronous mode)
Cultural	Social	Degree of common ground (local usage and norms); individual and group behaviour; degree of education and training
Emotional		Emotional behaviour; empathy capacity; ability to care about group members; collaborative attitude
Lingual		Multi-lingual setting (international projects, globalisation); ability to translate
Relational		Interpersonal relationships (weak or strong ties); interpersonal awareness; degree of trust; degree of solidarity; degree of reciprocal appreciation; interaction capacity
Cognitive		Degree of mutual understanding (size of the interaction arena according to the extended Johari Window model); degree of diversity; absorptive capacity
Conceptual	Technical	Degree of ambiguity (amount of specific disciplines vocabulary); common description capacity (mitigating the risk of conceptual misunderstanding)
Contextual		Capacity to support context awareness (reducing the users' cognitive overload); degree of local and situational working arrangements
Referential		Degree of relevance (relatedness, connectedness)
Semantic		Degree of meanings, difference or semantic proximity (semantic relatedness and similarity, relationships among content objects)
Technological		Degree of media-naturalness; degree of technological knowledge; usage capacity; degree of technology intiutivity and friendliness; capacity to meet user expectations; degree of interoperability of collaboration services
Ownership	Legal	Capacity to set-up a common ownership policy (copyrighting, patenting, creative commons, research commons, service commons, open source); capacity to track IPRs; ownership strategy and behaviour
Financial		Capacity to set-up a common investment policy and regulation; investment strategy and behaviour
Contractual		Degree of globalisation; capacity to set-up a common contract (covering both legal and ethical aspects); ICT policy (security, confidentiality, privacy)

Table 2.1: List of distance factors grouped by collaborative distance types and dimensions

2.6 Structural Dimension

The structural dimension includes five distance types: configurational, institutional, organisational, spatial and temporal. Collaboration activities are supported by different arrangements in space and time. Both synchronous and asynchronous interactions are important (Olson & Olson, 2001), and several research studies have already addressed the ways distributed teams communicate synchronously and asynchronously (DeSanctis et al., 2001; Pauleen & Yoong, 2001). However, it might be valuable to have some figures about the use of synchronous and asynchronous communication. In mass collaboration style, people simply interact asynchronously. Collocated team members use the synchronous interaction mode, while distributed team members interact asynchronously. Occasionally, when absolutely necessary and if a broadband connection is available, distributed team members turn to synchronous interactions supported by ICT (telephony, web-conferencing, online chat, application sharing, whiteboard). In online collaboration, access to information and resources is almost limitless on the Internet, the Web and through multiple available digital libraries (Murray, 1999).

2.6.1 Configurational Distance

Configurational distance refers to the distribution of resources, expertise and R&D work (Grinter et al., 1999; Miller, 1987) through the arrangement of group members across different localisations (O'Leary & Cummings, 2002), and the way they are connected to each other through work spaces and physical aspects of work environments (Oldham et al., 1995). Observed factors are leadership, collaboration incentive, team membership (identity), group cohesion, competition and conflict, as well as unbalanced power and expertise in decision making (Ancona & Caldwell, 1992). While Meyer et al. (1993) experimented with different configurational approaches for organisational analysis, others have studied the mutual knowledge aspect and its consequence for distributed collaboration (Cramton, 2001), as well as organisational configurations and induced performance (Ketchen et al., 1997).

2.6.2 Institutional Distance

Institutional distance is related to regional contextual developments and to country specific regulations that impact collaboration performance (Filippi & Torre, 2003; Barkema et al., 1997; Wilkof et al., 1995). Observed factors are historical and political particularities, as well as economic, educational and technological development, and climatic differences (Child et al., 2002). Institutional distance is also considered as learning about and understanding of a foreign environment and its national or regional culture, often embedded in its language (Nordstrom & Vahlne, 1992). It could also be related to regional and national standards such as the metric system. It is believed that the globalisation effect drives an on-going institutional convergence of life styles, consumption patterns, human rights standards, legal frameworks and business practices (Child et al., 2002).

2.6.3 Organisational Distance

Organisational distance represents the degree to which explicit or implicit rules of interaction and routines of behaviour that make coordination more effective are different and not necessarily interoperable (Torre & Rallet, 2005). Weick (1979) explored the social psychology of organising and later made observations on sense-making in organisations (1995). Traditional factors encountered are management overhead and coordination burden, as well as different communication channels, lack of interoperability, belonging and behavioural cohesion (Pallot et al., 2000; Pallot & Hof, 1999). While Schein (1985) argued that organisational culture and leadership work together in creating organisation distance, Smircich (1983), stated that organisations provide a structure for shared meaning.

2.6.4 Spatial Distance

Spatial distance is an objective measurable distance among collaboration stakeholders (Wilson et al., 2005). Physical, geographical, local and territorial distance types are considered as being synonymous (Knoben & Oerlemans, 2006). Spatial barriers impede collaboration interaction across distance (Fischer, 2005a; Raymond & Young, 2001; Scharff, 2002) and make collaborative design difficult to support even if ICT enables new forms of collaboration (Olson & Olson, 2001). Related factors are a notable difficulty in building trust among collaboration stakeholders (Wilson, 2001) due to the lack of collocation and face-to-face communication, and increased cognitive effort due to lower level of media naturalness (Kock, 2005). Antoniac and Pulli (2000) studied the use of new technologies, such as the Internet, Mobile Communication, Virtual Reality, Augmented Reality and Telepresence (Pulli et al., 1998), for enhancing the information on stakeholders' behaviour that helps to build trust. A temporary collocation of all stakeholders in the same location at the start of a project and for later project meetings facilitates interpersonal relationships and trust building through the use of social activities.

2.6.5 Temporal Distance

Temporal distance is measurable in order to qualify time distortion in the working environment. This time distortion could be caused by collaboration across several time zones or across several working shifts, or through redesign and evolution by people not necessarily involved at the earlier stage of a design process (Finholt et al., 2001; Fischer, 2004; Shipman, 1993). A special case of collaboration called 'reflexive Computer Supported Cooperative Work' supports the same individual user who can be considered as two different persons at two different points on a time scale (Thimbleby et al., 1990). Long term collaboration requires that present day designers are aware of the rationale (Moran & Caroll, 1996) behind decisions that shaped the artefact, and of information about possible alternatives that were considered but not implemented.

2.7 Social Dimension

The social dimension comprises five distance types or classes: relational, cultural, emotional, lingual and cognitive. If the cognitive distance does not include the absorptive capacity factor then it is necessary to add a learning distance type. All these distance types are related to social interaction factors that facilitate or impede knowledge sharing, mutual understanding and knowledge creation (Schmidt, 1994). It is widely recognised that collocated situations facilitate social activities among team members, helping everyone to know one another better. This facilitates the building of trust, as well as common ground, hence mutual understanding. Another very important aspect is social and team awareness (Prinz, 1999; Schäfer et al., 2004), or social translucence (Erickson & Kellogg, 2000), the ability of every group member to foresee what others will do in order to be able to contribute where it is most appropriate. The use of virtual worlds to better support social translucence has already been explored within a previous experimentation (Prinz et al., 2004). However, it might be worthwhile to compare group awareness or social translucence with 'social intelligence' (Goleman, 2006), combining social awareness (what we sense) with social facility (what we do) in order to clarify the conceptual approach of group awareness.

2.7.1 Relational Distance

Relational distance refers to the way people build relationships with one another. Different authors use various labels for the same concept, and Knoben and Oerlemans (2006) found other sources of ambiguity. For example the concept named 'personal proximity' (Schamp et al., 2004) is identical to 'relational proximity' (Coenen et al., 2004), and these are in turn the same as 'social distance' or 'social proximity' (Boschma, 2005; Rice & Aydin, 1991).

Building relationships with one another leads naturally to the notion of social networking and the self-organising aspect of communities often called communities of practice or communities of knowledge (Lave & Wenger, 1991; Brown & Duguid, 1991; 2000; Brown et al., 1994; Wenger, 1998), where members share practical experiences within informal settings (Wenger, 1998). Observed induced factors are cohesion and trust level, as well as motivation to share knowledge (Jarvenpaa & Leidner, 1999; Wilson, 2001). It should be noted that weak heterogeneous ties are more appropriate when there is a greater cognitive distance that could lead to important stimuli for innovation (Nooteboom, 2000; Grabher, 2004). Luft and Ingham (1955) argue that the larger the interaction arena (space of mutual understanding), the more productive the interpersonal relationship will be. Interestingly, Wasserman and Galaskiewicz (1994) introduce social network as channelling relational ties. They also state that social or interpersonal influence, which does not require face-to-face interaction as the only precondition is information about the attitudes or behaviours of group members, leads to behavioural contagion. Of course, current social networking applications available on the Web allow individuals not only to maintain relational ties and social proximity with previous project colleagues, but also to build new ones with colleagues of colleagues. As such, social networking increases the ability to make new friends at a distance and induces some entry trust level (Efimova, 2004; Pallot et al., 2006; Walther, 2002).

2.7.2 Cultural Distance

Cultural distance represents the understanding and behavioural differences among people living and working in various regions of the world and involved in distributed work (Moon & Sproull, 2002; Malone, Yates & Benjamin, 1987; Hofstede, 1980, 1994). These people do not communicate information, interpret it or react in the same way (Zheng et al., 2006). For example, a lack of interaction could lead to non-collaborative behaviour (Biggs, 1996).

Previous studies have introduced different elements to the discussion about the effect of cultural distance in the context of international diversification (Morosini et al., 1998; Shenkar, 2001; West & Graham, 2004; Tihanyi et al., 2005; Gasson, 2004; Gertler, 1995). Theoretical and empirical evidence has been used to explain diverging findings in order to help resolve the national cultural distance paradox (Brouthers & Brouthers, 2001). It has been found that observed cultural distance factors impede mutual understanding and agreement on organisational structures during decision processes or communication procedures (Shane, 1994; Alexander, 2000; Pawar et al., 1994). However, cultural differences contribute largely to the richness of diversity, which supports a higher level of creativity (Nooteboom, 2000; Bonifacio & Molani, 2003; Fischer, 2005c). Therefore, there is an interesting paradox between a homogeneous group, where it is easier to reach a mutual understanding but there are fewer creative stimuli, and a heterogeneous group, where it takes longer to reach a mutual understanding but there are more creative stimuli (Boland & Tenkasi, 1995). Levina and Vaast (2005) studied a case of Intranet use for turning collaboration into transaction in boundary-spanning practices.

2.7.3 Emotional Distance

Emotional distance represents the way individuals or groups can perceive one another's feelings or emotional state or socio-emotional exchange (Halliday & Hasan, 1976; Goleman, 1998; Piwek et al., 1995); this could be disturbing, slowing-down or even impeding a specific collaboration process such as the confrontation of arguments or the negotiation of requirements (Glover, 2000). On the other hand, a case study about distant negotiation reveals that a requirement for negotiation meetings to take place within computer-mediated distributed settings did not result in decreased performance. The ability to better sense emotional states (Goleman, 1998) within face-to-face meetings brings the risk of impeding the negotiation process (Damian, 2002). A recent field study on the use of shared workspace and group blogging reveals that emotional and social distances provide a chance to start remotely a relationship with someone who is too shy or emotional to interact directly (Pallot et al., 2008; Efimova, 2004).

2.7.4 Lingual Distance

Lingual distance determines the level of difficulty for a heterogeneous group of people to share meanings and understanding, while at the same time it brings diversity. Languages are very much based on history, culture and tradition (Wong & Trinidad, 2004), and therefore play a key role in cultural and cognitive behaviours. A greater lingual distance slows down or even blocks interactions among collaboration stakeholders. However, while there are encountered factors such as feelings of isolation, discouragement from collaborating, or difficulty in establishing relationships and mutual understanding, there could also be more creative ideas present due to the higher level of diversity.

2.7.5 Cognitive Distance

Cognitive distance refers to the way an individual or specific group interprets, understands and evaluates things differently than others (Gundel et al., 1993; Nooteboom, 1992, 2000). In this context, Nooteboom, who introduced this concept, defines cognition as a broad range of mental activity, including proprioception, perception, sense making, categorisation, inference, value judgments, emotions and feelings, all of which build on one another. As for the relation between cognitive distance and innovation performance, Nooteboom proposes that there is an inverted-U shaped curve relationship whereby cognitive distance has a positive effect on innovation capacity until learning by interaction can occur (Nooteboom, 1992, 1999). If cognitive distance is too large, then it impedes learning by interaction and makes mutual understanding difficult or impossible.

It is often said that innovation resides at the frontier of disciplines. Absorptive capacity is recognised as an important factor in this context (Nooteboom, 2000). The innovation performance is also strongly related to the novelty effect which originates from making new combinations. The positive effect for firms is much higher when engaging in more radical, exploratory alliances than in more exploitative ones.

Another interesting aspect is to look at the way communities interact and to try to better understand the meaning, role and importance of cognitive distance (Cohendet, 2005). Furthermore, Hollan et al. (2001) envision distributed cognition as a new foundation for Human-Computer Interaction (HIC) research.

2.8 Technical Dimension

The technical dimension includes five distance types or classes: conceptual, contextual, referential, semantic and technological.

2.8.1 Conceptual Distance

The greater the number of disciplines involved in a distributed collaboration, regardless of what is induced by other distance factors, the greater the difficulty to synthesise all perspectives and to collide concepts issued by different specialists (Fischer, 2001). Conceptual barriers, mentioned as being an expertise gap, appear systematically during communication between domain experts and novices, while a conceptual gap appears during communication between stakeholders from different disciplines or practices (Fischer, 2004). The latter is seen as a conceptual dimension between different domains (Liu & Singh, 2004). Fischer argues that collaboration can be spatially, temporally, technologically and conceptually distributed (Fischer, 2005b).

In fact, conceptual distance represents the differences among concepts expressed in a value of the semantic network connecting those concepts (Hofstadter & Mitchell, 1995). For example, proximity expresses nearness while distance expresses farness. As farness is the antonym of nearness, one may conclude that distance is also the antonym of proximity. Distance is a concept in which value ranges from nearness (proximity) to farness (distance). In conclusion, the greater the proximity, the smaller the distance, and vice-versa. Collaborative learning and working require a shared understanding environment in which the meanings of terms or labels, concepts and related objects can be debated and resolved (Resnick et al., 1991).

2.8.2 Contextual Distance

Contextual issues affect knowledge application in various situations that lead to improving problem-solving in the workplace (Finke et al., 1992; Hymes & Olson, 1992). For example, a context menu provides the user with a set of specific contextualised actions according to the nature of the selected object. Knowing about the context of specific activities allows the connection of various pieces of information and the creation of possible paths for the user. This also provides functionality for updating and extending content, allowing people from the workplace to become content providers (Prante et al., 2002). Thus, it is argued that ICT can help bridge contextual distance (Demetriadis et al., 2005) in designing context awareness (Gross & Prinz, 2003). Context awareness, within computer science, refers to the idea that computers can both sense and react based on their environment. In this area Dey, Salber, and Abowd define context as ‘any information that can be used to characterise the situation of an entity. An entity is a person, a place or an object that is considered relevant to the interaction between a user and an application’ (Dey et al., 2001).

2.8.3 Referential Distance

Referential distance corresponds to the distance between the point of origin and the correlating document measured by the number of necessary references. In this way, it is possible to describe the potential relevance of a document compared to the origin of referencing. If the referential distance increases, the relevance can be expected to decrease (Fuchs-Kittowski & Köhler, 2005). Bowker and Star (2000) carried out a specific study on classification and its consequences.

2.8.4 Semantic Distance

Semantic distance, like semantic relatedness (Budanitsky & Hirst, 2001) and semantic similarity (the inverse of distance, also known as semantic proximity), represents the level of relationship of one term to another (Suchman, 1987). It can be expressed by a number from -1 to 1, or between 0 and 1, where 1 represents high relatedness and 0 represents none. Ontologies help to define a distance between terms or words by tracking nodes and edges in graph representations (Norman & Hutchins, 1988). Statistical tools, such as a vector space model, are used to correlate words and textual contexts from a suitable text corpus (co-occurrence). Semantic differential is another way of looking at semantic distance, through a potential rating scale used to measure the connotative meaning of terms or concepts (Bowers, 1993).

2.8.5 Technological Distance

Technological distance is the result of the differences between the use of various technologies, which could be either ICT or production technologies, or even a combination of other technology types (e.g. biology). Collaboration activities are potentially enhanced, as collaborative technologies enable individuals to contribute with their own specificities to the collective work (DeSanctis et al., 2001). However, distributed group members should have a mutual understanding about the collaborative technologies (Mulder, 2002) and their availability at their own location (Mayben et al., 2003). Moreover, it can be argued that often individuals do not feel comfortable with using ICT to support distant collaboration (Pauleen & Yoong, 2001), hence the high usage rate of both telephone and electronic mailing technologies, as nowadays almost everyone is able to use them properly.

Synonymous with technological distance is industrial distance, as it is often related to organisations using similar or close production technologies (Hyypiä & Kautonen, 2005). In addition, Boix Miralles (2001) argues that there is a technological distance resulting from the differences between the product and production technologies involved in a purchase. This is confirmed by Winroth and Danilovic (2002) in another empirical study on distance in IOC.

Technological distance is generated by the gap of technological knowledge that individuals can learn from one another. A lower technological distance (nearness) among collaboration stakeholders facilitates the acquisition and development of technological knowledge and technologies (Knoben & Oerlemans, 2006). Hence, technological distance is linked to the concept of absorptive capacity as the ability to assimilate and apply external knowledge (Nooteboom, 2000; Cohen & Levinthal, 1990).

2.9 Legal Dimension

Legal and ethical aspects should not be neglected, since there are demonstrated relationships with social implications, exploitation objectives, security and confidentiality agreements, as well as privacy and inclusion concerns, which often lead to situations of conflict among collaboration stakeholders. On the one hand, social implications are related to trust building and mutual confidence among stakeholders. On the other hand, social implications are related to public and management recognition, such as reward mechanisms, as well as learning, pre-emptive protection, control, and enabling commercial production of the outcome, as demonstrated by Sawhney (2002). Legal and ethical distance factors, when wrongly addressed, could easily turn any collaboration into a very low performance. Despite their importance, however, they have often been ignored within previous empirical studies.

2.9.1 Ownership Distance

Ownership distance is related to Intellectual Property Rights (IPR), patenting and copyrighting as well as ‘open source design’ or ‘creative commons’ (Gupta and Landry, 2000). Sawhney (2002) argues that IPR play an important role in making design innovations accessible to target communities and producers in developing countries. Property rights in scientific research and academic settings have caused passionate debate as to whether they should have a public or commercial nature. Currently, there are two opposite trends: a willingness to promote greater commercialisation of research through formal IPR mechanisms such as patents and copyrights; and a growing support for greater openness towards academic programs and research through Open Source initiatives (Sawhney, 2002) and for open mass collaboration (e.g. wikis) through creative commons (Pallot et al., 2006). Ristau Baca states that while the creative commons licensing system has achieved major recognition and use, its application to scientific transactions presents major challenges, as it involves copyrighted works based on individual licensing of creative works for use on the Internet, while a science commons license implies a transfer of physical goods or information not subject to copyright (Ristau Baca, 2006). According to Ristau Baca, science commons involve significantly more complex and sophisticated parties, though a properly implemented science commons license could bridge ownership distance (Ristau Baca, 2006).

2.9.2 Financial Distance

Hart and Moore make the case that the value of a business relationship depends on the participation of the parties in the relationship and the investments made (Hart & Moore, 1990). A player's participation may be indispensable to an asset. If he does not participate in the venture then the asset may not be productive at all. Financial investment behaviour is often related to past collaboration experiences and confidence, in that there is no financial investment gap or distance with other partners. Some investments are relationship or asset specific, meaning that their value outside the relationship is very low (Hart & Moore, 1990).

2.9.3 Contractual Distance

Contractual distance is related to the aspect of specifying participants' rights and obligations within different conceivable circumstances which may occur during a collaboration project (Grossman & Hart, 1986). Many contingencies may not be possible to foresee, or even if they were, it might be prohibitively expensive to draft contracts encompassing all conceivable contingencies, as argued by Hart and Moore (1990) in a theory of property rights based on incentives. Hence, many contingencies, often related to IPR, security and confidentiality, as well as ethical aspects such as privacy and inclusion (Silverston, 2004), are not properly addressed in contracts. Therefore, they create contractual distance among parties that may impact collaboration performance. The security aspect is often neglected, yet wrongly, as it appears to be one of the necessary conditions for enabling trust building among distributed collaboration stakeholders, especially in the context of the Internet and the Web (Appelt et al., 2007).

Furthermore, national regulations regarding the use of ICT might differ from one country to another, which would create contractual distance regarding the protection of ownership, security and privacy. Where a group of partners do not share certain concerns, virtual mediation will not create proximity even if ICT appears to compress spatial distance (Introna, 2005).

2.10 Mutual Understanding

In the context of open innovation, project teams are multidisciplinary, where team members operate collaboratively in a social process (Bucciarelli, 1994). Kleinsmann (2006) provides the following definition of collaborative design:

> *The process in which actors from different disciplines share their knowledge about both the design process and the design content. They do that in order to create shared understanding on both aspects, to be able to integrate and explore their knowledge and to achieve the larger common objective: the new product to be designed.*

Valkenburg (1998) stated that team members create mutual understanding when the interpersonal communication is efficient. Other authors, such as Dong (2005), Kleinsmann and

Valkenburg (2005) and Kleinsmann et al. (2007), have conducted research on factors influencing the building of mutual understanding. Kleinsmann and Dong (2007) investigated the impact of the affective force on building mutual understanding. Valkenburg (2000) developed a graphical method for representing the process of mutual understanding, in which he introduced the concept of ‘shared frames’. Shared frames are created by a team during a reflective practice (Schön, 1983). The reflective practice comprises four activities: framing (describe the solution space), naming (make explicit all that needs attention), moving (create ideas, explore problems, assess the impact of decision) and reflecting (look at themselves and reframe the problem). In this reflective approach the building of mutual understanding is presumed to be decoupled.

There are a number of published papers which compare physically and virtually collocated teams, and demonstrate a higher effectiveness and efficiency of the collocated form. This is partly due to there being an easier and faster way to reach a shared understanding among team members. In fact, ‘shared understanding’ in this context means mutual understanding, because a mind is not a sharable device. Shared understanding is also referred to as common understanding (Büchel & Denison, 2003) or mutual understanding (Vaidyanathan, 2006), and is promoted by shared vision, goals and culture.

Sakiroglu compares virtual teams and collocated teams in using situational awareness. He acknowledges that the two conditions achieved in the experiment represent two extremes (Sakiroglu et al., 2002). The fully collocated case is rare, because experts in all aspects of the product lifecycle do not usually work in a collocated manner; while conversely, dispersed teams usually have some face-to-face meetings throughout the project. He also explains that the results highlight statically significant differences between the two conditions, with virtual teams manifesting less situation awareness and higher frustration. As for shared understanding, he writes:

Understanding – that is, how easy it was to make sense of the information being *provided. The results were not significant here, but there was a clear trend indicating that the collocated team found it easier and increasingly easier to make sense of the task as the game progressed. This was not so evident for the virtual team.*

According to Hill, shared understanding is a critical element in successful collaborative design (Hill et al., 2001). Toye argues that within a multi-disciplinary collaborative product development environment, design occurs as a social process of reaching a shared understanding of the design problem, requirements and process itself (Toye et al., 1993). Furthermore, Hill (2001) citing Kilker (1999) found that "engineers bring their own language, jargon and perspectives, resulting in incompatible viewpoints among design team members which may lead to ineffective collaborative, sub-optimal decision-making and impaired projects".

Büchel and Denison (2003) state that creating a common understanding among the NPD team stakeholders enables the different functions to contribute to the success of the team. Dense networks foster shared understanding, leading to the creation of knowledge necessary to mobilise innovative action. They found that terminology such as 'shared understanding', 'shared cognition' or 'collective sense making' are similar to the concept of mental models, with each concept postulating that common perceptions at the team level have a positive impact on team outcome. Furthermore, Neumann et al. (2006) propose a framework for shared mental models in design; the framework includes four models: task model, process model, team model and finally, competence model.

According to Donnellan and Fitzgerald (2003), the dependence on tacit knowledge, which is situated in individuals' minds, combined with temporary involvement in project teams, leads to a lack of shared understanding among NPD team members.

Kleinsmann and Valkenburg (2005) argue that previous research shows that shared understanding is important for the ability to manage the integration of different knowledge domains. In their study, they describe learning opportunities as being enablers or disablers for the achievement of shared understanding. They recommend the explicit use of storytelling during an NPD project to create a learning organisation with shared understanding between the actors.

Based on some prevailing theories of interpersonal communication, Wertsch (1991) states that a shared understanding between communicators comprises both design objects and design vocabulary. He also refers to the popular expression of a team being 'on the same page', meaning that a true collective understanding occurs. For Wertsch, when a design team is 'on the same page', this implies group acceptance of a common set of design vocabulary, especially when team designers come from different disciplines or backgrounds. Fischer also points out that similarity in voice collaboration path (Fischer, 2005a) between designers is a critical element to progressing through the design process (Arias et al., 2000).

According to Cooper and Kleinschmidt (1995), Griffin (1996) and Citera et al. (1995), high-performance teams excel in developing shared understanding through cooperative exchanges of information and mutual agreements. Communication in a social setting is often characterised as the creation of shared understanding through interaction among people. For Robinson and Bannon (1991), groups of people form 'semantic communities' with their own conventions of meaning, especially when they communicate often and over long periods of time. Bodker and Pedersen (1991) defined the term 'workplace culture' as a common 'code of conduct' shared among group members. Others argue that teams must be able to synthesise shared knowledge into a shared understanding in order to ensure successful outcomes (Baird et al., 2000; Lloyd, 2000).

Gerhard Fischer (2005a) mentions shared understanding as one of the most fundamental challenges facing Communities of Interest (CoI). He states that combining different and often controversial points of view to create a shared understanding among these stakeholders can lead to new insights, new ideas, and new artefacts. Fischer also highlights a way of creating shared understanding. He argues that the traditional model for collaboration, the ‘division of labour’, is inadequate to address the critical issues of social creativity.

Communities of Practice (CoP) (Wenger, 1998) consist of field experts operating in specific domains, while Communities of Interest (CoI) are composed of experts from different fields, who collectively solve particular issues. Wenger argues that communication within CoI is difficult because the stakeholders, coming from different fields of practice, use different languages, different conceptual knowledge systems, and sometimes even different notational systems. Fischer (2005a) cites Wenger’s work (1998) for explaining that CoI have greater potential for creativity than do CoP. Different backgrounds and different perspectives can lead to new insights (Bonifacio & Molani, 2003; Csikszentmihalyi, 1996). Based on previous work (Clark & Brennan, 1991), Fischer declares that the most fundamental barrier that CoI need to overcome is the challenge of creating common ground and shared understanding.

In this study, in order to avoid any ambiguity, ‘common’, ‘shared’ and ‘mutual’ understanding are considered synonymous terms. The term ‘mutual understanding’ seems to be the most appropriate because as mentioned above, an individual’s mind is not a sharable device. It represents the outcome of combined activities of sense-making and shared meaning that allows a group of individuals to reach the same level of understanding. Vision, perspective (viewpoint), language, jargon and other specific vocabulary or representation models resulting from cultural practices, backgrounds and conventions are involved in the process of reaching a mutual understanding. As a matter of fact, it is well known that project teams get a mutual understanding of their process as soon as they are able to collectively represent and refine it graphically (e.g. functional activity modelling based on the use of IDEF0 modelling technique and tool).

2.11 Virtual Collocation with Collaboration Technology

2.11.1 Face-to-face versus Distributed Environment

Issues	Physical Collocation	Virtual Collocation
Proximity	*Close*	*Remote*
Typical Use	*In small and medium sized companies with one or few sites*	*Multi-national and international organisations with different sites*
Cultures	*Limited diversity, since the team members come from the same company or site*	*Larger diversity due to participants from different countries or regions*
Information Exchange	*Opportunity for sharing formal and informal information (ideas, dilemmas)*	*Limited opportunity to share informal information due to the dispersed location*
Relationships	*Ample opportunity for face-to-face interactions*	*Limited opportunity to interact and build relationships*
Purpose	*An evolving common sense of purpose*	*A directed common sense of purpose*
Resources	*Ample opportunity for sharing of resources (technical, human, financial)*	*Limited access to similar technical and non-technical resources*
Technology	*Fewer hiccups due to possible sharing of technical systems*	*Possible problems due to variations in non interoperable technical systems*
Working Environment	*A higher sense of belonging within the team*	*Feelings of isolation and frustration, and possible absence of a sense of belonging*
Accessing Information	*Availability of information at any time to every team member*	*Limitation in time and space for accessing information*
Transparency of Activities	*Greater visibility of the design work*	*Lack of visibility of the work being carried on by the group*
Education Background	*Similarity of work method and employment*	*Difference in education, language, training, time orientation and expertise*
Empowerment	*A lower degree of empowerment and closer supervision*	*A higher degree of empowerment and delegated authority and looser control*

Table 2.2: A comparison of the typical characteristics of physically or virtually collocated teams (Sharifi and Pawar, 1997)

Today, there is no longer debate about whether collaboration adds to a face-to-face (physical collocation) or distributed (virtual) environment. There are two main reasons for this: First of all, numerous empirical studies have demonstrated the benefits of face-to-face collaboration simply because it is a human activity, while Kock (2005) argues that a decrease in the degree of communication naturalness decreases the interaction quality.

Second, the race to increase productivity and innovation leads to a greater openness to external ideas and competences that in turn leads to distributed Collaborative Working Environments (CWE). Because technology lowers time and distance barriers, teams grow with a broader life-cycle scope and involve new stakeholders such as suppliers, customers and end-users, most of them operating from dispersed locations. This issue was identified by Lipnack and Stamps (1997) in their model named 'Team Size and Bands of Involvement', with its three layers: 'inner circle', 'extended team' and 'external partners'. They also explained the process: 'Make a first pass at the team's bands of membership: the small core group, the extended network of closely involved part-timers, and a periphery of experts and support people who are recruited on an as needed basis.'

One previous study, carried out by Sharifi and Pawar (2002), explores and compares the concepts of the collocation of teams in physical and virtual environments. The authors state that a face-to-face environment implies that stakeholders contributing to the design and development of a new product are located in close proximity to each other. They note that major benefits of collocation are often described in terms of increased interactions, ease of informal communication and efficiency of use of resources. However, they cite Rafii (1995), who considered these gains as illusory, arguing that centralised collocated product development activities become inefficient in the context of globalised manufacturing. They state that electronic mail and engineering databases are often used to facilitate a kind of virtual collocation simulating face-to-face communication (Pawar & Sharifi, 1997), and provide a table (see Table 2.2) that lists a set of issues and respective characteristics on the basis of which the two forms of teaming may be compared. Lipnack and Stamps (1997) propose three foundational concepts: 'people, purpose and links' and state that: 'The principles of people, purpose and links form a simple systems model of inputs, processes and outputs.' Their book is structured according to these three principles (see Table 2.3).

Concepts	**Inputs**	**Processes**	**Outputs**
People	Independent Members	Shared Leadership	Integrated Levels
Purpose	Cooperative Goals	Interdependent Tasks	Concrete Results
Links	Multiple Media	Boundary-Crossing Interactions	Trusting Relationships

Table 2.3: Virtual Team System of Principles

(Lipnack & Stamps, 1997)

Later, these three principles were extended by S. Lamont (see the allcollaboration.com website[7]) into the four P (principles) of effective collaboration: purpose, people, processes and place. The 'links' proposed by Lipnack and Stamps become 'processes' and the concept of 'place' is added to represent the interaction modes, such as face-to-face and virtual collocation or a combination of the two.

More recently, Siebdrat et al. (2009) carried out a study on virtual teams, revealing that dispersed teams can actually outperform groups that are physically collocated. They argue that virtual (distributed) collaboration must be managed in specific ways in order to succeed. Their findings indicate that the overall effect of dispersion is not necessarily detrimental. They claim that this depends on a team's task-related processes, including those that help coordinate work and ensure that each member contributes fully. They also found that even small degrees of dispersion (e.g. different rooms and floors in the same building) can substantially affect team performance.

Finally, Siebdrat et al. (2009) found that managers should carefully consider the social skills and self-sufficiency of the potential members of a virtual team. In terms of opportunities raised by distributed collaboration they list heterogeneous knowledge resources, cost reduction,

[7] http://allcollaboration.com/home/2009/12/15/the-four-ps-of-effective-collaboration.html

access to diverse skills and experience, knowledge about diverse markets and a 'follow the sun' working strategy. In terms of difficulties they list language differences, cultural incompatibilities, harder to establish 'common ground', fewer (or even no) synchronous face-to-face interactions and harder to achieve good teamwork (Nardi & Whittaker, 2002). One might conclude that temporal distance (team spanning different time zones) is a special case where the benefit of working 24 hours a day as a 'follow the sun' strategy is very clear, and physical collocation is not an option.

The use of collaboration technology in cooperation between individuals and organisations is currently growing. This is due to various driving forces, such as globalisation and outsourcing trends, workforce demand for flexibility, critical need for rapid innovation, and value co-creation among suppliers, customers and end-users. Other driving forces include technology and tools enabling a networked world, and the behaviour and expectations of the Net Generation or Digital Natives. Collaboration is becoming an ever more essential competitiveness tool for both individuals and businesses.

While collaboration remains among people, the adoption of collaboration techniques, methods, technology and tools induces significant challenges. Collaboration applications, whether traditional or Web 2.0, widen the scope of functionalities, including social networking. The dedicated selection of appropriate collaboration tools is a real challenge for most organisations. They can choose either many tools for different purposes or a few tools to which new functionalities can be added based on the needs of evolving projects. New ways of doing things require, at least, the adaptation of current processes or even the creation of new ones in order to achieve a greater value. One might see collaboration as a coin having two sides: the social elements on one side and the technical means on the other side. Inside the collaboration coin reside structural and legal ingredients.

Collaboration experts[8] D. Coleman, S. Lamont, L. Datta and A. Schmidt have declared on their website:

> *We repeatedly make the case that enterprises need to approach collaboration holistically. Effective collaborations must cross functional and company boundaries to include all the right people. They must challenge and inspire the teams to invent new approaches. And they must encompass more than the team assignments and the tools. In short, they must address the Four Ps of Collaboration[9]: Purpose, People, Processes and Place.*

Place refers to the 'place' where the team conduct their interactions, such as face-to-face or virtual collocation, through the use of synchronous interactions (physical meetings, phone or Web conferences) or asynchronous interactions (message boards, wikis, e-mail exchanges, etc.). In fact, with the exception of physical meetings, all types of places are virtual collocation; hence the use of collaboration technology. However, they also mention that interactions or place might change over the course of the collaboration project; for example there might be a kick-off meeting for more direct contact at the start of the collaboration project, followed by virtual interactions throughout the project duration, then a final face-to-face meeting with direct contact to arrive at the solution.

It is worthwhile to note that Coleman et al. also recommend the use of a holistic approach for implementing a collaboration project. A possible comparison of the dimensions used in their holistic approach of collaboration and the one used in this study could be the following: purpose and processes mean the structural dimension, people refers to the social dimension and place corresponds to the technical dimension.

Coleman et al. also state that:

[8] http://allcollaboration.com/about-me/

[9] http://allcollaboration.com/home/2009/12/15/the-four-ps-of-effective-collaboration.html

Collaboration requires culture change aimed at flattening hierarchy, increasing transparency, allowing right talent to naturally flow to right endeavours without organizational barriers, establishing open communication, ensuring recognition commensurate with contributions, firing know-it-all's and gate-keepers, and so on. You will know you have succeeded when leading companies are trying to steal your employees because of their collaboration skills. Seemingly little things can become big, especially when it comes to the human element. It helps a great deal to pay close attention to communication styles and needs, cultural differences, personal desires and constraints, and recognition and rewards.

2.11.2 Groupware versus CSCW

In terms of collaboration technology, two research streams, 'CSCW' and 'Groupware', appear in the literature. Koch and Gross (2006) define CSCW as follows:

The research field Computer-Supported Cooperative Work (CSCW) is concerned with understanding social interaction and the design, development, and evaluation of technical systems supporting social interaction in teams and communities – or in other words it is about researching the use of computer-based technology for supporting collaboration. The field was coined in the 1980s by researchers from computer science, information science and social science.

Koch and Gross (2006) adapt a functional classification comprising five application classes: awareness support, communication support, coordination support, team support and community support, often used for discussing groupware applications (Borghoff & Schlichter, 2000).

Groupware is a general concept representing technology that supports group collaboration. Defined by Ellis et al. (1991) as 'computer-based systems that support groups of people engaged in a common task or goal and that provide an interface to a shared environment', groupware encompasses groups of technologies that mediate interpersonal collaboration through computers and networks such as the Internet. It encourages collaboration and interpersonal productivity by automating tasks and enhancing communication efficiency. In terms of applications, groupware can be anything from e-mail and online conferencing to workflow automation. First described by Peter and Trudy Johnson-Lenz in 1978 as 'intentional group processes plus software to support them', groupware has been referred to by Doug Englebart (1988) as 'a co-evolving human-tool system'. Later, David Coleman (1997) described groupware as 'computer-mediated collaboration that increases the productivity or functionality of person-to-person processes'.

The primary motivations for groupware were fewer face-to-face meetings (reduced travel costs), automation of routine processes (increased individual productivity), integration of geographically disparate teams (reduction of relocation costs) and extension of the organisation to include both customers and suppliers (better coordination and customer service). Other motivations were enhancement of competitiveness through faster time to market and better support for Total Quality Management. Later, groupware evolved as a broader concept to foster collaboration and increase interpersonal productivity by automating tasks (workflow) or enhancing the efficiency of communication and interaction.

2.11.3 Collaborative Working Environments

The myriad software tools to support distributed collaboration include real-time conferencing tools, collaborative authoring tools, workspace functionality, messaging support, functions to coordinate tasks, awareness information about the people collaborating, facilities for persistent conversations and functionality to syndicate contributions. Figure 2.5 below, an updated version by Slagter et al. (2006) of a previous figure by O'Kelly and Gotta (2006), illustrates the key functionalities of a Collaborative Working Environment (CWE).

Many different tools and applications support collaboration. Within a group of independent eProfessionals, team members will have different preferences and experiences regarding the use of these tools and applications. Moreover, eProfessionals often contribute to more than one project. Consequently, they are members of different shared workspaces and have their own personal information spaces where they keep track of their overall planning and store their private information.

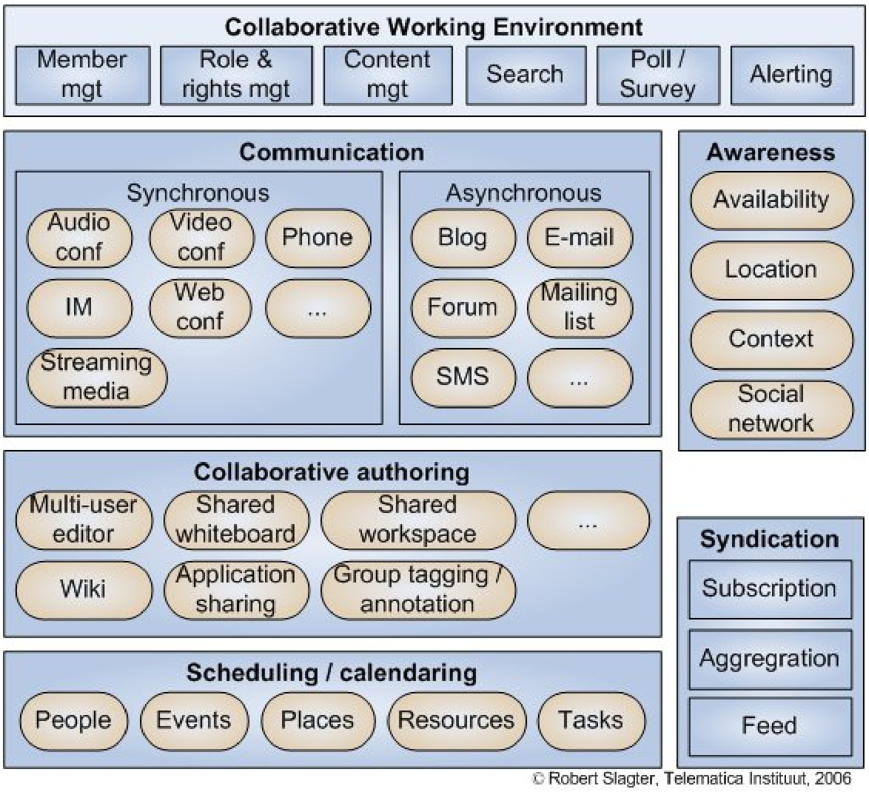


Figure 2.5: Key functions of collaboration and communication infrastructure

Slagter et al. (2006) updated from O'Kelly & Gotta (2006)

Major bottlenecks with current collaboration tools are the lack of interoperability and information overload. Most of the collaboration applications are designed under the assumption that all project team members will use the same application. While this is an attractive and simplifying goal for collaboration tool designers, it does not reflect the reality.

The descriptions of current collaboration ICT infrastructure show that most of the tools focus on supporting individuals' activities rather than team activities. A survey carried out by

Davenport (2005) revealed that many knowledge workers are not satisfied with current communication channels and platforms. Davenport found that while all knowledge workers surveyed used e-mail, 26% felt that it was overused in their organisations, 21% felt overwhelmed by it and 15% felt that it actually decreased their productivity. Reducing information overload is an important challenge for collaboration tools. This is confirmed by another survey, carried out by Morris (2005), in which only 44% of the respondents declared that it was easy to find what they were looking for on their own Intranet portal.

2.11.4 Classification of Collaboration Tools

Collaboration tools can be classified in many different ways. Table 2.4 shows a collection of tools supporting asynchronous interactions (traditional, Web 2.0 and SW), and those supporting synchronous or live interactions (IM chat and electronic meetings).

Traditional	Web 2.0	IM Chat	Shared Workspace	Electronic Meetings
• Voicemail • E-mail • Fax	• Wikis • Blogs • Intranet publishing • Internet publishing • Social networking sites • IPTV • Internet forums or discussion boards	• Instant messaging • Text messaging • Online chat	• Revision control or document review • Knowledge management systems • Electronic calendars • Online spreadsheets • Application sharing or co-browsing • Workspaces	• Conference calls • Video conferencing • Telepresence • Web or data conferencing • Electronic meeting systems

Table 2.4: Collaboration Tools for Sharing Information across Distance and Time Boundaries (source: CISCO Survey[10])

Current collaboration tools support a number of human operations (see Table 2.5), such as people discussion (live or not), exposure and feedback seeking (e.g. group blogging, event and task scheduling, shared calendar, internet publishing, polling, eSurvey). They also support knowledge sharing (content management), social translucence (e.g. presence awareness, contextual awareness, progress awareness, expectation awareness, event awareness) and co-

[10] CISCO Survey on Collaboration: Know Your Enthusiasts and Laggards

working (collaborative authoring, application sharing, co-browsing, electronic whiteboard) as well as social intelligence. Social networking is still considered as a newcomer in the collaboration tools arena.

Group or community discussion		**Exposure & feedback seeking**	**Knowledge sharing**	**Social translucence**	**Co-working**	**Social intelligence**
Live (synchronous)	***Differed (asynch)***	***Differed***	***Differed***	***Live – Differed***	***Live - Differed***	***Differed***
• Conference calls • Video conferencing • Web or data conferencing • Electronic meeting systems • Instant messaging • Text messaging • Online chat • Virtual world	• E-mail • Internet forums • Discussion boards • Community blogging	• Group blogging • Micro-blogging • Shared calendar • Video publishing • Photo publishing • Event and task scheduling • Polling • eSurvey	• Document sharing • Tagsonomy • Revision control or document review • Knowledge management systems • Shared workspaces • Shared links • People-concepts networking	• Presence awareness • Contextual awareness • Expectation awareness • Activity awareness • Event awareness • Travelling awareness	• Co-editing (wikis, online spreadsheet, text editing & presentation) • Application sharing • Co-browsing • Electronic whiteboard	• Social networking • Self coordination • Community tagging • Community bookmarking • Collaborative searching • Community annotating • Community notification

Table 2.5: A proposed classification of collaboration tools

Many studies on collaboration technology and tools report e-mail overuse (around 70% of people collaboration is still based on e-mail exchange). While these studies fail to identify a reasonable explanation, a testimony blog entry from Jim McGee[11] provides an interesting comment, confirming that e-mail is the lowest common denominator tool for supporting collaboration:

Most organizations still operate on the notion that the corporate network is a fortress to be protected. This makes my life difficult from two perspectives. First,

[11] 2005 Jim McGee Extreme mobility and knowledge work effectiveness
http://www.mcgeesmusings.net/2003/07/13.html#a3512

getting into my own network is more difficult than I would like from my selfish, time-pressed, user perspective. Second, when I am with clients, my effectiveness is compromised by the hurdles I have to negotiate to get access to material on their networks. Email becomes the lowest common denominator for coordinating work and the impacts on knowledge work effectiveness are invisible to the organization. Extra hours that I work to cope with these limits don't show up anywhere in the reporting systems.

However, in the case of mass collaboration where people use wikis (e.g Wikipedia), e-mail and other synchronous tools become useless because page history and discussion are directly integrated into the wiki applications. In this study, group blogging is expected to significantly decrease the number of e-mails exchanged among team members. All the participants were able to write blog entries about project activities and personal feelings that could be read and commented on by all team members. This constitutes a kind of 'project history' that could be browsed afterwards when looking for explanations about specific situations and decisions taken. It also constitutes a remarkable instrument for deeper ethnographic studies, as it leaves a permanent trace of the project activities and of individuals' feelings.

2.12 Gaps in Existing Literature

The missing holistic view of all distance types and factors (see Figure 2.7) affecting collaboration effectiveness and efficiency constitutes the most important gap in the existing literature. As a result of this lack, it is not possible to disentangle all factors in order to better understand their interrelationships. Furthermore, the conceptual ambiguity among different concepts used in the literature does not facilitate the task of identifying the different types of distance and their respective roles. Finally, the absence of a holistic model of collaborative distance inhibits any willingness to compare findings, according to their specific research methodology, among the published case studies. The needed holistic model would facilitate study of the potential capacity of new practices and new tools for compressing or bridging distances.

However, one of the aforementioned papers related to proximity in collaboration does address this aspect of a broader view in a specific domain of application, Inter-Enterprise Collaboration (IEC), and attempts to disentangle relevant factors. Knoben and Oerlemans' (2006) conceptual approach to the dimensions is still based on too many levels, hindering any real attempt to better understand or clarify relationships among all factors.

Regarding literature related to mutual, shared or common understanding, there is very little research exploring the role of distance factors in affecting the way collaborating individuals reach a mutual understanding. This confirms the existence of a gap in mutual understanding models, where relationships with distance factors appear sufficient for better comprehension.

Interestingly, social interaction is often mentioned in the literature, without any explanation of its link to the ability to reach a mutual understanding leading to new knowledge. When, in 1955, Luft and Ingham developed the well-known 'Johari Window' to explain interpersonal communication and development of relationships, a model of social interaction was lacking.

2.13 A Holistic View and Model on Collaborative Distance

Collaborative distance is a complex phenomenon and a paradox. It is like a coin with two sides, each bringing both positive and negative effects. On the one side, while some distance types provide opportunities to increase overall productivity and decrease lead time, others (or even the same ones) contribute to decreasing collaboration effectiveness and efficiency. For example, temporal distance could result from an extension of daily work to 24 hours by engaging teams located on different geographical sites around the world. A second example, cultural distance, increases the teams' diversity, enhancing the creativity and innovativeness potential through the involvement of different regional and cultural usages and norms (Nooteboom, 2000). Emotional distance provides another example, as it helps team members to conduct a negotiation process without being too disturbed by emotional feelings (Byron and Stoia, 2003).

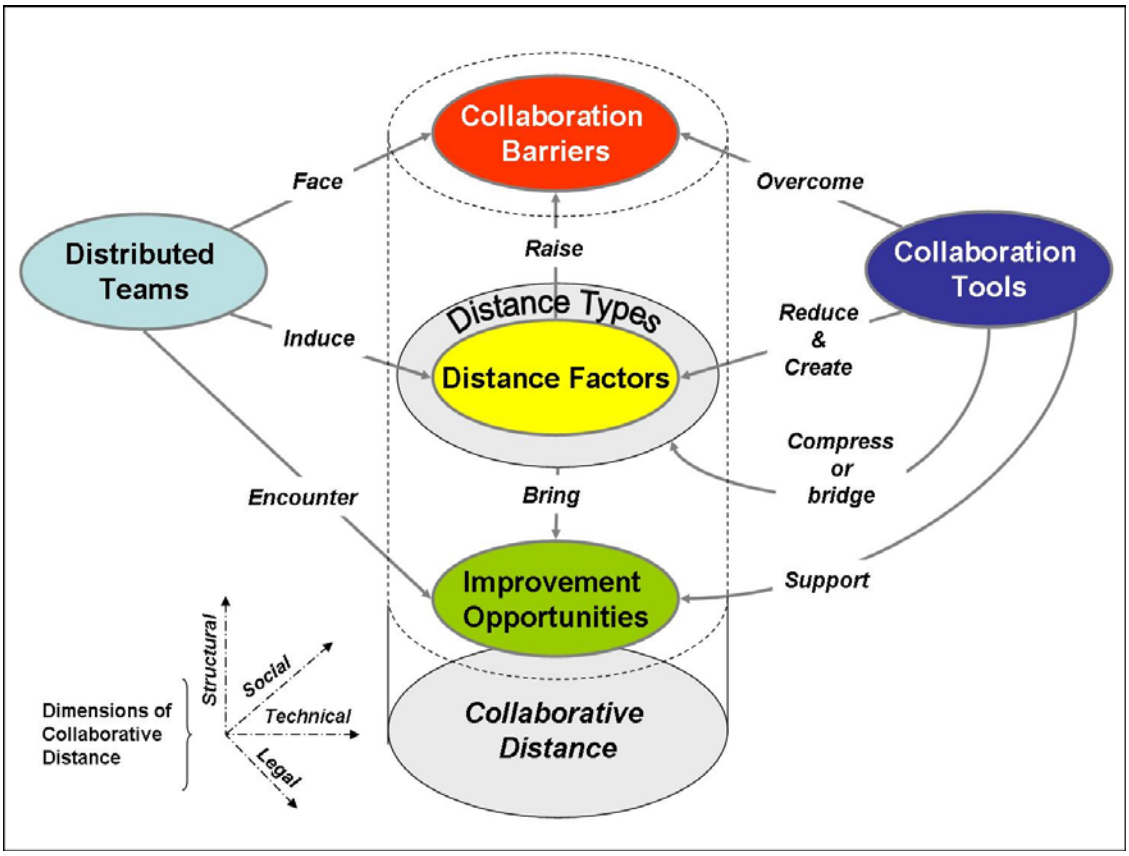


Figure 2.6: The Holistic Model of Collaborative Distance

(Pallot et al., 2010)

On the other side, while collaboration techniques, methods, technologies and tools are intended to overcome collaboration barriers raised by distance factors, they also contribute to increasing the collaborative distance by creating other distance factors, such as technology skills and usages.

The collaborative distance (CD) of distributed teams results from all induced distance factors grouped into various distance types, according to the four dimensions of the holistic model (see Figure 2.6). Distance factors raise collaboration barriers faced by distributed teams. On the other hand, distance types bring opportunities to improve the overall productivity and lead time, as explained above. This CD is bridged or compressed by various collaboration techniques, methods and tools, which in turn introduce new distance factors, such as different technology skills and platforms, leading to well-known collaboration barriers such as lack of common usages and interoperability.

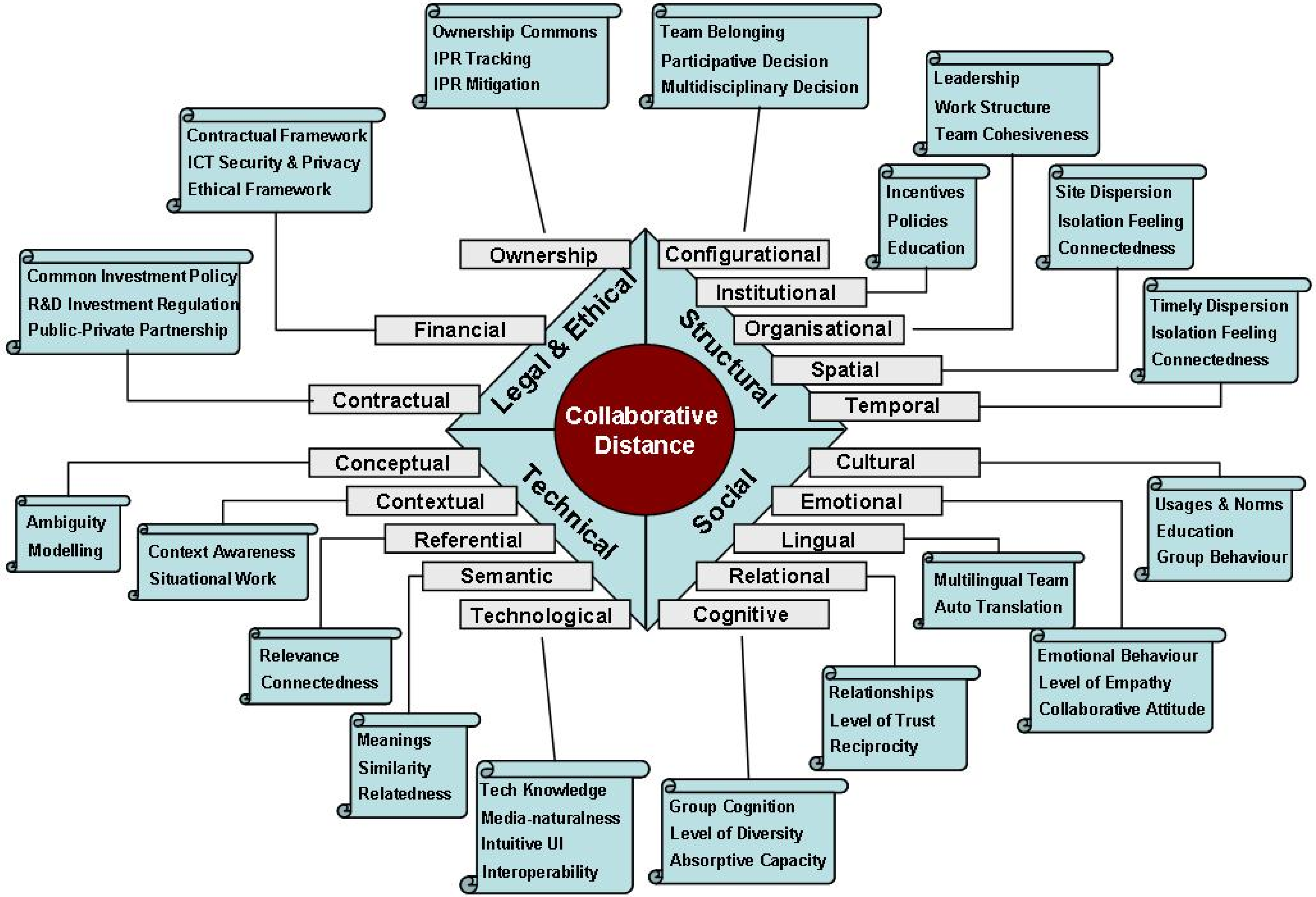


Figure 2.7: Holistic View of Collaborative Distance and Factors

2.14 A Social Interaction Model

The main idea behind this social interaction model is to combine interpersonal relationships and shared understanding in a single model. Such a model highlights the role of distance factors affecting collaboration in the complex process of interaction among individuals. While productivity of individual work using information technology has been increasing year-on-year, there has been little research in terms of collective or interpersonal productivity. The paradox of collaborative technologies is that they focus on the increase of individual rather than interpersonal productivity.

The Johari Window (Luft and Ingham, 1955) illustrates the process of interpersonal communication (see Figure 2.8). It is an easily understood model of communication which employs a four-part figure reflecting the interaction between two sources of information - self and others. In contrast with personal space (Sommer, 1969), the squared field, representing 'interpersonal space', is partitioned into four regions.

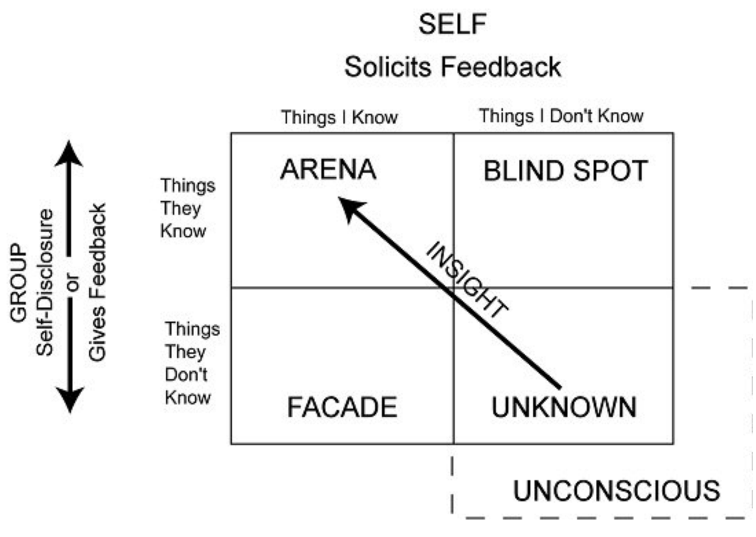


Figure 2.8: JOHARI Window Model

(Luft & Ingham, 1955)

The arena is the portion of the total interpersonal space devoted to mutual understanding and shared information. This 'known by the self - known by others' facet of the relationship is thought to control interpersonal productivity.

The assumption is that productivity and interpersonal effectiveness are directly related to the amount of mutually-held information. Therefore, the larger the arena becomes, the more rewarding, effective, and productive the relationship is apt to be. The arena can be thought of as the place where good communication happens. As the size of this region increases, exposure and feedback seeking also increase.

Figure 2.9 shows an adaptation of the Johari Window model in the age of the Internet, Web and shared workspaces where eProfessional individuals, groups and communities have the ability to expose and share their knowledge. This extended model, also called the on-line Community Window Model, illustrates the process of Web enabled interpersonal communication through the use of collaborative shared workspaces.

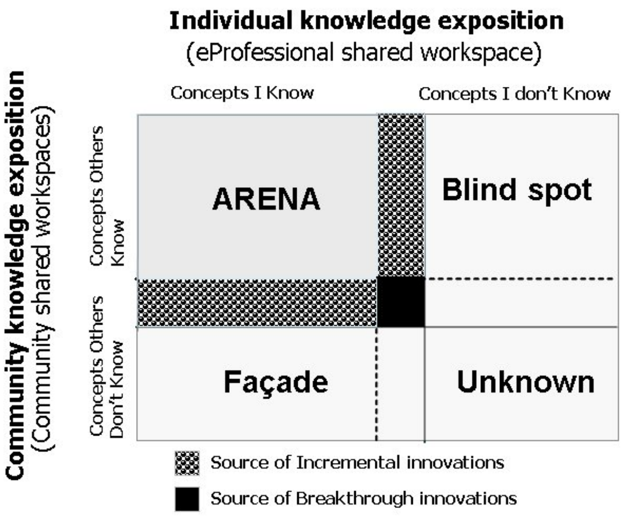


Figure 2.9: Extended JOHARI Window model

(Pallot et al., 2005)

This model, like the Johari, employs a four-part figure to reflect the interaction of two sources of knowledge: self (the eProfessional characterised by his individual shared workspace) and others (characterised by the group or community shared workspaces). The size of the squared field, representing the arena, is increased by knowledge exposition into two different regions. The dashed region represents the source of incremental innovation and the solid filled region represents the source of breakthrough innovation (Pallot et al., 2005).

As argued in a previous paper, there has been almost no work done in the area of interpersonal productivity (Pallot et al., 2006). Individual productivity is still considered as the holy grail by industrial companies (Puybaraud, 2004, 2005), which do not consider social interaction as a vital activity for a business organisation, even though social interaction has been demonstrated as the source of knowledge creation (Nonaka & Takeuchi, 1995).

Figure 2.10 shows another potential use of the Johari Window model in its enhanced form. An interesting aspect of this process for reaching a mutual understanding is the confrontation among existing domains of knowledge from which new ideas and concepts emerge. One may conclude that discussion among individuals confronting different knowledge domains may lead to a kind of 'instant learning', increasing the space of mutual understanding – the arena – and at the same time decreasing the unknown area. This unknown area, according to the Johari Window model, resides in the unconscious of individuals. It could be deduced that new ideas and concepts emerge from the unconscious to the conscious.

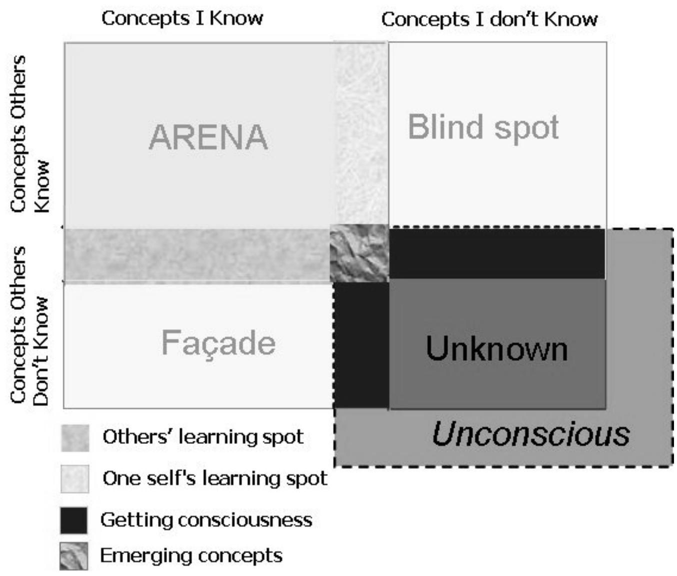


Figure 2.10: Emerging concepts at the frontier of the unknown world

(Pallot et al., 2005)

The model shown above derives from a community based collaborative window where the interpersonal communication arena leads towards both incremental and disruptive innovation areas. The disruptive innovation area is smaller, as the resulting intersection space is produced by the overlap between the extension of oneself and of community knowledge areas. It could be located entirely or partially in the perceptual space (see Figure 2.10). Within the 'inter-personal communication arena', the group of people share knowledge and confront their ideas (social interaction). In doing so, they create new knowledge that will lead to new concepts if they are successful in reaching the proper level of mutual understanding, consciousness and emerging behaviours. This approach has been further explored by Antoniac et al. (2006) in the context of virtual and augmented reality for supporting group consciousness within CWE.

2.15 Towards A Generic Collaboration Process

2.15.1 Collaboration Layers

It has been argued that communication, coordination and cooperation are the three layers supporting both collocated and distributed collaboration (Pallot et al., 2004). Communication represents information and data exchange, while coordination represents task and object synchronisation. Cooperation represents collective operations in a common workspace. Communication and collaboration are fundamentally different, in that communicating information does not mean that the person receiving the information will necessary understand it; if not, he will be unable to collaborate properly. Indeed, communicating or sharing information is essential for enabling collaboration.

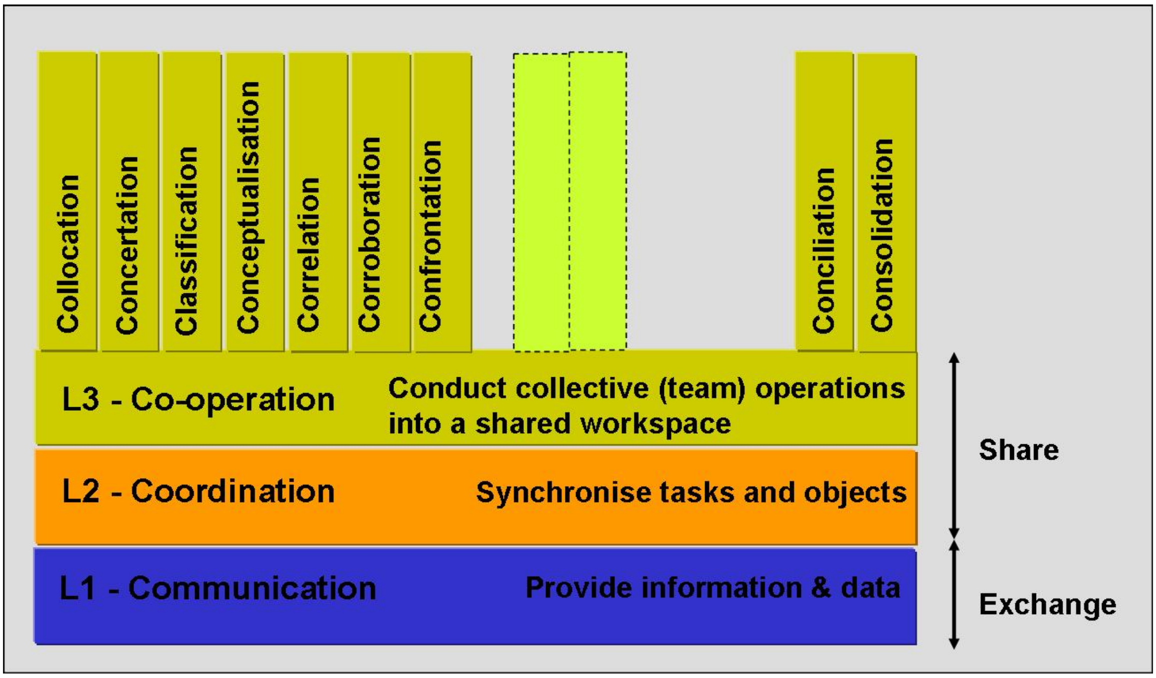


Figure 2.11: Layers of a generic collaboration process

(Pallot et al., 2004)

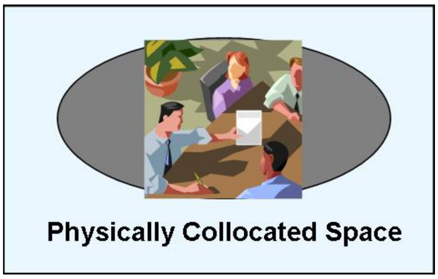
Nonetheless, as one's mind is not a sharable device, it is almost impossible to share automatically the understanding of information until a mutual understanding is built-up through social interaction (where the process of interpersonal communication supports group discussion).

Interestingly, the above Figure 2.11 shows not only the three layers of collaboration, but also the activities that need to be conducted for collaborating, as follow:

- Collocation: group members are either physically or virtually collocated into a shared workspace for promoting social interaction. Shared workspaces, either physical or virtual, behave as social innovation spaces.
- Concertation: a shared workspace is used for sharing explicit as well as tacit knowledge (e.g. chat among group members).
- Classification: expressed knowledge is then classified by group members. This classification becomes a specific new knowledge created and shared by the group.
- Conceptualisation: new ideas and knowledge are formalised into construct or artefact design. This illustrates the emergence behaviour in a group where new ideas and new concepts are born.
- Correlation: interrelationships among new concepts are evaluated for building a mutual understanding.
- Corroboration: relationships between new concepts and existing knowledge are evaluated.
- Confrontation: new concepts in the context of other expertise (e.g. the potential adoption of new artefacts by users) are evaluated.

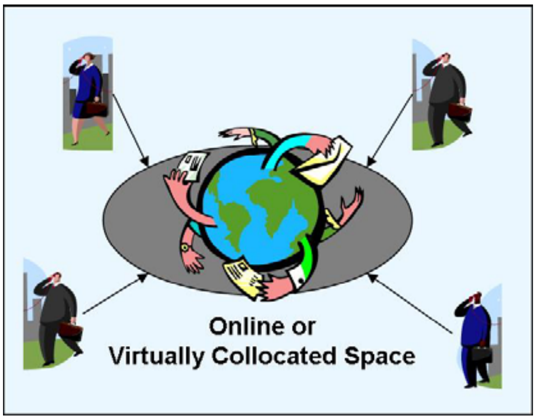
2.15.2 Shared Workspace

Gutwin and Greenberg (1999) state that in the real world, a shared workspace is a physical space where people can undertake tasks as a group. For example, a classroom is a workspace where teachers and students carry out the learning



process. Such workspaces can vary widely in their appearance, as small or large, two- or three-dimensional, connected or discontinuous. These authors found that the main motivation for people to use workspaces is that they conveniently contain both a task artefact and its objects. For them, an artefact exists at both literal and representational levels. While physical objects can be manipulated in accordance with their physical structure, artefacts are also markers for relevant concepts in a task. Hence, manipulations and relationships can often be interpreted as being the task. Gutwin and Greenberg conclude that groups use workspaces for collecting and structuring different kinds of information necessary to achieve their collaboration goal. Necessary information is often represented by messages, documents, graphics, spreadsheets, tables or even software.

For Gutwin and Greenberg, combining space and artefact makes a shared workspace an external representation of the activity as a group. This is validated by previous studies (Clark, 1996; Norman, 1993; Hutchins, 1990). Different uses of external representations in collaboration were previously expressed by Clark (1996). They serve as a reminder of what is going on, are useful for engaging follow-up tasks or as a means for task actions.



Gutwin and Greenberg conclude that shared artefact and external representations can be used as a means for communicating in the shared workspace. However, they recognise that other kinds of non-verbal communication, such as using gestures for identifying objects, are also supported. Gesture can efficiently complement verbal communication (Gutwin & Greenberg, 2002). Gutwin and Greenberg claim that shared workspaces play a major role in the richness of interaction in order to conceptualise the knowledge space where the common understanding is developed through the manipulation of knowledge artefacts.

It also appears that shared workspaces have natural constraints and affordances shaping people's awareness about one another. The most important property is that workspaces provide an environment for interaction, giving people awareness of generated events.

Gutwin and Greenberg recognise three additional properties that affect awareness, namely perceptual availability, spatial organisation and bounded interpretation. They argue that perceptual availability enables people to observe others as they move in the space and work on different artefacts, to recognise particular actions and tools others use and to identify where others are looking. Regarding spatial organisation, they refer to specific locations in the workspace where artefacts are interpreted in part by their spatial location, as people often make use of spatial metaphors for organisation. They explain that bounded interpretation serves to provide a bounded environment that constrains interpretation and allows people to map perceptual information.

2.15.3 The Mechanics of Collaboration

Gutwin and Greenberg (2000) state that in order for a collaborative task to be conducted by a team in a shared workspace, a variety of activities must happen. They explain that the resulting teamwork comprises two main areas, the social and affective elements that make up group dynamics and the mechanics of collaboration. They believe that affective elements are important, but do not consider them further in their study. Instead, they focus on the collaboration mechanics, which they define as 'the things that groups have to do, over and above what an individual has to do, in order to carry out a task'.

From their previous research on shared-workspaces (Gutwin & Greenberg, 1999) and from the literature (Clark, 1996; Tang, 1991), Gutwin & Greenberg (2000) identify seven major activities which comprise the mechanics of collaboration: explicit communication, consequential communication, coordination of action, planning, monitoring and gathering information, assistance and protection.

Explicit communication occurs when group members intentionally provide each other with information, as verbal and written communication is a cornerstone of collaboration. As for consequential communication (Segal, 1995), Gutwin and Greenberg found that as they go about their activities people unintentionally provide information which is complementary to explicit communication. In terms of coordination of action, they explain that people organise their actions in a shared workspace in order to avoid any conflict with others. Furthermore, people learn to predict others' actions in order to achieve effective and efficient collaboration. They recognise that some planning activities are too high-level to be considered mechanics of collaboration.

Gutwin and Greenberg claim that many of the other activities of collaboration mechanics rely on the ability to monitor and gather information about other participants in the workspace. Much of this information is simply workspace awareness information (Gutwin & Greenberg, 2000), helping to answer the following questions: Who is in the workspace? Where are they working? What are they currently doing?

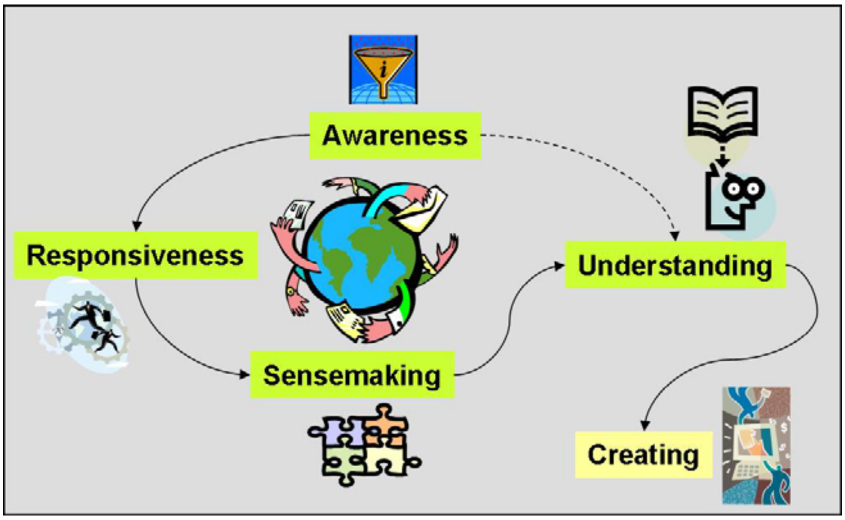


Figure 2.12: Logical view of the collaboration mechanics

Group members provide assistance to one another when needed as a kind of solidarity behaviour (Gutwin & Greenberg, 2000). However, to be appropriate, any assistance requires that one understands what others are doing and where they are at in their tasks. In terms of protection, the traditional danger in group work is to inadvertently alter or destroy work carried out by one another.

Roschelle (1992) claimed that building a mutual understanding that is based on shared meaning is the essence of collaboration. In this study on conceptual change, Roschelle presented a particular stance on the role of collaboration, having in common with contemporary cognitive theory an emphasis on the restructuring of common-sense metaphors. However, it differed from that theory in taking the view that meanings are relational and that collaboration provides a mechanism for achieving convergent relational meanings. Roschelle stated that convergent conceptual change is achieved incrementally, interactively, and socially through collaborative participation in joint activity. He also drew attention to the process of mutually contributing to shared knowledge, whereas conceptual convergence emphasises mutual construction of understanding. Hence, we drafted a logical view of the collaboration mechanics as shown in Figure 2.12.

2.15.4 Collaboration Process Model

The collaboration process model presented in the Figure 2.13 is based on the building of a mutual understanding which starts by sharing knowledge and ends by creating new knowledge. There are two side activities: enlarging the interaction arena in exposing and seeking feedback from the group (online Johari Window), and gaining consciousness of emerging ideas and concepts through the intersection of frontier objects.

This conceptual approach demonstrates that collaborative distance factors impede mutual understanding by interfering in one or several activities of the collaboration mechanics. The ultimate goal is to demonstrate that all distance factors operate within the context of a shared workspace regardless of its nature, whether physical or virtual or a mix of both. The well-known geographical distance and lesser known temporal distance are just the tip of the iceberg. Ideally, mapping of the distance factors with the above mentioned activities of the generic collaboration process would help to improve understanding of how to overcome distance factors to achieve a higher level of collaboration performance.

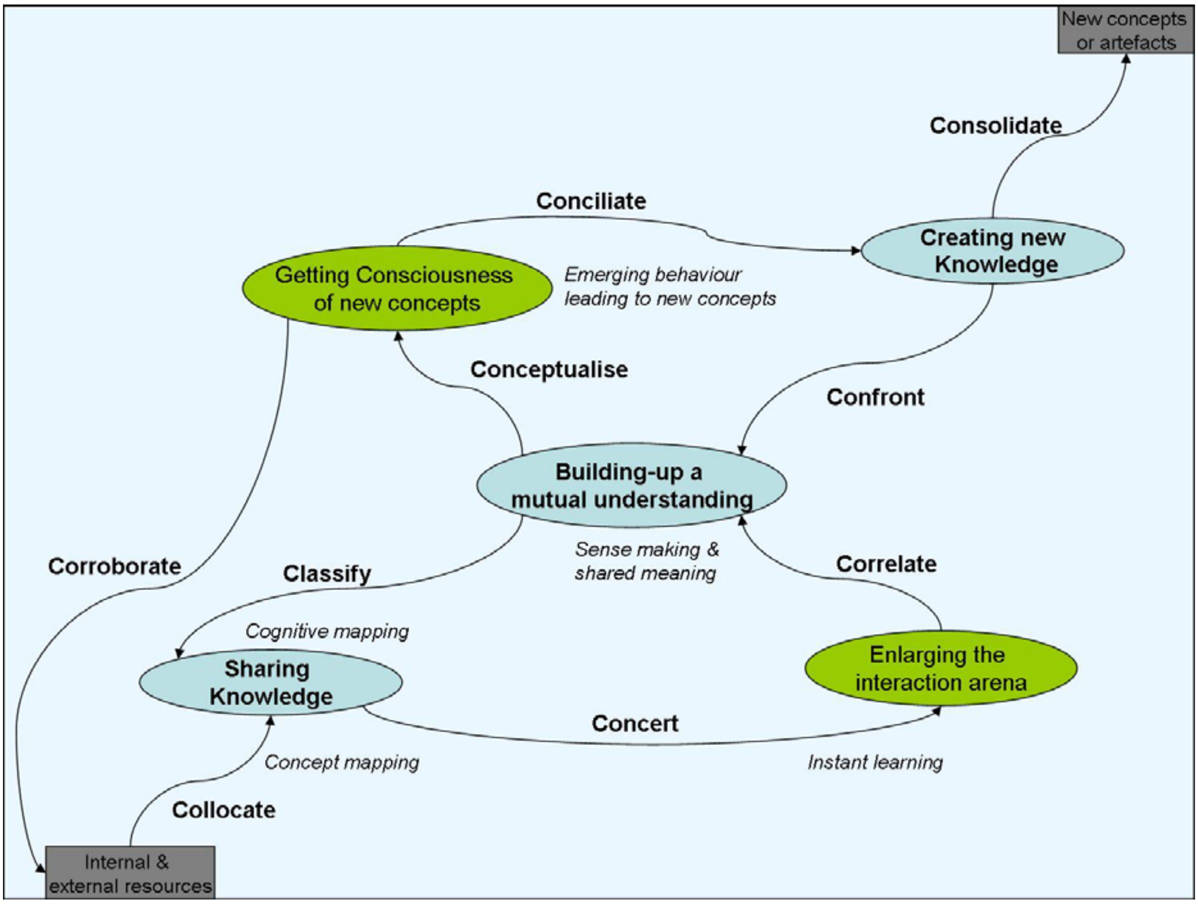


Figure 2.13: Integrating collaboration process and mechanics

2.16 Propositions

A number of issues need to be investigated during this empirical study with regard to increasing the level of knowledge on:

- The impact of distance factors on the ability to reach a mutual understanding;

- The use of collaboration techniques, methods and tools (collaboration technology) to bridge distances and to enable mutual understanding and shared knowledge;
- The role of mutual understanding in the collaboration mechanics and increase of collaboration performance;
- The role of trust among group members in enabling shared knowledge and mutual understanding.

All these issues are related to the research questions, specifically addressing the correlations between the above mentioned aspects that lead to the following propositions:

Proposition 1: Collaboration performance is decreased by distance factors due to the fact that it takes more time and effort to reach a certain level of mutual understanding.

With more distance factors, it becomes more demanding and takes longer to reach a mutual understanding, implying lower collaboration effectiveness and efficiency, leading to lower project performance[12].

Proposition 2: Knowledge sharing is increased by the use of collaboration techniques, methods and tools (collaboration technology) that contribute to overcoming or compressing collaboration barriers raised by distance factors.

The more collaboration techniques, methods and tools are used to overcome distance factors, the faster and less demanding it will be to reach a mutual understanding.

Proposition 3: Collaboration performance is increased by the use of collaboration techniques, methods and tools that contribute to overcoming collaboration barriers raised by distance factors.

[12] Comparing realised achievements within a fixed duration, where it is assumed that an individual alone will not obtain the same level of achievements as will a group.

This implies higher collaboration effectiveness and efficiency, leading to higher project performance.

Proposition 4: Roschelle & Teasley (1995) claim that reaching a mutual understanding based on a shared meaning is the essence of collaboration. According to Roschelle (1992): 'The essence of collaboration is the construction of shared meanings for conversations, concepts, and experiences.' With the developed model of a generic collaboration process (Pallot et al., 2008) and extended JOHARI Window model (Pallot, 2007), one can increase the size of the arena (area of interpersonal interaction) by exposing and requesting feedback, resulting in a more productive interpersonal relationship. Consequently, collaboration performance is higher when mutual understanding is broader. This depends on the level of trust among group members.

Proposition 5: The broader the mutual understanding, the higher the level of trust among group members. Reciprocally, the higher the level of trust among group members, the broader the mutual understanding.

2.17 Summary

Because of the impressive number of distance types, there is a plethora of collaborative tools used to support online collaboration. However, identifying the frontiers among communication tools (e.g. telephony, VoIP, e-mailing, IM), coordination tools (e.g. shared agenda, workflow) and cooperation tools (Shared Workspace) is not straightforward. It has been argued that communication (information & data exchange), coordination (task & object synchronisation) and cooperation (collective operations in a common workspace) comprise the three layers of either collocated or distributed collaboration (Pallot et al., 2004). Some tools, such as Shared Workspace (e.g. BSCW, SharePoint), cover several layers through embedded communication features (e.g. event notification) and coordination features to synchronise objects (e.g. object upload & download, versioning, history). Some have cooperation features which synchronise tasks and online collocation of workspace members (e.g. presence), as well as concertation (e.g. group blogging, polling) and classification features (e.g. object tagging). Even so, it is necessary to use other tools such as Web-conferencing and instant messaging (IM) for synchronous communication, and e-mailing for asynchronous communication. Furthermore, whatever features are integrated into a Shared Workspace tool, not everyone will necessarily use the same set of features and tools. Hence, the personalisation and interoperability within the technological distance is of paramount importance.

In this section, the need for clarification of concepts used to represent factors and group them into valid classes was discussed. This led to the design of the Collaborative Distance Framework (CDF), which disentangles these distance factors. Hence we were able to categorise previous published empirical studies on distance factors and concurrently to foresee how an existing or emerging concept and related artefact could bridge a specific collaboration distance type. Identifying interrelationships among the different factors and foreseeing their respective impact would make this CDF even more valuable.

As mentioned in the literature review, individuals entering into collaboration face a kind of paradox. On the one hand, close proximity among team members speeds up the process towards reaching a mutual understanding, but on the other hand, it simultaneously reduces creativity (Sternberg, 1988) and innovation due to a lower level of diversity. It has been observed that a higher diversity level means spending much more time reaching a proper level of mutual understanding, while enabling an effective collaborative innovation.

Chapter 3. Methodology

If I have seen farther than others, it is because I was standing on the shoulders of giants. **– Albert Einstein**

This chapter introduces the research strategy and compares various research methods that could be used in this empirical study on collaborative distance. The selected survey and comparative case study, including focus group interviews and log data, are combined into a triangulated research approach. The chapter also presents the selected group work performance model (IPO), which is turned into an efficiency and effectiveness collaboration performance model on the basis of IDEF0 functional activity modelling. Finally, the observation model and platform are depicted.

3.1 Introduction

This empirical study on Collaborative Distance in Open Innovation (Chesbrough, 2003), intends to restrict the number of variables in play during the comparative cases, as previously explained in the research strategy. All comparative cases are dedicated to the observation of various distance types and collaboration barriers raised by distance factors, and the ways in which they are bridged or compressed by collaboration technology within projects on collaborative innovation (Ahuja, 2000) involving different disciplines and stakeholders (e.g. external experts, customers).

Furthermore, all subject types of the 14 project cases constituting the comparative case study were dedicated to the same topic of collaborative innovation, in order to avoid the introduction of variables related to the nature of the projects (for example comparing a project dedicated to Front End Innovation with other projects dedicated to software development, design in architecture, design engineering or manufacturing engineering). The research strategy also included evaluation of the 'boundary objects' theory (Star & Griesemer, 1989), exploring the potential impact of applying shared practices across all project cases, to determine whether the impact is constant across all cases. Finally, another research objective was to evaluate the impact on bridging various distance types when all project cases used a shared project model, based on a combination of SADT (Structured Analysis Design Technique) (Ross & Schoman, 1976), IDEF0 (Integrated Definition for Function Modelling) (Ross, 1985; 1989), OBS (Organisational Breakdown Structure) and WBS (Work Breakdown Structure) techniques.

Research questions and issues to be investigated were formulated in a manner that led naturally to the design of a triangulated research approach comprising qualitative and quantitative methodologies. The qualitative part is intended for the observation of distance factors affecting collaboration performance within 14 comparative cases and the corresponding focus group interviews, as well as the related log data. The quantitative part is intended to provide indications on the perceived effect of collaboration barriers raised by distance factors. Figure 3.1 below illustrates the analysis and research approach from initial propositions to re-visited propositions.

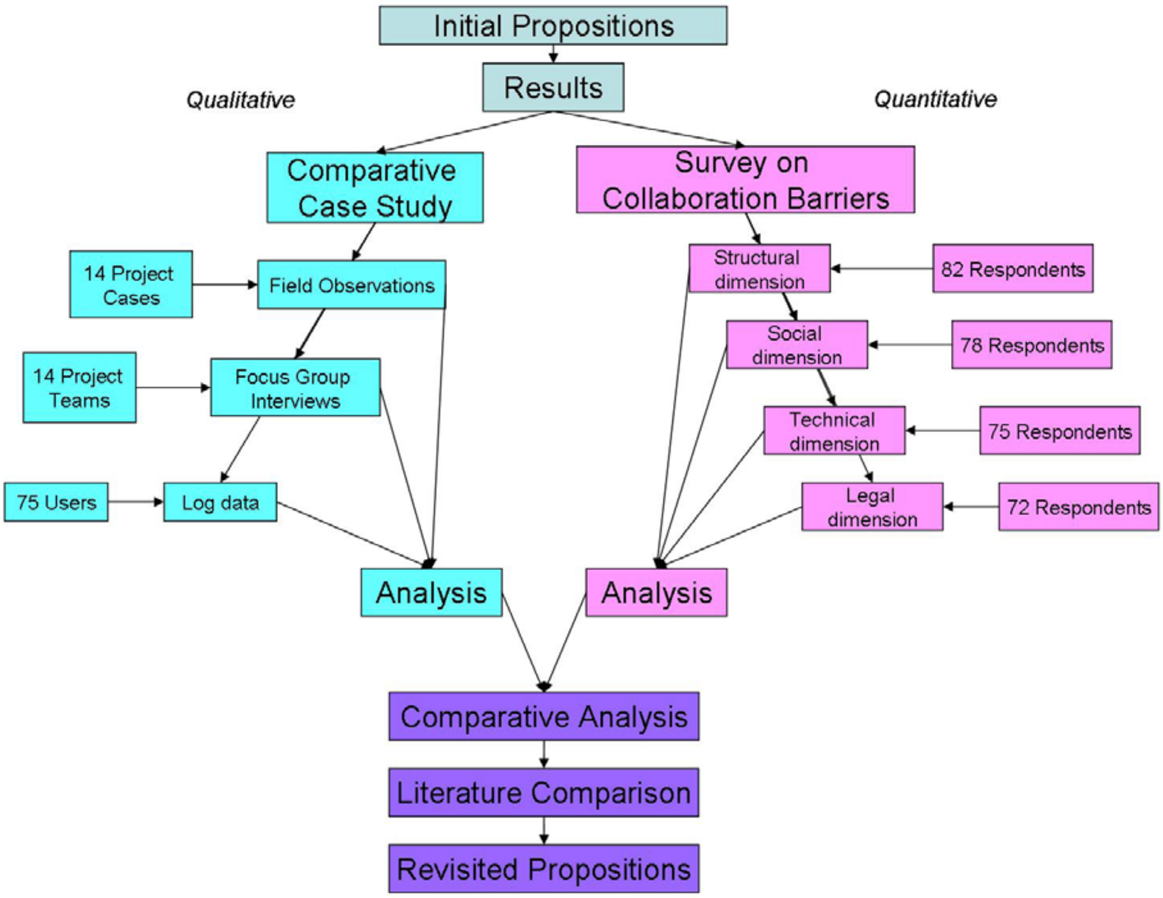


Figure 3.1: Triangulated Research Approach

For many years now there has been an ongoing debate among researchers within the social sciences concerning the best methods for science to use to research society. Typically, this debate focuses on which of two methodologies is the more appropriate. Quantitative research aims to collect facts and figures using methods such as social surveys or statistical analysis, while quantitative methods translate data into information.

Qualitative research aims to gain a more in-depth understanding of a situation. Many methods and approaches fall under the category of qualitative research, for example case studies, participatory inquiries, interviews, participant observation, visual methods and interpretive analysis. Table 3.1 highlights the main differences between quantitative and qualitative research methods.

Quantitative research	Qualitative research
Hard	Soft
Fixed	Flexible
Objective	Subjective
Value-free	Political
Survey	Case study
Hypothesis-testing	Speculative
Abstract	Grounded

Table 3.1: Distinctions between quantitative and qualitative research methods

(Silverman 1997)

In this empirical study, the quantitative method, in the form of a survey on collaboration barriers, is selected for measuring the perceived impact of collaboration barriers raised by distance factors among communities of experienced people.

The qualitative part is conducted through focus group interviews and a comparative case study carried out from 14 project cases and corresponding log data. In addition to the traditional list of research question and sub-questions, a number of related issues are proposed for investigation.

3.2 Methodology Review

3.2.1 Quantitative Methodology

Quantitative research, primarily concerned with objectivity, seeks to achieve explanations and predications that one can generalise in other circumstances and settings (Maxim, 1999). Rigid sampling strategies, combined with identifiable variables and measurable relationships, form the data collection process and make it possible to obtain results that can be generalised (Thompson, 1992). Based on the ontological assumption that the social reality is independent of human minds, the role of the quantitative researcher is to obtain scientific knowledge through observing and measuring objective reality (Phillips, 1987). Various methods, such as surveys, experiments, inventories and demographic analyses, are employed to produce quantitative data, on the basis of which correlations between defined variables can be established (Griffin & Kacmar, 1991).

3.2.2 Qualitative Methodology

By contrast, qualitative research aims to explore, investigate and understand phenomena that are socially constructed, complex and indivisible, into discrete variables. The aim of qualitative research is not to measure and predict the studied phenomena, but to interpret the social actor's perception of the meanings embedded within the social settings (Sackmann, 1992). Qualitative research, by focusing on the unfolding of the process rather than the structure, is broader and more holistic than quantitative research (Das, 1983). Furthermore, qualitative research often uses case studies as its preferred method of study, in contrast to the surveys and experiments of quantitative research (Bryman & Burgess, 1999).

As explained above, this research does not seek to test or measure the relationship between the chosen phenomena or to offer any predictions. Rather, it aims to understand how teams interact within different cultural contexts. In other words, it follows the principles of the social construction perspective (Glaser & Strauss 1967). In the light of these research objectives, qualitative rather than quantitative methods are clearly appropriate here.

Questionnaires are a particularly valuable method, as they allow the collection of data from large numbers of people. Questionnaires are particularly useful for finding out about the incidence of some behaviour or the opinions, beliefs or attitudes of large numbers of groups of people. According to Hoinville and Jowell, a questionnaire has to help engage people's interest, encouraging their cooperation and eliciting answers as close as possible to the truth (Hoinville & Jowell 1978).

Focus Group Interviews in Qualitative Research

Focus group interviews (FGI) are commonly included in a triangulated research approach in order to introduce a qualitative side. Stewart and Shamdasani (1990) provide the following list of FGI applications:

- Obtaining general background information about a topic of interest;
- Generating research hypotheses that can be submitted to further research and testing using more quantitative approaches;
- Stimulating new ideas and creative concepts;
- Diagnosing the potential for problems with a new program, service or product;
- Generating impressions of products, programs, services, institutions, or other objects of interest;
- Learning how respondents talk about the phenomenon of interest, which may facilitate quantitative research tools;
- Interpreting previously obtained qualitative results.

FGIs are essential in the evaluation process as part of a needs assessment in order to gather perceptions as to the outcome. They could be conducted during, at the end or even months after the completion of a program.

A group size of a minimum of four to a maximum of twelve participants is recommended, while the number of groups is dependant on the population segments. Questions should be sorted from the more general aspects to the more specific ones. While questions of lesser significance should be located near the end, those of greater importance should be situated near the top of the questionnaire. It is also recommended to avoid a long list, keeping to below ten questions.

In this empirical study, each focus group corresponds to one of 14 project cases. This is intended to provide a more coherent debate according to the specific activities carried out by the team members, and more accurate answers to the questionnaire.

All project teams received specific documentation on collaborative distance, including the list of barriers raised by different distance types, and factors that could be faced by team members.

3.2.3 Case Study

Cunningham (1997) shows that there are at least nine different case study types (see Table 3.2).

Concepts	**Intensive cases**	**Comparative cases**	**Action research**
Purpose	To develop theory from intensive exploration	To develop concepts based on case comparisons	To develop concepts which help facilitate the process of change
Assumption	Creativity through comparison with existing theories	Comparison of cases leads to more useful theory	Theory emerges in the process of changing
Examples	Dalton	Eisenhardt	Trist
Situation	Usually evolves out of a researcher's intensive experience with culture or organisation	Usually concepts are developed from comparing one case with another case	Developing theory to assist practices and future social science
Types	Narratives Tabulation Explanatory Interpretative	Case comparisons Case survey Interpretative comparisons	Diagnostic A. R. Experimental A. R.

Table 3.2: Different types of case studies

(Cunningham, 1997)

Because there are case study types belonging to different research approach categories, this method cannot be classified into only one class. Traditionally, the case study research method has been classified into the theory-creating research approach. However, one can decide to apply the comparative cases type for interpretative comparisons.

The question of whether there is a need to conduct a survey, carry out an experiment or an observation, or even use a case study, shapes the research approach. The decision about which methodology one should use is dependent on a number of factors, but most importantly, on the type of questions posed (Langdridge, 2004). The research methods to be applied are usually decided according to research situation, operational context, or sometimes even researchers' interest.

In this empirical study, the selected type of case study is the 'comparative cases' type for interpretative comparisons. The main goals are to evaluate and check the impact and consistency of distance factors on collaboration performance across 14 project cases. In order to avoid the introduction of variables polluting the comparative cases, all the project cases were to apply the same collaboration techniques, methods and tools to support their teamwork. If project cases apply different techniques, methods and tools, then the resulting observed differences in collaboration performance among the different teams could be due to the use of a higher or lower performing technique, method or tool.

3.2.4 Triangulated Research Methodology

This empirical study applies quantitative research through surveys dedicated to people's perception of the impact induced by various collaborative distance factors. It also applies qualitative research through focus group interviews (FGI) and selected comparative case study, providing a more accurate in-depth picture of what is happening during collaboration. Moreover, correlating a survey's figures with both interview responses and case study log data provides a more valid view.

In addition to the traditional comparison of advantages and disadvantages of various research methodologies, triangulated research methodology appears to be most appropriate due to the level of complexity brought by entangled factors affecting collaboration. Triangulation is defined as comparing different types of information (Mårtensson, 2001). The goal of triangulation is not to determine the objective truth, but to add breadth and scope to the analysis. Coviello and McAuley (1999) have suggested that triangulated research methodologies offer a better opportunity to capture complex issues involved in internationalisation. Mårtensson (2001) regards triangulation as a means of alternative interpretation rather than a search for absolute truths. The results are analysed through a process of interpretation based on empirical sources, empirical material and empirical description followed by conclusions. In this study, phenomena and events are investigated over time and as they occur in different cases. The term 'analysis' is used to refer to an iterative process that follows this approach.

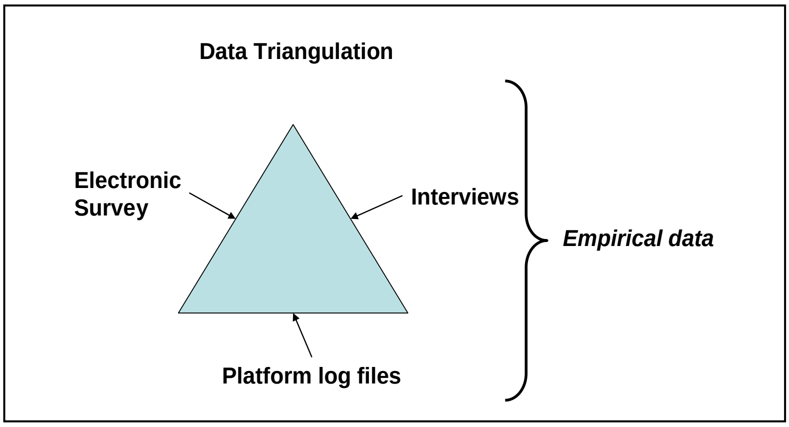


Figure 3.2: Data Collection

The research methodology is based on a data triangulation approach (see Figure 3.2) comprising the following research instruments:

1. Quantitative: Survey on collaboration barriers raised by distance factors (electronic survey via a combination of several polls posted on a collaborative Web environment of about 1500 community members).
2. Comparative case study (14 collaboration project cases). Collected data come from the 14 corresponding shared workspaces as a log file.
3. Qualitative: 14 FGIs of the 14 corresponding project teams.

3.2.5 Evaluating Project Team Performance

It is assumed that collaboration performance relies on the level of the project team's effectiveness and efficiency. While effectiveness is the ability to have high quality projects and outputs, efficiency is the ability to perform project tasks well with a minimum resource level for a maximum output (high productivity level). To be synthetic, effectiveness is about quality, and efficiency is about productivity. Efficacy refers more to the ability to fulfil a request in due time, without concern for the mobilised resources, methods and tools used or the quality of the project and outcomes. Both effectiveness and efficiency are necessary for evaluating the performance of project teams within the 14 comparative cases. Distance factors, identified during the literature review, impact collaboration effectiveness and efficiency through raising collaboration barriers. Collaboration technology (techniques, methods and tools) is intended to overcome the collaboration barriers.

It should be noted here that there may be ambiguity in the use of terms such as 'group', 'team' and 'project team'. A group assembling a few people (small group) could be considered as a team, where all participants can easily interact with one another. By contrast, a group assembling a lot of people (large group) is considered as a community, where all members cannot interact with one another simply because there are too many members. One could argue that a group of people does not necessarily form a team until they are trained to operate as a team. The metaphor often employed is that of a sports team. Real life experience has shown that a group of high performing individual players facing difficulties playing together often does not outperform a group of lesser performing players operating with a great team spirit, where each member sacrifices his own individual interest for the benefit of the team. In this empirical study, a team is considered as a small group of project stakeholders where social interaction happens among collaborating team members. By extension, a project team is a team of individuals whose common goal is to collaborate in order to achieve project objectives. In this case, synchronous interaction is the norm. By contrast, a very large group could lead to mass collaboration where social interaction is rarely the norm due to the impossibility of interacting with all participants (e.g. Wikipedia); hence it no longer constitutes a team, but rather a community of contributors. Nonetheless, there could be collaborative authoring of Web pages where participants use the discussion page to agree on content. In this case, asynchronous interaction is the norm.

Another interesting aspect is the discussion about comparing face-to-face collocation and virtual collocation (Nardi & Whittaker, 2002). This discussion is, in effect, obsolete, because in reality project teams are more and more based on a mixed mode of collocation (McDonough et al., 2000; Malhotra et al., 2001; Gartner and MIT, 2001). While several of the members of a project team could be physically collocated on a common geographic site, all other participants might be in a distributed situation, operating from home, during travels, or in a remote situation such as at a customer or supplier site.

Years ago, groups were necessarily physically collocated because project teams were more effective and because before the Internet, computer networks were both undeveloped and very expensive. Nonetheless, group performance in terms of effectiveness was already a research topic for such prominent authors as McGrath (1964), and for Hackman & Morris (1975), who adapted the work of McGrath to develop the famous ‘Input-Process-Output’ (IPO) model for evaluating the performance effectiveness of a group. This model is the probable inspiration behind Lipnack and Stamps' (1997) description of 'A System of Virtual Team Principles', illustrated by a matrix composed of 'Inputs-Processes-Outputs' on one side and 'People-Purpose-Links' on the other. According to Lipnack and Stamps: 'The principles of people, purpose and links form a simple systems model of inputs, processes and outputs.'

The IPO model proposed by Hackman and Morris is a general paradigm for analysing the role of group interaction process as a mediator of input-performance relationships, as shown in Figure 3.3. They explain:

> *The fundamental assumption underlying the IPO model is that input factors affect performance outcomes through the interaction process. Thus, if highly cohesive groups (input at t1) perform better on some tasks (outcome at t2) than less-cohesive groups, it should be possible to explain the performance difference by examining the difference between the interaction processes of the high and the low cohesive groups.*

The concept 'interaction process' refers to all observable interpersonal behaviour occurring between two arbitrary points in time mentioned in the figure as 't1' and 't2'. Hackman and Morris argue that: 'The state of all system variables potentially may be assessed at any given "slice" in time, and therefore input-output relationships may be examined for periods of time ranging from a few seconds to a year or more.'

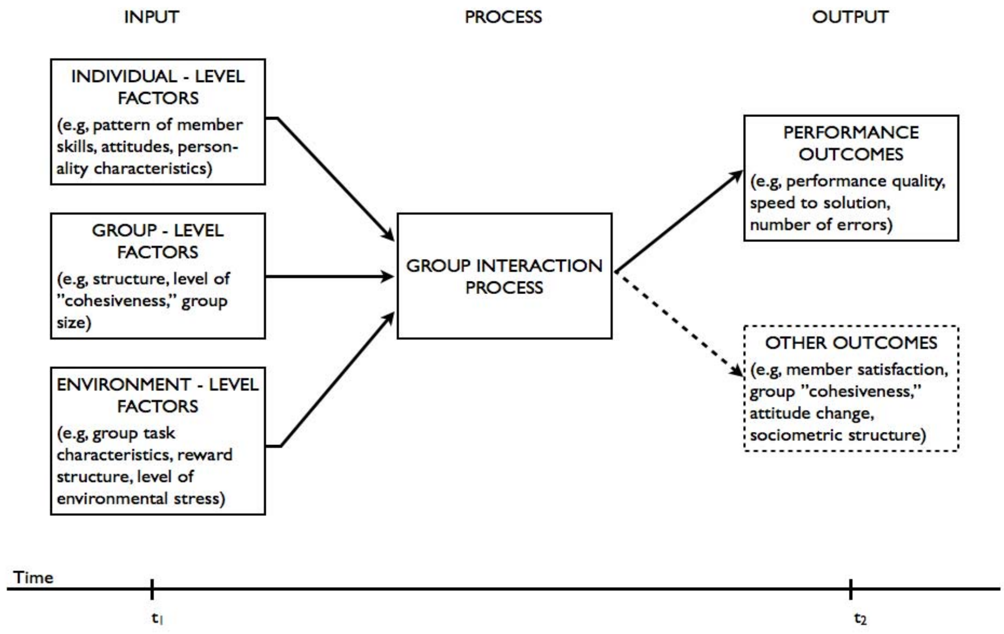


Figure 3.3: IPO Model

Hackman and Morris (1975 – Adapted from McGrath [1964])

Hackman and Morris also state that no general theory of small group effectiveness has appeared, even though there have been numerous attempts to integrate findings about group effectiveness and to draw general-level conclusions about behaviour in groups. They suggest the possibility that no single theory would encompass and deal simultaneously with the complexity of factors that can affect group task effectiveness. Hence, they propose looking for a number of smaller theories, each of which would be relevant to a specific aspect of the process performance or effectiveness performance under certain specified circumstances. They attempt to examine in some depth three different aspects: the role of group interaction process as a major determinant of group productivity; some selected input variables that strongly influence group performance and thus serve as useful points of leverage for changing performance - whether directly, or through the group process. They propose three summary variables - level and coordination of member effort, task performance strategies, and team member knowledge and skill - as devices for summarising the stronger proximal causes of group task effectiveness. A general IPO framework explains how these three classes of variables interact in the task performance sequence (see Figure 3.4) showing the relations among the focal input variables, group interaction process and the three summary variables in affecting group performance effectiveness.

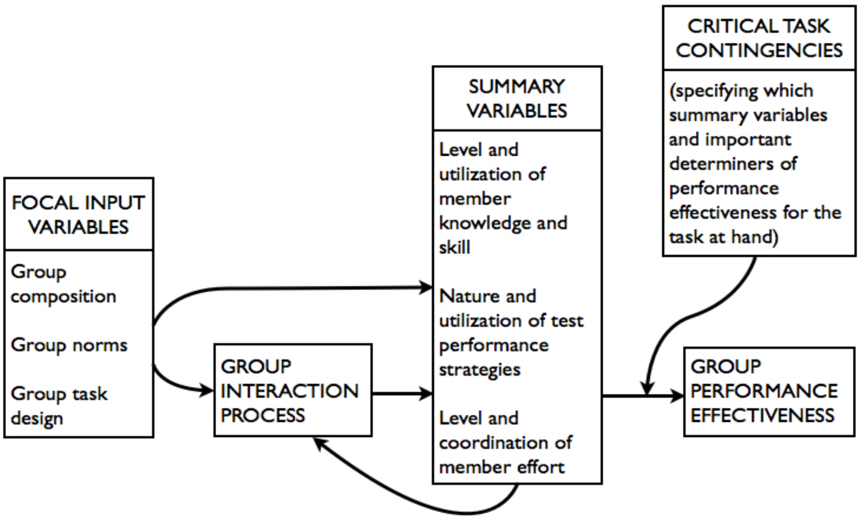


Figure 3.4: IPO Framework

(Hackman & Morris, 1975)

Finally, they argue:

By further researching this input-process-output sequence for different types of tasks (here classified in terms of the summary variables), we believe that additional understanding can be achieved which will aid both in predicting and in changing group effectiveness in a large number of performance settings. But in any event, a general and unified theory of group effectiveness, we believe, is currently out of reach - and is likely to remain so.

They conclude their research on group effectiveness:

It will be necessary to attempt to create effective groups in order to understand their dynamics. Merely describing what happens in existing natural groups is *unlikely to generate knowledge useful for improving group effectiveness because some of the most critical ingredients of truly effective groups may never appear spontaneously in groups allowed to develop naturally. As a start toward the design of such research, we have proposed several ways in which 'input' factors might be experimentally modified to see if they generate more task-effective group processes and higher quality outputs.*

Later research on Virtual Teams (Saunders, 2000; Marks et al., 2001; Powell et al., 2004; Martins et al., 2004; Ortiz de Guinea et al., 2005; Webster and Staples, 2006; Egea, 2006) continued to use the Hackman and Morris (1975) IPO model.

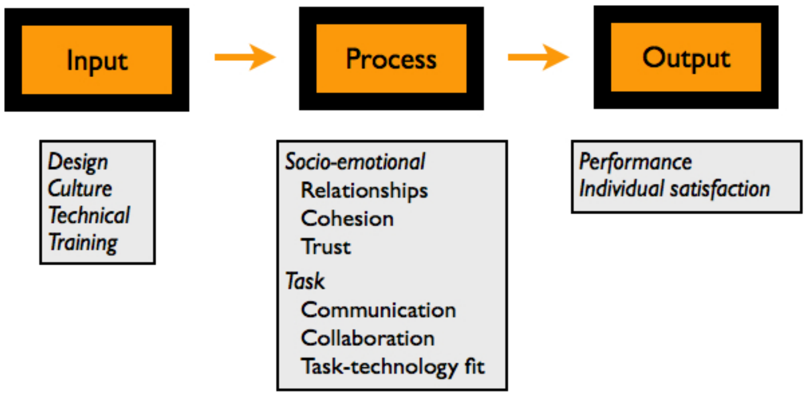


Figure 3.5: Re-visited IPO Model as Virtual Team Life-cycle

Saunders (2000)

While 'input' to a virtual team is the initial contributions (team design and construction), 'process' represents the ongoing interaction between group members, even from distributed locations. Process refers to the interdependent actions carried out by members (Gaudes et al., 2007), also known as 'group interaction', and is affected by numerous input factors (Hackman and Morris, 1975) which transform input into output. The group interaction process is subdivided into task and non-task processes, also called 'socio-emotional process' (see Figure 3.5 for the Saunders version and Figure 3.6 for the Powell representation). Virtual team output refers to the consequences of a group's collaboration as they relate to task (task process) and non-task (socio-emotional process) items (Gaudes et al., 2007).

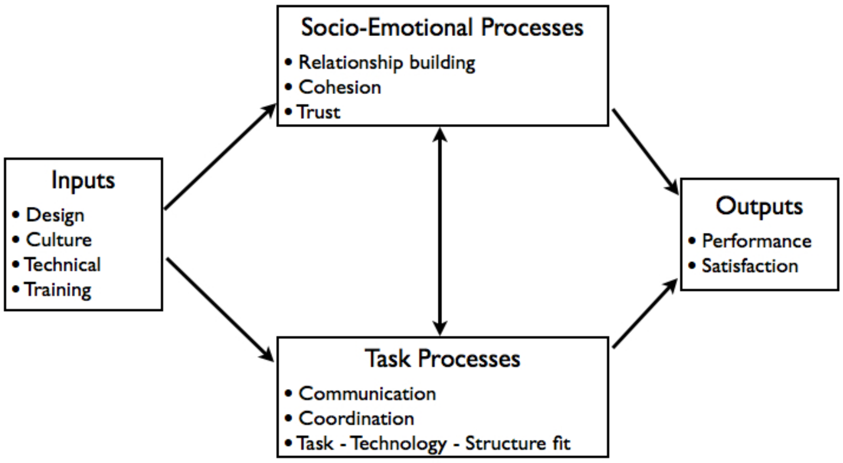


Figure 3.6: Re-visited IPO Model as 'Focus of Early Virtual Team Research'

Powell et al. (2004)

Today, group performance effectiveness has evolved with the proliferation of mixed collocation modes (face-to-face for physically collocated groups and virtual for distributed groups) to the extent that the group interaction process should take this new situation into account. In addition, collaboration technology is continuously evolving due to the rapid worldwide propagation of social media and the huge penetration of the Internet, Web and smart device technologies, which make tools and applications available whenever and wherever people need them, for a very reasonable price.

While ten years ago it was still extremely difficult to build a relationship with people working or living far away, today it is made simple by using Web 2.0 applications to share blog entries, photos, videos and other content objects. Indeed, it is becoming easier and faster to make new friends in the electronic world than in the real world. This constitutes an interesting opportunity when considering that group interactions will be conducted more and more often through collaboration technology (e.g. on the Internet through various Web applications), because data log and data mining provide the capacity to better track shared content objects and events. For researchers, this opens plenty of experimental possibilities and options for design.

In this empirical study, the design of the case study experiment also takes into account the legacy of the IPO model and the two types of processes, namely the task process and socio-emotional process. Prominent scientists in the area of emotional intelligence[13], for example Cherniss, Druskat and Goleman, have examined closely the role of emotional intelligence in organisational effectiveness. Emotional intelligence is defined as a combination of cognitive and emotional abilities (Goleman, 1998). Cherniss (2001) states that, according to Goleman, 'The essence of emotional intelligence is the integration of the emotional centers of the brain (the limbic system) and cognitive centers (prefrontal cortex).' He further explains:

> *Emotional Intelligence influences organisational effectiveness in a number of areas, such as employee recruitment and retention, development of talent, teamwork, employee commitment, innovation, productivity, efficiency, sales, revenues, quality of service, customer loyalty, client or student outcomes.*

Cherniss adds: 'Similarly, Mayer, Salovey and Caruso (2000) conceive emotional intelligence as a set of skills that involve processing information about emotion.' Druskat and Wolff worked out the emotional intelligence of a group and argued that the essence of group emotional intelligence is constituted by norms and processes that support awareness and regulation of emotion within a group (see Figure 3.7), rather than the sum of the group members' individual emotional intelligence (Druskat and Wolff, 2001).

The proposed IPO model for collaborative distance (see Figure 3.8) for this empirical study includes the Druskat and Wolff emotional process as the socio-emotional process and a project process model as task process. All participants in the project cases were trained in using

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[13] http://www.eiconsortium.org/members/consortium_membership.htm

IDEF0 as a technique and tool for modelling their respective project processes, including the project management tasks with reviews. Each project selected a leader, who acted as the project coordinator in charge of the relationships with the customer and review committee. Project reviews provided insights about the collaborative attitude of team members, team cohesiveness, trust level, leadership, shared vision and goal, contributions, and project and tasks structure. Outcomes of reviews were used for rating the collaboration effectiveness of each project (see Figure 5.12).

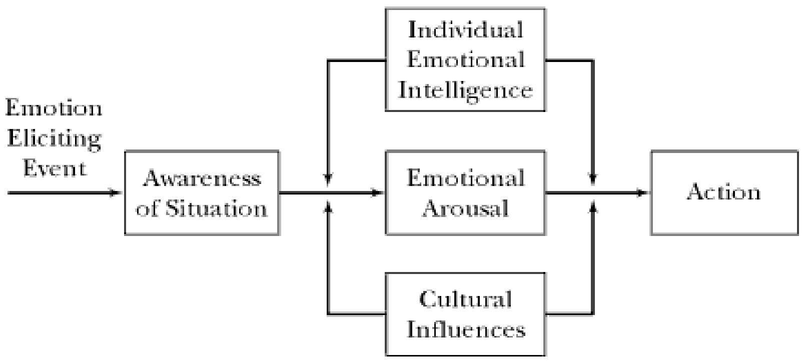


Figure 3.7: The Emotional Intelligence and Emotional Process

(Druskat and Wolff, 2001)

As for the project process modelling (IDEF0) and project structuration (OBS and WBS), all project teams were trained in structured analysis using the same technique and tool. This was intended to enforce a common work culture in order to ensure a shared project view among all involved stakeholders.

In terms of CWE for supporting the task process, a shared workspace (BSCW) was created for each project. A group blog was initiated to support the socio-emotional process. Project team members were able to interact asynchronously with the shared workspace through group blogging, as well as e-mailing. For synchronous interactions, team members used instant messaging (text based) and Web conferencing (voice based) tools.

A generic model of a group interaction process is tentatively designed (see Figure 3.9), taking into account the previously described social interaction model (see Figure 2.8) and collaboration process and mechanics models (see Figure 2.13) in Chapter 2.

Collaboration efficiency was evaluated through the various activities and related interactions conducted on the CWE platform. The resulting log data are explored in the findings and analysis. The efficiency is assessed through two aspects: the ratio of produced content objects per project participant (output per mobilised resource) and the ratio of generated events per project participant (see Figure 5.12).

All factors are shown in Figure 3.8 'Input' factors are related to individual team members, culture, organisation, team and technology. 'Socio-Emotional Process' factors are related to relationships building, team cohesiveness and trust. 'Task Process' factors are related to coordination, communication and technology. Finally, 'Output' factors are related to collaboration performance and individual satisfaction.

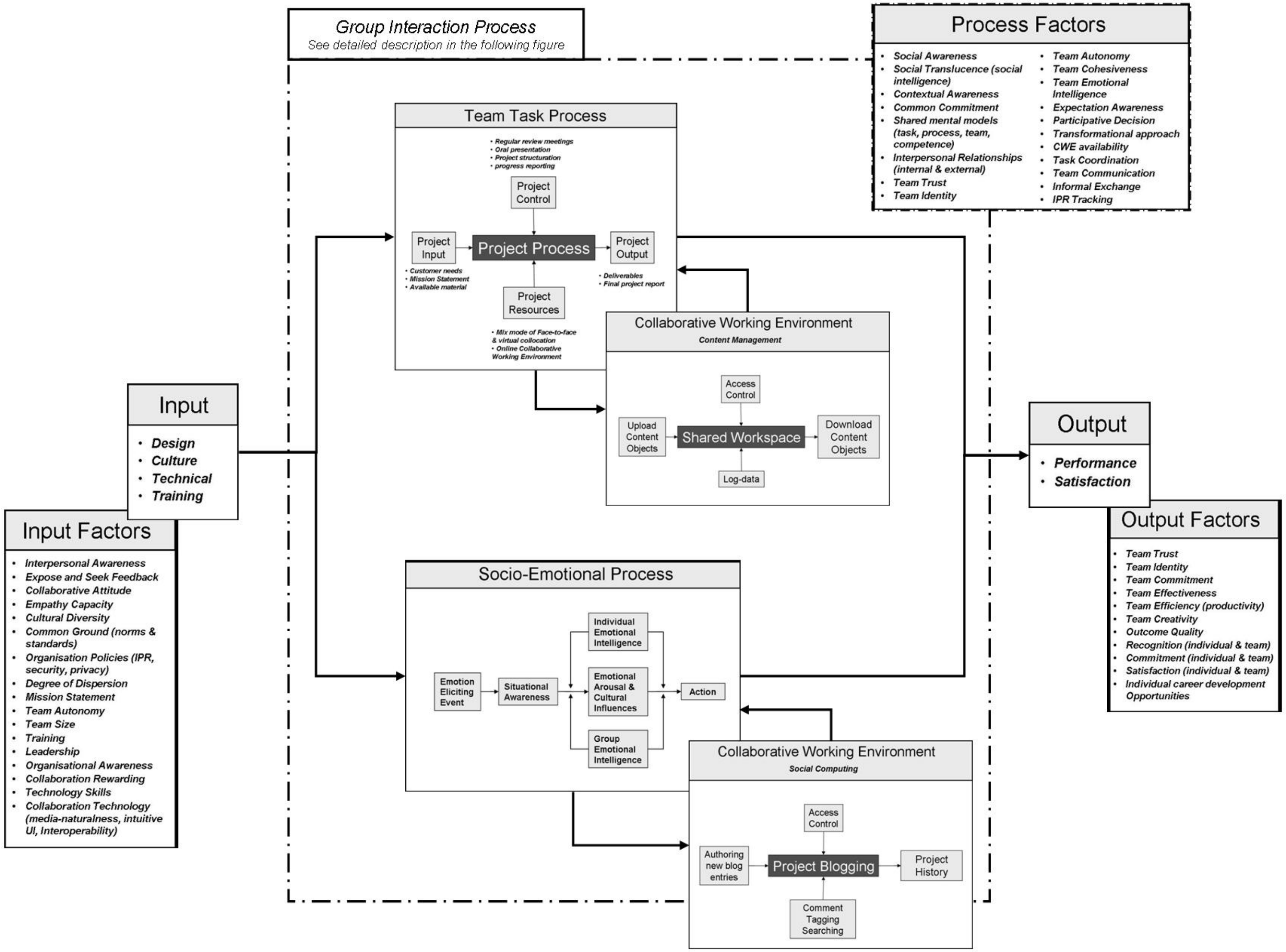


Figure 3.8: The IPO Model for the Collaborative Distance Experiment

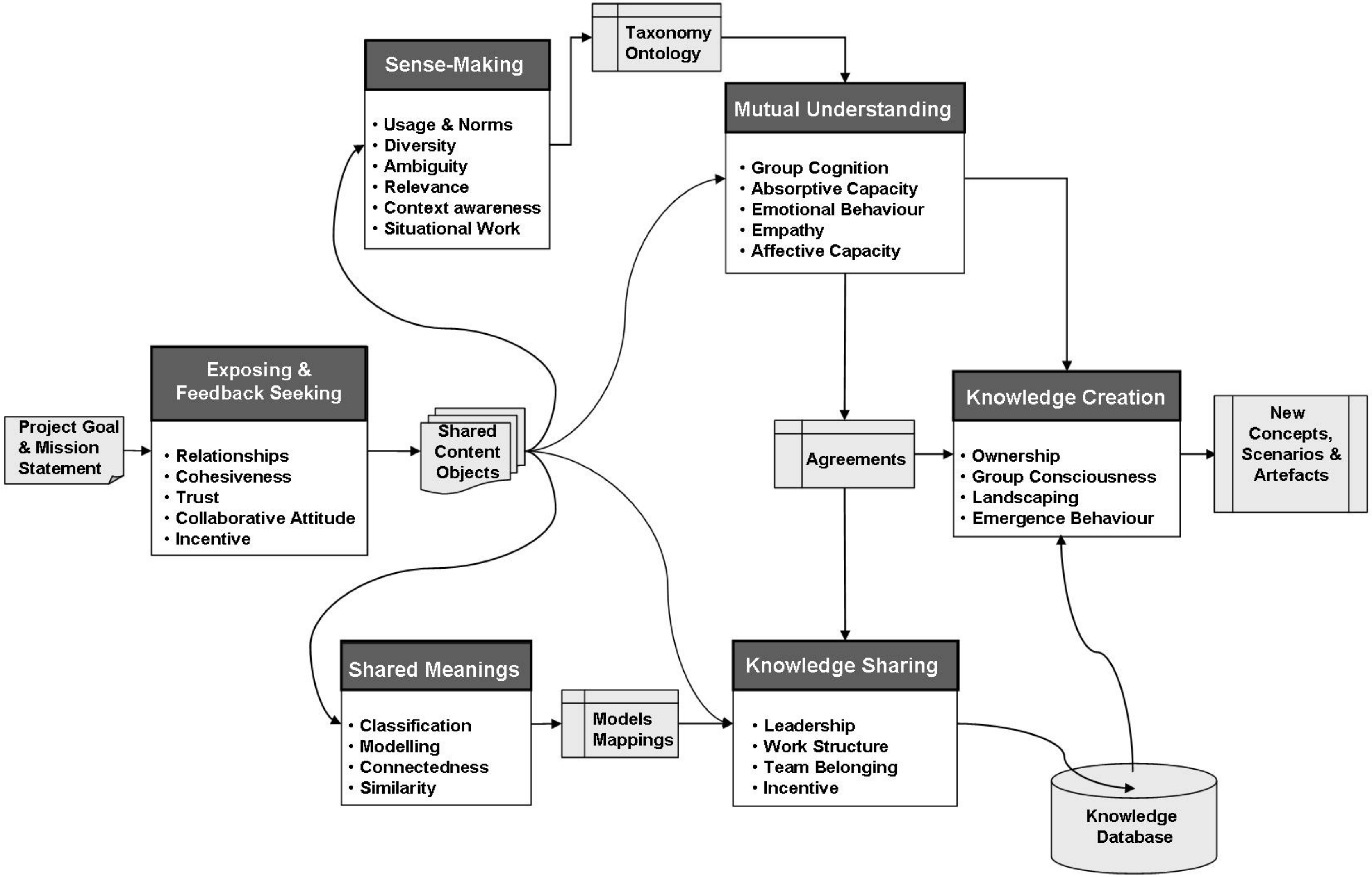


Figure 3.9: A generic model of a Group Interaction Process based on the collaboration mechanics

3.3 The Observation Model

The observation model, as shown in Figure 3.10, is designed according to the above described research methods in order to get a better understanding of what is going on when individuals collaborate. This collaboration, whatever the distance factors, uses an online Shared Workspace platform where generated events are recorded.

The online Shared Workspace platform provides an opportunity to observe the interaction process, as proposed by the IPO model for the CD experiment (see Figure 3.8), especially the nature and frequency of interactions among individuals through the analysis of resulting log data.

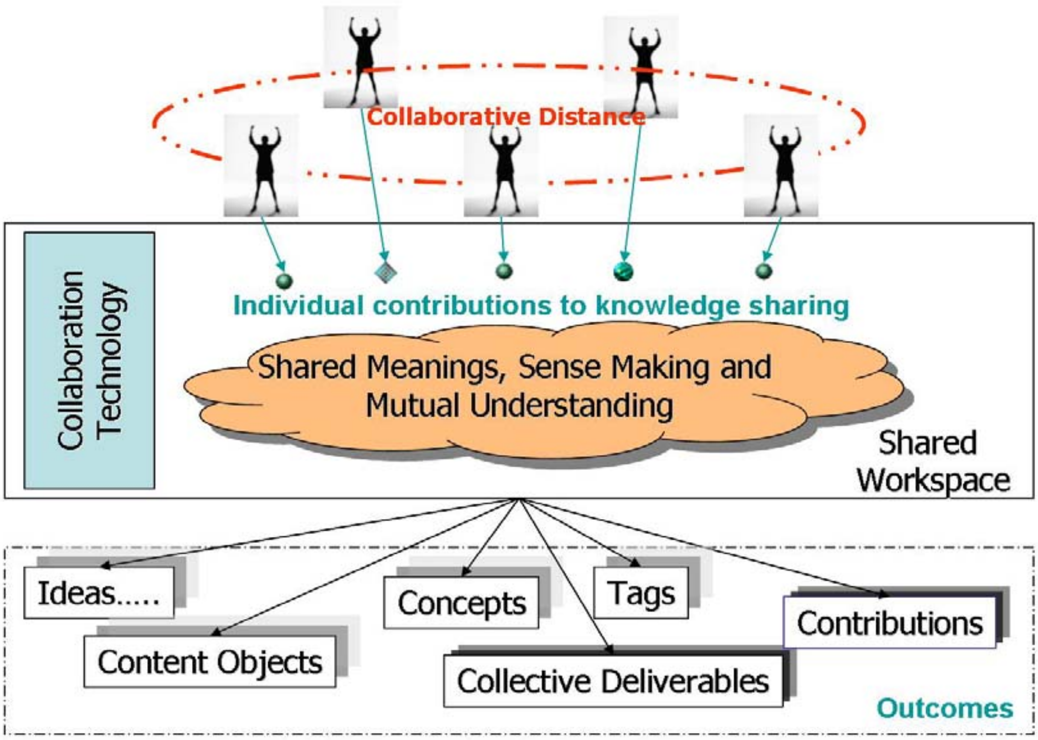


Figure 3.10: The Observation Model

Collaborative distance among individuals collaborating through the use of asynchronous tools such as a Shared Workspace technology (BSCW), including group blogging and other synchronous collaboration tools (e.g. MSN, Skype), is observed through their level of interaction in developing the produced outcomes and through the number of generated events.

3.4 Comparative Cases

3.4.1 Case Objectives

The first objective was to compare, among a set of collaboration projects, the degree to which team members perceived the impact of distance factors on their collaboration as reported by project participants during the focus group interviews.

The second objective was to observe and compare, among all project teams, the degree to which the use of an online Shared Workspace platform had allowed team members to overcome or bridge collaborative distances, as reported by project participants during the focus group interviews and as recorded in the log-data of the collaboration platform.

3.4.2 Case Selection

In selecting the comparative cases, the main idea was to use the projects of Master's degree students at ISTIA Innovation as an interesting opportunity to compare the feedback of professionals (survey on collaboration barriers) with that of participants representing the Net-Generation. Even more importantly, all students' projects apply the same methodology and collaboration platform, while in industry it would be extremely difficult to find a set of projects sharing the same size and timeframe, and using the same methodology and toolset, hence making any tentative comparison risky.

Second year Master's degree students at ISTIA Innovation (University of Angers) form project teams in order to carry out a concrete project with real customers and involving various external experts. These projects deal with a variety of innovation subjects provided by local industry or regional authorities. Students have one day per week devoted to their project, over a period of five months. They operate in a hybrid collaboration mode of collocated/distributed team and use an online shared workspace for sharing information and documents.

These experiments were intended to confront students with collaboration barriers and distance factors, which they would try to overcome through the use of collaboration technology and tools (online Shared Workspace). Important issues, such as whether the collaborative platform had helped in sharing knowledge and reaching a mutual understanding, and in overcoming various types of collaborative distance, were also part of this study.

3.4.3 Context of the 14 projects

The experimentation was conducted from October 2007 to February 2008. The 75 participants had an average age of 25 years, representing the Net-Generation. Project teams comprised Master's degree students from four innovation domains: Strategic Information, European Venture, Agro-biology, and Virtual Reality. Students had one full day per week devoted to their respective collaborative project for applying what they had learnt during courses. There were three intermediate project reviews and a final one in the presence of the customer and a panel of external experts; these reviews were intended to evaluate the collaboration performance and satisfaction of the customer.

Owing to a confidentiality agreement between customers and ISTIA Innovation, the contents of the projects could not be presented. However, as they all addressed innovation in various sectors, with specific activities such as technology or competitiveness study, the projects had the same sort of generic process which, once personalised, neither interfered in observations nor polluted collected data.

According to the defined research strategy, the 14 comparative cases implemented a structured analysis approach (SADT) and a functional activity modelling instrument (IDEF0), used by project participants to define and agree on their respective project processes. The strategy included team building (purpose, people, process and place), relationship and leadership experiments throughout the project life-cycle (project duration was five consecutive months). In terms of shared techniques and methods enforcing a shared understanding, in addition to the previously mentioned use of SADT and IDEF0, all project teams used WBS and OBS for the structuration of their respective projects. The BSCW platform log data, together with the level of interaction and usage, is intended to provide insights into the various collaborative activities conducted by each team, such as shared models, common classification, shared structuration, team communication and shared space. In terms of team performance, log data are also intended to provide figures on the level of team productivity, compared to the level of interaction and number of project stakeholders.

3.4.4 Focus Group Interviews

In order to have a more immersive experience, focus groups replicated project teams. To reach the proper level of group consciousness, interaction should be as inconspicuous as possible and should encourage presentation and perception among participants; therefore, it should not be forced by the moderator. In this kind of experimentation environment, users should have a total freedom and wide access to the collaborative platform functions without any specific restriction or obligation. In this case, the collaborative environment was flexible enough to fit team members in their respective daily activities.

The questionnaire for the focus group interviews, based on open ended questions, included three main discussion topics:

- The degree to which mutual understanding is perceived as the key to an effective collaboration;
- The appropriateness of online Shared Workspace and Group Blogging (collaboration technologies) for sharing information and documents, hence making more effective

the collaboration among team members wherever they are located and whenever they need it;

- The degree to which collaboration technologies allow the bridging or compression of distances and whether the use of technologies creates in return a specific distance type.

The interpretation of the results of the focus group interviews is used to scale comments on the degree to which the used collaboration technology allowed project teams to bridge or compress distance types, from ‘not at all compressed or bridged’ (value 0), ‘not satisfactorily compressed or bridged’ (value 1), ‘only partially compressed or bridged’ (value 2), to ‘fully compressed or bridged (value 3).

The above described scale of four different ratings is intended to correspond to the four ratings of the survey on collaboration barriers, in order to make easier the comparison between the rated collaboration barriers by professionals (survey) and experienced technology capacity to overcome these distance types during students’ projects (see Figure 5.11).

All project participants received specific training on collaborative distance and collaboration technologies when they started their projects.

3.4.5 Data Sources

In this empirical study, data sources comprise a survey, focus group interviews and log data. The survey represents the quantitative side of the triangulated research approach, while the focus group interviews represent the qualitative side. The log data complete the triangulated research approach.

3.4.6 Data Collection

Data are collected from a survey, focus group interviews and comparative cases. For comparative cases, log data come directly from the shared workspace environments (BSCW), either from direct data export or through data mining techniques that are not part of the shared workspace environment (see explanations below regarding the data mining techniques).

3.4.7 Data Mining

Artefacts can be accessed in BSCW by interactive navigation along the predefined folder structures and by search facilities that offer comprehensive specifications of all available attributes (e.g. artefact name, content, metadata, activities). The tracked user activities can be requested by history of artefacts, awareness icons, mail notification, and search. However, there is no tool support for gaining a good overview of topics and activities within the workspace. Similar observations have been made for other workspace support systems.

A more comprehensive and flexible support of asynchronous awareness should enable the user to analyse cooperation activities from different perspectives (Pankoke-Babatz et al., 2004). Graphical overviews, together with text mining, can significantly facilitate the investigation of larger tracks of cooperation artefacts. Novak and Wurst (2005) claim that multi-perspective visualisations for cooperative work analysis must not be static, but rather must provide the current picture of a cooperation environment and offer flexibility through rich interaction.

Recent work within a European research project has already addressed some aspects of activity analysis. Two approaches are of particular interest here: The Readers system (Pallot et al., 2006) uses a Hypergraph metaphor to link group members and content objects with generated events. A red link indicates the creation of an artefact, while a green link depicts a read-activity. Filters can be defined to restrict time and other criteria, leading to new graphs.

Using Readers, one can comfortably identify knowledge creators and monitor read activities of specific documents. The SmartMaps system (Gross et al., 2003) uses a tree-map metaphor to display overviews of all artefacts and folders. With activities highlighted, SmartMaps provides a folder-centric overview of activities in a shared workspace and supports overall awareness. Other approaches can be found in Pankoke-Babatz et al. (2004).

SWAPit offers the opportunity to provide the user with a better overview and rich interactive features for activity and content analysis. The idea is to apply SWAPit's multi-perspective approach to a subset of users, artefacts and activities as specified by the user, so that all relevant access dimensions and associations among them might be provided as navigational paths for that user. The challenge here is to offer just the required information and functionality in an intuitive way.

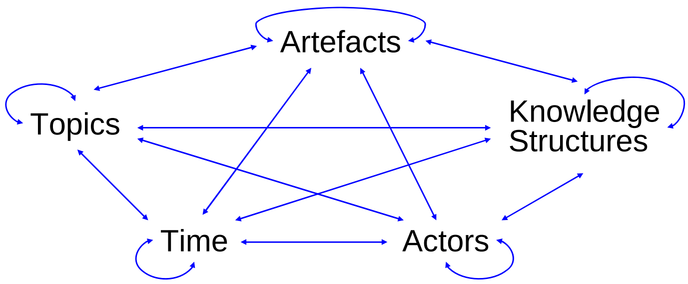


Figure 3.11: Cooperation activity-related data and relationships

Using the access paths depicted in Figure 3.11, we can distinguish types of supported tasks. Tasks can be divided into three groups: Awareness (e.g. 'what's new'), Access (e.g. 'what's related' or finding experts or artefacts for a given topic), and Analysis (e.g. for project management or system administration: 'what's there', 'who's active').

3.5 Summary

In this chapter, the selected triangulation research approach was discussed with a comparison of quantitative and qualitative research methods. Different types of case studies were introduced for explaining that the type of comparative cases was selected in this empirical study for carrying out interpretative comparisons. As for evaluating collaboration effectiveness and efficiency, the "Input-Process-Output" (IPO) model is also discussed and explained as well as adapted versions of the IPO model by Saunders (2000) and later on by Powell and colleagues (2004). In addition, the Druskat and Wolff (2001) emotional process is included in the IPO model for the Collaborative Distance experiment which is adapted from Hackman and Morris (1975).

Further to this, the observation model is described for enabling the evaluation of the nature and frequency of interactions among individuals through the analysis of log-data. The objectives of the comparative cases and their selection, as well as, the context of the project cases were explained. The focus group interviews, including the questionnaire and ratings, were presented and explained. Finally the data sources and data collection strategy, as well as, data mining within the Shared Workspace (BSCW) were described.

Chapter 4. Research Findings

Reality is merely an illusion, albeit a very persistent one. – Albert Einstein

This chapter presents the findings from the survey on collaboration barriers raised by distance factors, and from the focus group interviews and the comparative cases log data. It introduces the context of the survey and respondents' perceptions of the impact of distance factors in raising collaboration barriers. It also describes the collaboration technology used consistently across all comparative project cases. Finally, the outcomes of the focus group interviews and comparative project cases are presented in terms of the resulting data.

4.1 Survey Data

A survey on collaboration barriers, carried out from June 2007 to June 2008, was intended to collect respondents' views about a number of collaboration barriers based on their own experience forged during previous collaborative projects. Each assertion included in the questionnaire identifies a potential barrier which implies a certain negative impact on collaboration performance. The question that respondents answered was: 'Do you believe that this assertion corresponds to a collaboration barrier which has a negative impact on collaboration performance?'

Respondents were asked to check only one of the following possible answers: major impact, average impact, minor impact, or no impact at all. Collaboration barriers included in this survey correspond to various distance factors as previously discussed in the literature review. These collaboration barriers or distance factors were grouped into four dimensions corresponding to the Collaborative Distance Framework: structural, social, technical and legal.

The website approach applied to post the survey comprised four complementary polls, one for each dimension. This approach provides a lot of flexibility to respondents, as they can start expressing their opinion for one poll and then pause for a while if they need to before turning to another dimension, or vote for several polls during the same visit. The main objective is to ensure that respondents do not spend too much time completing the whole survey at once. Furthermore, current voting figures are always available to respondents without their having to respond to the survey. This means that there is no risk of participants giving fake responses just to get access to the results.

This is considered a valid approach to avoid low quality responses, because only motivated people respond to the survey. Moreover, another interesting added value of conducting an online survey through community website polling is the immediate shaping of the resulting figures, which enable us to understand the community opinion.

At the time the survey was conducted, the AMI@Work communities' website, where it was posted, had more than 2000 registered members. Most were experienced researchers, developers or engineers. This online survey had a maximum of 82 respondents for the structural dimension (see Figure 4.1). Resulting figures appearing on the Web pages received more than 4000 visits. The survey questionnaire included 25 collaboration barriers, based on 25 distance factors grouped into four dimensions as explained above.

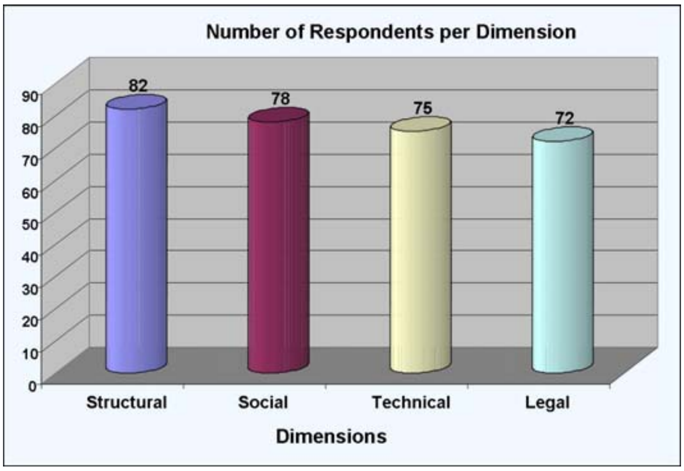


Figure 4.1: Level of Survey Respondents

Table 4.1 below shows the full list of factors grouped by dimensions, and the resulting estimated impact levels as rated by respondents. When rating the estimated impact level, respondents chose among the following options: major, average, minor and no impact. 'Major impact' corresponded to 'most significant impact', while 'average impact' meant 'significant impact' and 'minor impact' meant 'less significant impact'.

The final option, 'no impact' meant that a mentioned factor was definitely not a collaboration barrier because it did not affect collaboration performance. Fortunately, this option did not attract a significant number of votes (between 0 and 7), hence revealing that all included factors corresponded to real barriers. It should be noted that all included barriers or factors came from the literature review conducted for this research.

Factors	Dimensions	Major impact	Average impact	Minor impact	No impact	Participants
1.1 Geographical dispersion	Structural	24	24	33	1	82
1.2 Different time zones		14	30	38	0	82
1.3 Unbalanced power		35	38	7	2	82
1.4 Unbalanced expertise		29	38	14	1	82
1.5 Multi-disciplinary setting		17	36	22	7	82
1.6 Lack of clear leadership		60	18	4	0	82
1.7 Lack of incentive		42	26	8	6	82
2.1 Lack of commons	Social	29	39	10	0	78
2.2 Weak ties		20	38	18	2	78
2.3 Lack of interpersonal awareness		26	32	18	2	78
2.4 Multi-lingual setting		14	35	27	2	78
2.5 Emotional behaviour		11	31	33	3	78
2.6 Lack of mutual trust		51	21	6	0	78
2.7 Diversity setting		16	36	23	3	78
2.8 Lack of absorptive capacity		29	36	11	2	78
3.1 Lack of media naturalness	Technical	11	35	27	2	75
3.2 Lack of common description		34	32	9	0	75
3.3 Multi-platform setting		7	30	35	3	75
3.4 Lack of meaning		33	32	9	1	75
3.5 Unbalanced technological usage		20	43	9	3	75
3.6 Lack of contextualised mode		19	39	16	1	75
4.1 Unbalanced IPR approach	Legal	33	25	11	3	72
4.2 Different investment regulations		18	39	14	1	72
4.3 Different contractual settings		18	37	16	1	72
4.4 Lack of common security rules		28	31	10	3	72

Table 4.1: Rating of Collaboration Barriers by the Survey Respondents

In the following sections, resulting votes are presented by dimension, with a cumulated view for each factor where major, average, minor and no impact votes appear on the same bar in different colours. This kind of cumulated bar graph representation provides a direct view of the division of votes.

Introduction to the Survey as Posted on the Website

Today, it is widely recognised that diverse factors impact collaboration effectiveness and efficiency. Those factors create different types of distance among collaborating people such as eProfessionals. The literature review has allowed us to identify a number of factors grouped into twenty factor types or classes that are tentatively clustered into an overall concept named ‘collaborative distance’. This overall concept of collaborative distance has four dimensions: structural, social, technical and legal. Collaboration barriers are generated by factors creating different types of collaborative distance, which negatively impact collaboration performance.

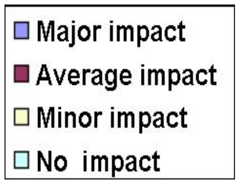
Participants were informed that the survey was intended to collect their views about the specified collaboration barriers based on their own experience forged during collaborative projects. Resulting figures were constantly monitored during the complete cycle of the survey. Each assertion identified a potential barrier implying a certain negative impact on collaboration. The question that respondents were asked to answer was: ‘Do you believe that this assertion corresponds to a collaboration barrier which has a negative impact on collaboration performance?’

When expressing their opinions, respondents were requested to check one of the four possible ratings:

- Major impact: Implies a collaboration barrier that has a major negative impact on collaboration effectiveness and efficiency.
- Average impact: Implies a collaboration barrier that has an average negative impact.
- Minor impact: Implies a collaboration barrier that has a minor negative impact.
- No impact: Implies no collaboration barrier!

4.1.1 Structural Dimension

The legend (see right) shows the colour code for each possible vote. The legend is not repeated for the other dimensions because the same colour code is used.



In the structural dimension, seven potential barriers or distance factors were included. The most famous from the point of view of the literature is the geographical dispersion of collaboration participants, often referred to as distributed groups or virtual teams (no physical collocation), which creates spatial, organisational and institutional distance. The second corresponds to collaborating participants or team members operating from different time zones or in flexi-time mode (variable work schedule), creating temporal, organisational and institutional distance.

The third barrier represents an unbalanced power in decision making, for example in the case of a hierarchical driven process (the boss is always right!), creating organisational distance at distributed power level. The fourth, unbalanced expertise, can be seen in another well-known case, that of committees where not all the disciplines necessarily involved in the daily work participate in the decision making (e.g. product life-cycle consideration); this creates organisational distance at the multidisciplinary team level.

The fifth barrier, multidisciplinary setting, refers to the fact that with the involvement of more participants and diversity, management overhead and coordination burden increase, creating organisational distance. The sixth, lack of clear leadership, refers to a situation where no-one appears to be leading the collaboration process, which creates organisational distance with a serious limitation on shared vision, goals and objectives.

Finally, the lack of incentive means that there is no motivation for collaborating with others. Where management evaluates employees purely on the basis of individual productivity and not at all on interpersonal productivity, the result is organisational distance, which limits individuals' willingness to collaborate.

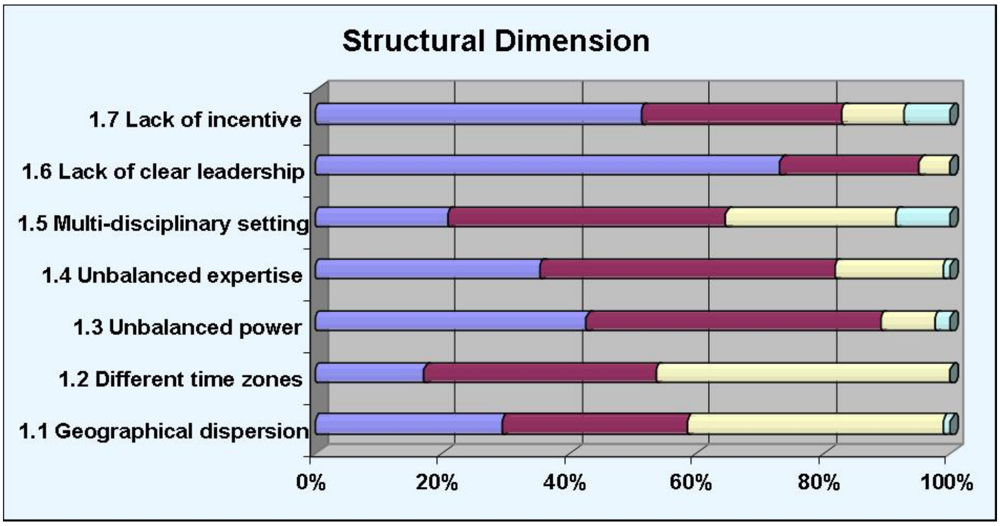


Figure 4.2: Ratings for the Barriers belonging to the Structural Dimension

The above cumulated bar graph (see Figure 4.2) presents the results for each proposed barrier in the structural dimension. It reveals that lack of clear leadership has by far the most significant impact on collaboration performance, followed by lack of collaboration incentive. Unbalanced power and expertise in decision making were rated as having a significant impact, as was the multidisciplinary setting, which induces management overhead and coordination burden. Notably, geographical dispersion was rated as having a less significant impact. This reveals that in respondents' experience, current available ICT support is satisfactory for overcoming this kind of barrier, and for collaborating over different time zones. Because the latter situation requires mainly asynchronous communication and interaction, it has a minor impact on collaboration performance. In contrast, distributed groups are not necessarily limited to asynchronous communication. Although synchronous communication and interaction, whether oral, written or both, can lead to more technological and cost problems, there are free tools available on the Web (e.g. Skype) which can be used to hold voice or video conferences with group members.

4.1.2 Social Dimension

In the social dimension, eight potential barriers were proposed to the survey participants:

1. Lack of common usage and norms (often due to different geographical areas, business or organisation cultures) creates cultural distance.
2. Weak ties among individuals create social distance.
3. Lack of interpersonal awareness creates relational distance.
4. Multi-lingual setting creates lingual distance (because interpretation is a source of misunderstanding).
5. Emotional behaviour creates emotional distance.
6. Lack of mutual trust creates relational distance.
7. Diversity setting (each discipline has its own vocabulary) creates cognitive distance and is a source of misunderstanding.
8. Lack of absorptive capacity (the ability to learn quickly and adapt in a short period of time) creates cognitive and learning distance.

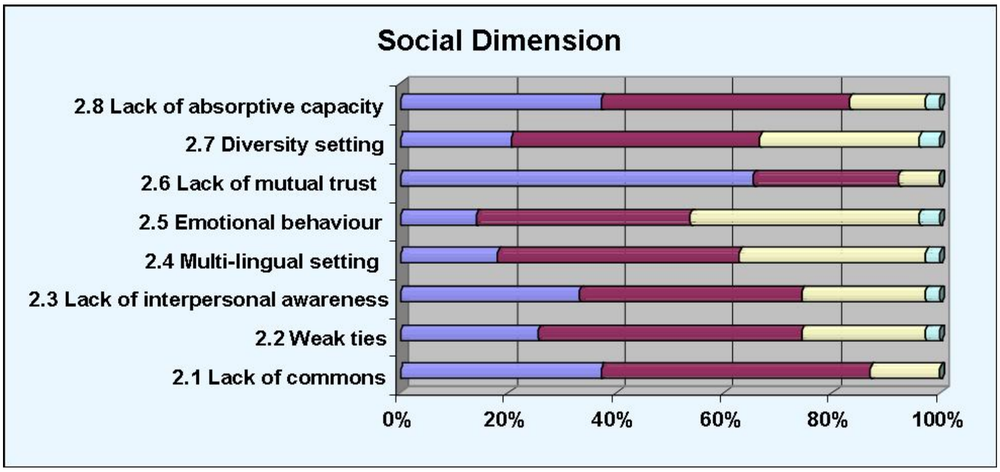


Figure 4.3: Ratings for the Barriers belonging to the Social Dimension

The above cumulated bar graph (see Figure 4.3) presents the results for each proposed barrier in the social dimension. It reveals that lack of mutual trust has by far the most significant impact on collaboration performance, which confirms the outcome of the literature review regarding the trust factor. However, there is no relevant trust model for collaboration that explains the links with other factors such as weak ties and interpersonal awareness. There is a possible link with the multi-lingual setting factor, since the bringing together of people from different cultures speaking different mother tongues does not encourage a good level of confidence and trust. Lack of common usage and norms, together with lack of absorptive capacity (Tsai, 2001), were also rated as having a quite significant impact on collaboration performance. The diversity setting was rated as having a significant impact, since on the one hand it brings more creative potential, while on the other it brings more cultural and cognitive distance, noticeably impeding collaboration performance. In contrast, emotional behaviour was rated as having a less significant impact. This might be explained by the fact that people, especially those who are shy, feel more comfortable in situations where there is emotional distance.

4.1.3 Technical Dimension

In the technical dimension, six potential barriers were proposed to the survey participants:

1. Lack of media naturalness (such as facial expression and gesture) creates cognitive distance.
2. Lack of common description (such as concepts, references and taxonomy) creates conceptual distance.
3. Multi-platform setting (in terms of types of device and operating systems for example) creates referential and technological distance.
4. Lack of meaning creates semantic distance.

5. Unbalanced technological usage and expertise creates technological distance.

6. Lack of contextualised operational mode (such as context awareness) creates contextual distance.

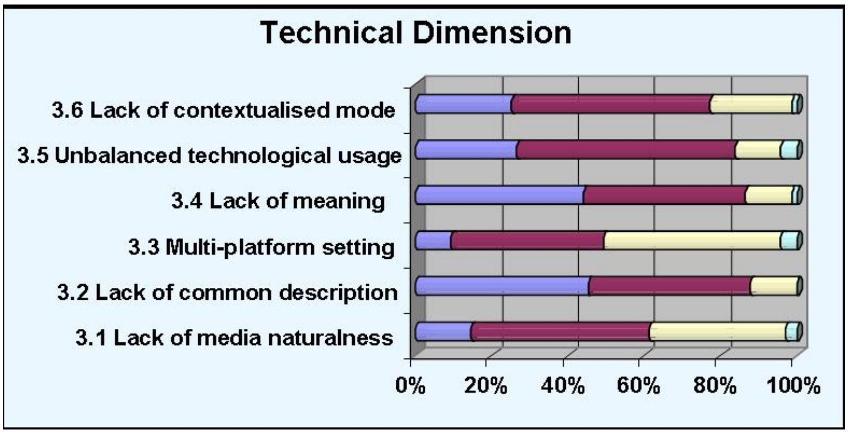


Figure 4.4: Ratings for the Barriers belonging to the Technical Dimension

The above cumulated bar graph (see Figure 4.4) presents the results for each proposed barrier in the technical dimension. It shows that lack of common description (shared knowledge), together with lack of meanings (shared sense-making) were rated as having the most significant impact. This also confirms the findings from the literature review that shared knowledge and sense-making constitute the essence of collaboration. Unbalanced technological usage, which induces technological distance, and lack of contextualised operational mode, which induces contextual distance, were considered as having a significant impact on collaboration performance. Interestingly, the multi-platform setting was rated as being a less significant factor, which may lead to the interpretation that survey participants are satisfied with the current level of tools execution whatever the computing device and operating system used.

4.1.4 Legal Dimension

In the legal dimension, four potential barriers were proposed to the survey participants:

1. Unbalanced Intellectual Property Rights (IPR) approach creates ownership distance.

2. Different investment regulations create financial distance.

3. Different contractual settings create contractual distance.

4. Lack of common security rules creates confidential distance.

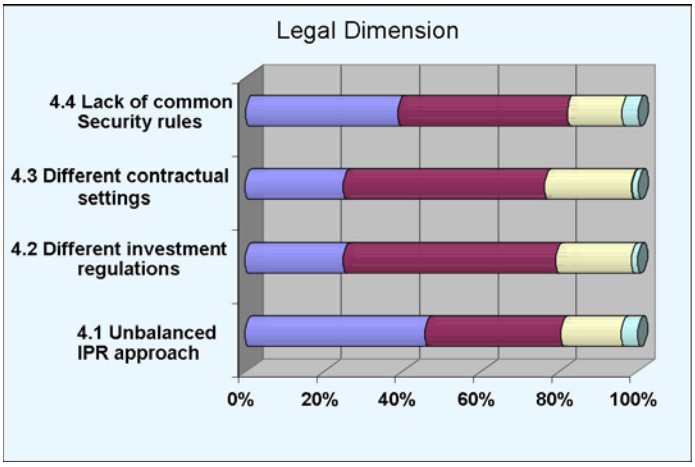


Figure 4.5: Ratings for the Barriers belonging to the Legal Dimension

The above cumulated bar graph (see Figure 4.5) presents the results for each proposed barrier in the legal dimension. This shows that an unbalanced Intellectual Property Rights (IPR) approach, which induces ownership distance, was considered as one of the six most significant factors. The wide range of ownership approaches, from creative commons to patenting, makes diffusion of restricted and confidential information difficult. This in turn impedes the collaboration performance. The different investment regulations and contractual settings according to the respective policy of the country where each distributed group is located, as well as the lack of common security rules, had a significant impact and impeded collaboration performance.

4.2 Focus Group Data

4.2.1 Introduction

This section presents the results of the focus group interviews (FGI). It also addresses the use of collaboration technology and tools such as an online Shared Workspace (SW) platform operating on the Web. The study was conducted as a real life experiment, through the use of a SW platform that included a number of new features, such as presence and expectation awareness, and group blogging. The basic idea was to engage a community of users in collaborative project experimentations. These experiments were intended to confront students with collaboration barriers and distance factors, and for them to try to overcome these barriers through the use of collaboration technology and tools. Important issues, such as whether the collaborative platform had helped in sharing knowledge and reaching a mutual understanding, and in overcoming various types of collaborative distance, were also part of this study.

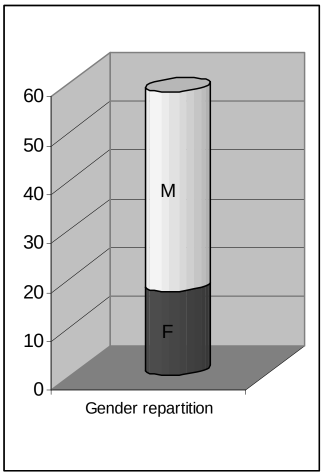
The first goal was to evaluate the impact of various collaborative distance factors during real life collaboration projects. All project cases were conducted by groups of students together with external participants such as customers and experts. The second goal was to explore the use of collaboration technology and tools for overcoming barriers in bridging collaborative distances.

It was expected that FGI would support the creation of an inter-personal communication arena among focus group members. Group members share knowledge and known concepts, and compare their ideas while discussing their own experience using the SW platform. Through this social interaction, they gain a better consciousness of the various concepts embedded in the SW platform, and their benefits versus difficulties based on diverse encountered situations.

In order to have a more immersive experience, focus groups replicated project teams. To reach the proper level of group consciousness, interaction should be as inconspicuous as possible and should encourage presentation and perception among participants; therefore, it should not be forced by the moderator. In this kind of experimentation environment, users should have a total freedom and wide access to the collaborative platform functions without any specific restriction or obligation. In this case, the collaborative environment was flexible enough to fit team members in their respective daily activities.

The SW platform used for the 14 project cases automatically collected data from users' generated events, forming a log data set. The objective in using both the log data sets and the focus group interviews was to make better evaluations.

The experimentation was conducted from October 2007 to February 2008. The 75 participants had an average age of 25 years, representing the Generation-Y[14] or Net-Generation, also named Digital-Natives[15]. Most were Master's degree students in one of four innovation domains (Strategic Information, European Venture, Agro-biology, and Virtual Reality). Students had one full day per week devoted to their respective collaborative project experimentation.



Over two thirds of participants were male, while the average age (without taking into account external participants such as experts and customers) was 25 years. A majority of participants (58%) were experienced users of Workspace technology (see Figure 4.6), while a minority (42%) had no experience at all (42%). Only one third were experienced in the use of an individual blog, while two thirds of participants did not have any real experience. More than two thirds said that they were used to working in collective activities, hence in a collaboration project, while under a third stated that they had no real experience so far on a collaboration project.

[14] http://en.wikipedia.org/wiki/Generation_Y

[15] http://en.wikipedia.org/wiki/Digital_native

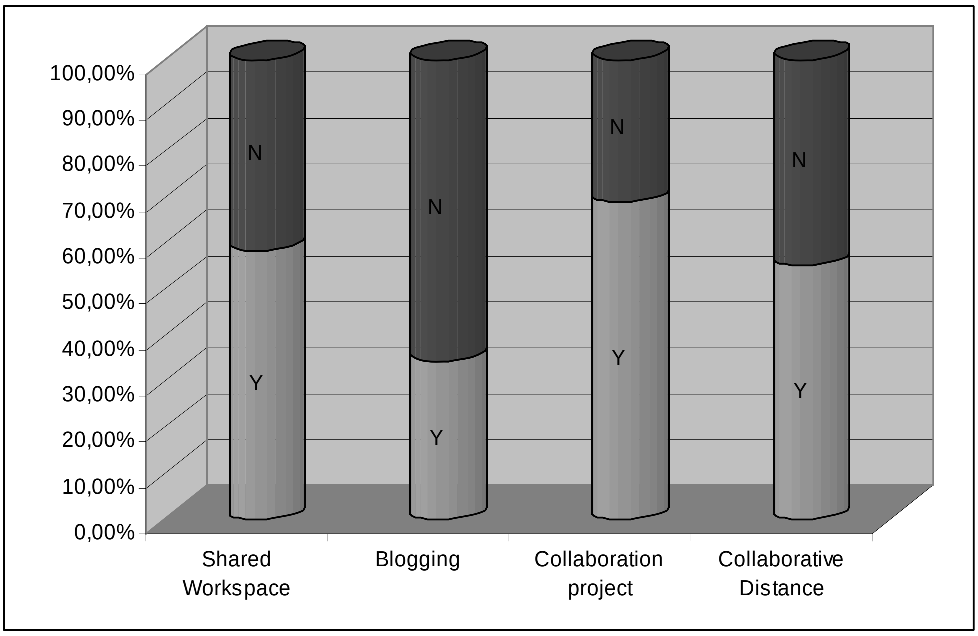


Figure 4.6: Previous Experiences

A one-page description of collaborative distance types was provided in advance of the focus group interviews.

4.2.2 Methodologies Applied by all Project Cases

According to the defined research strategy, the 14 comparative cases implemented a structured analysis approach (SADT) and a functional activity modelling technique (IDEF0), which were used by project participants to define and agree on their respective project processes. The overall approach included a team building (purpose, people, process and place), relationships and leadership experiment throughout the project life-cycle of five consecutive months. In terms of shared techniques and methods enforcing a shared understanding, in addition to the already mentioned SADT and IDEF0 all project teams used WBS and OBS for the structuration of their respective projects (see Figure 4.7). The idea was to have project teams building shared mental models about their project tasks, process and team, as proposed by Neumann et al. (2006). The BSCW platform log data is intended to provide not just the level of interaction and usage, but also insights on the various collaborative activities conducted by each team, such as shared models, common classification, shared structuration, team communication and shared spaces. In addition, log data is intended to provide figures on the level of team efficiency as a ratio of produced content objects per resource (see Figure 5.12), for comparison with the level of interaction and number of project stakeholders as a ratio of generated events per project participant.

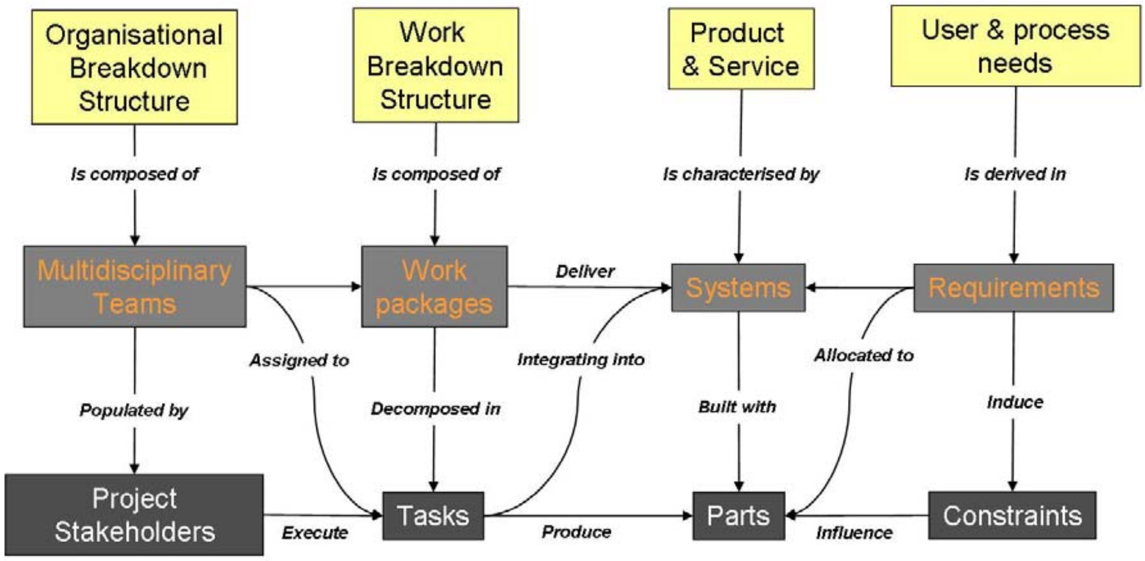


Figure 4.7: Project Structuration Model with OBS and WBS

The use of common techniques, methods and tools, as mentioned in the boundary object theory (Star and Griesemer, 1989), facilitates shared mental models among participants belonging to different disciplines or communities. According to Star and Griesemer:

> *Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable means of translation. The creation and management of boundary objects*

constitute a key in developing and maintaining coherence across intersecting social worlds.

In this empirical study it is expected that during the modelling sessions project team members will discuss, and argue about, their view of the project according to their own expertise. At the end they should agree on a shared view that constitutes the mutual understanding of the whole project process from mission statement to deliverables.

4.2.3 Focus Group Questionnaire

The list of open ended questions used for the focus group interviews (see Table 4.2) began by asking for views on the appropriateness of reaching a mutual understanding among group members and ended with discussion about proposed new features for better support of shared knowledge and the reaching of mutual understanding. Questions 2 to 4 addressed technology and respective usage satisfaction, while questions 5 and 6 addressed the potential contribution to either overcoming collaborative distance factors or, by contrast, creating even more collaborative distance.

Ref	Questions
Q1	What do you think about mutual understanding as being the essence of collaboration?
Q2	What do you think about the use of Shared Workspaces (Project Spaces)?
Q3	What do you think about the use of Group Blogging (Project Blogs)?
Q4	What do you think about their complementarity?
Q5	What do you think about technologies bridging or compressing various distance factors?
Q6	What do you think about technologies creating even more distance factors?
Q7	What do you think about the usefulness of a collaborative platform?
Q8	What do you think about using emails with attachments for sharing documents?
Q9	What other features would you like to have for better supporting knowledge sharing and mutual understanding among group members?

Table 4.2: List of Questions for the Focus Group Interviews

Question 7 referred, in essence, to a synthesis of using a collaboration platform and its capacity to deal with the various collaborative distance types. Question 8 addressed a crucial and very sensitive point in the domain of collaborative technology, as people still rely so much on their e-mail tool that they are often reluctant to use a Shared Workspace tool. Therefore, this question was intended to get a better understanding of the preference and motivation for e-mailing, which is only one of the many asynchronous communication tools.

The fourteen focus group interviews corresponded to the fourteen project cases and took place after their projects at the end of the first semester. For reasons of privacy and confidentiality, the contents of the projects could not be presented. However, as they all addressed innovation in various sectors, with specific activities such as technology or competitiveness study, the projects had the same sort of generic process which, once personalised, neither interfered in observations nor polluted collected data.

Project tables listing the main relevant points mentioned during the focus group interviews are presented in appendix B.

4.2.4 Focus Group Project Case P01

- Project team members had difficulties reaching agreement on a shared view about project goal and objectives. However, they recognised that all project stakeholders should share their respective knowledge in order to reach a mutual understanding.
- The modelling of the project process, in terms of functional activities (IDEF0) was a demanding activity. Project participants did not perceive its full benefit from the beginning besides recognising only the easier production of a Pert diagram and Gantt diagram, because constraints were already specified in the functional model. Only after

some time did it become obvious that sharing a single homogeneous process description was making the reaching of mutual understanding easier and faster.

- Interestingly, some discussion took place about the classification of content objects, mainly multi-media documents and links to Web pages, and about the structuration of their online project space in various folders and sub-folders. Individuals all had their own approach, and were not willing to make any cognitive effort to learn or adapt to another's preferred structure. This situation, incidentally, demonstrated a lack of leadership and absorptive capacity.
- Finally, several team members suggested using another SW platform with which they had previously had a good experience.

4.2.5 Focus Group Project Case P02

- Although project goal and objectives were clearly expressed by the customer, a lack of mutual understanding meant that the project team members had been facing difficulties in formulating the list of necessary activities to be carried out. After some time it became obvious that sharing a single homogeneous process description was making the reaching of mutual understanding of necessary activities easier and faster.
- Project participants perceived the benefit of the central storage of documents right from the beginning, because it allowed everyone to access up-to-date documents. They stated that: '*Normally, we are used to storing documents on USB memory keys, but we realised that is not an effective way of sharing information.*'
- They were not used to blogging, hence they did not realise the full benefit of group blogging, especially because they were in a project configuration where most team members were physically collocated. However, they stated that blogging could be

complementary to Shared Workspace: '*Blog entries provide an opportunity to add specific information related to uploaded material and get comments about them*.'

- They found that technologies fully compress collaborative distances such as geographical and temporal distance types, while introducing another distance type based on the technology skills of the team members. They stated that relying too much on the use of technology leads to weak interpersonal relationships, creating relational distance.
- As for the use of the SW platform, one team member had previous experience, which proved to be useful for the others. They clearly learned from one another, demonstrating the usefulness of sharing knowledge and the importance of absorptive capacity.

4.2.6 Focus Group Project Case P03

- This project team also had difficulties reaching an agreement on the project goal and objectives, as well as necessary activities to be carried out. They declared that: '*The difficulty to make sure everyone understands the same thing is mostly due to the lack of time spent on sense-making at the team level.*' They also stated that the risk of misunderstanding leads to non-coherent work.
- Regarding the modelling of the project process in term of functional activities (IDEF0), two team members had previous experience, which proved useful for the others. They clearly learned from one another, demonstrating the usefulness of an open mind and absorptive capacity. It was still a demanding activity, but due to the previous experience, participants perceived the benefit of getting a shared functional model right from the beginning.
- Interestingly, some discussion took place about the classification of content objects and about the structure of their online project space in various folders and sub-folders. This

illustrated the fact that it is painful for anyone to make a higher cognitive effort to identify and locate the content objects.

- As for the SW platform, after some discussion, they finally stated that the technology and tools they used did compress geographical and temporal distances, especially for accessing documents that need to be shared by all project participants. However, it simultaneously created relational and emotional distances. They also noted the importance of being sure to use the latest document version on the SW platform.
- On the subject of group blogging, the team members declared it useful for developing a project culture and awareness about others' feelings regarding the progress of the project. Finally, they declared: '*Sending too many e-mails pollutes everyone's e-mail box and makes it very difficult to identify important messages that need a prompt reply.*'

4.2.7 Focus Group Project Case P04

- Project team members used the functional modelling (IDEF0) of their project process to establish a common view on the work to be carried out, allocation of resources and task responsibilities. They stated that this modelling approach was also very useful for establishing a trusting dialogue with customers, even if it took time to reach a mutual understanding among all project stakeholders. Some team members reached a clearer global view earlier than others, hence the difficulty for everyone to be at the same level of understanding. They found that this was probably due to their lack of experience.
- The project participants did not find the user interface of the SW platform intuitive enough, as it lacked an entertaining look and feel. However, they stated that generated events were useful for being aware of what other team members were doing. It was difficult to agree the folder structure because everyone wanted to have it his own way, thereby creating cognitive distance.

- Regarding the group blogging feature, they mentioned the complementarity in providing specific information about uploaded documents and awareness of the latest status. They also stated that it is useful for providing document links to external participants.
- As for the SW platform, they mentioned the lack of media naturalness for supporting the building of interpersonal relationships and trust among project stakeholders. Nevertheless, they recognised the capacity of collaboration technology and tools to overcome some collaboration barriers induced by distance factors. They declared that: '*It is impressive to see the democratic access to all documents and information provided by the SW platform as it was impossible to retain information*.'

4.2.8 Focus Group Project Case P05

- The project team experienced difficulties reaching a mutual understanding due to the fact that there was no common understanding among team members of the customer needs and requirements. They decided to set up a meeting with the customer and other project stakeholders in order to specify all needs and requirements as well as expected deliverables. Finally, an agreement toward a shared view about project goal and objectives was established.
- They stated that the modelling of the project process in terms of functional activities (IDEF0) helped to achieve a mutual understanding of the necessary activities to be carried out. The use of the group blogging facilitated the discussion with external participants operating from distributed locations.
- The use of e-mail appeared to be mandatory for informing all project stakeholders at once whatever their location. The project team noted that sending documents by e-mail attachment is less efficient than uploading documents on the SW platform.

- Regarding the SW platform, team members recognised the usefulness of the central storage compared to individual approaches (e.g. USB memory stick, CD), allowing for the compressing of geographical distance and more generally of all structural distance types. They also mentioned the sharing of documents and information as a very important aspect for building trust. They referred to the risk of working outside normal office time, such as over night and weekends, due to the permanent availability of up-to-date documents on the SW platform from anywhere at any time while there is a free Internet connection available. While discussing the various distance types and related factors, they declared: '*Too much individual work on the SW platform induces a lack of social activity, which creates relational distance.*'

4.2.9 Focus Group Project Case P06

- In this project, team members had difficulties understanding the vocabulary used by others, especially people representing the customer and external experts, as well as some student colleagues from different disciplines. Their experience demonstrated that reaching an agreement on the project goal and objectives is not the real problem, but that issuing a common vocabulary to enable everyone to understand requires time right from the beginning of the project.

- They were not able to experiment with group blogging because their customer required a more formal approach.

- Regarding the SW platform, they stated that both geographical and temporal distances were properly bridged, but that it created technological distance for those who had never used it before. They also noted that some difficulties in use were due to the lack of French language in the user interface, which created a lingual distance.

4.2.10 Focus Group Project Case P07

- While discussing the essence of collaboration, project team members stated that: '*Mutual understanding is the basis for making sure no-one is going to work in the wrong direction.*' They also said: '*Sharing permanent information among project stakeholders allows seeing what others are doing and how they make progress which is useful for everyone to adapt his own contribution in the most efficient way*.' This was related to the use of models for designing the activities to be carried out.
- In their case, group blogging was supplanted by face-to-face interactions. However, they recognised the interest of having a recorded history of progress in the blog.
- Regarding the SW platform, they appreciated the fact that there was no risk of losing documents or latest versions. The possibility of seeing the project progress on the basis of produced documents available on the SW platform was also recognised as an important element of project awareness, especially for involving external participants. They said that: '*It helped to largely overcome structural factors and bridged structural distance types such as geographical, temporal and organisational distances, while it created more distance from social aspects such as cultural and relational distance types.*'

4.2.11 Focus Group Project Case P08

This project case is special because team members did not use the SW platform intensively enough to have a real experience. However, students claimed to have used another SW platform, GoogleDoc, which is available free on the Internet. Their choice to use this SW platform was justified by the availability of an online document editing feature. The information they provided during the focus group interview was related to their experience with GoogleDoc; unfortunately, however, it was not possible to get log data from this platform.

- Project team members felt that group blogging is not something well-known and accepted by people.
- The modelling of the project process in terms of functional activities (IDEF0) was revealed as very useful for reaching a mutual understanding on the organisation of the project.
- As for the use of collaboration technology and tools, they stated that these overcome structural factors such as geographical and organisational dispersion, while creating a technological barrier for people who are not skilled in the use of ICT tools, as well as relational and emotional distance types. With reference to emotional aspects, they concluded that: '*It could help a person who is too shy to express problems during a face-to-face meeting*.'

4.2.12 Focus Group Project Case P09

- Team members considered the SW platform as a shared storage place to save documents where they uploaded the final version of their deliverables. This explains why they had a low number of files uploaded on the SW platform. Like the previous project team, they said that they used GoogleDoc, with the same motivation of online editing.
- They explained that collaboration technology and tools helped to overcome spatial distance, albeit only partially due to the lack of a synchronous communication tool on the SW platform. Nonetheless, they declared that it bridged the temporal distance because there, the need is for asynchronous communication tools. They found that too much technology creates a lack of social interaction, because it encourages participants to use asynchronous communication tools with limited or no level of interaction.
- As for e-mail and attached files for sharing documents, they stated that this is still their favourite asynchronous communication tool, especially when there is no attachment.

4.2.13 Focus Group Project Case P10

- Project team members spontaneously mentioned the use of the modelling approach as a kind of 'best practice' for ensuring that everyone has the same understanding of the project goal and objectives, as well as necessary activities to be carried out. A common model of the folders structure on the SW platform was also cited by team members as a standard for all project stakeholders. They mentioned several times that a mutual understanding is very important for team cohesiveness.

- Regarding the SW platform, they stated that it contributed to overcoming most of the structural barriers and bridged all related distance types while simultaneously creating relational, cultural and technological distances. When discussing distance factors, they stated that: '*Everyone does not have the same ICT skills and experience; hence this explains the need to learn from others and the importance of the absorptive capacity.*' They also mentioned that another type of technological distance was illustrated by the unavailability of the Internet and access to the Web, due either to the lack, or the high cost, of a Wifi connection. Finally, they found that it creates a specific online culture with the inherent risk of becoming addicted.

4.2.14 Focus Group Project Case P11

- Project team members apparently did not recognise the role of mutual understanding. They declared that it would have been far more interesting to share information among all projects.

- They found the SW platform useless for team members who were physically collocated, but useful for project stakeholders who were distributed. They stated that collaboration tools bridge spatial and temporal distances if and only if an Internet connection is available. Sharing information and documents was recognised by team members as building trust among project stakeholders, especially with customers.

4.2.15 Focus Group Project Case P12

- Team members did not believe they had reached a mutual understanding; they declared that they had faced many difficulties reaching an agreement on project goal and objectives.
- They found that the use of collaboration tools is appropriate only when participants are in a distributed organisation, because although these tools clearly contribute to compressing geographical distance, it is necessary to learn how to use them. They also said that the lack of a video conferencing tool for synchronous communication made the media naturalness even more difficult. Finally, they used the SW platform as a shared storage unit.

4.2.16 Focus Group Project Case P13

- Team members stated that the modelling exercise part of the project process revealed that the mechanics of collaboration is very much dependent on mutual understanding. They did not face real difficulties reaching an agreement on the necessary activities to be carried out and came rapidly to a shared view of the project goal and objectives.
- Regarding the use of collaboration technology and tools, they stated that these clearly contributed to overcoming structural barriers, while introducing a technological barrier because participants do not necessarily have the same ICT skills. Team members did not consider the fact that technology creates emotional distance as a negative aspect because it guards against over-reacting. They found that the usefulness of the SW platform was unquestionable, especially in terms of sharing documents and being sure of using the latest version. However, there was a question about what would happen if different SW

platforms were used in the same project, as this could introduce another technological distance.

4.2.17 Focus Group Project Case P14

- Project team members discussed the modelling approach with members of the P10 project team, with regard to best practice for reaching a mutual understanding in a short time period. They stated that the success of this approach was explained by the reduced number of syntactic and semantic rules of the modelling language, the simplicity of IDEF0, and the involvement of all necessary disciplines operating on the life-cycle.
- They explained that they did not use group blogging because they thought that too much communication on the basis of individual feelings would disturb the cohesiveness of the group.
- As for the SW platform, they found that it helped to overcome most of the structural factors, while creating relational, cultural and technological distances as previously explained. Interestingly, they declared that even for a physically collocated team the use of an SW platform is useful as a standard storage to collectively manage deliverables.

4.3 Log Data and Cases Overview

Findings are based on log data collected in the 14 project cases described in the following sections. The main interest is to try to identify relationships among collaborative distance types through related factors and project outcomes in terms of both generated events and produced content objects. A content object could have different versions representing the maturity level that increases over time simultaneously with the increasing number of participants' contributions.

Items	Val													
Projects	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14
Members	5	4	8	5	7	8	7	6	5	4	5	4	4	9
Folders	12	8	17	10	10	20	3	1	2	7	4	5	14	17
Files	69	55	36	32	52	81	11	1	7	25	10	21	36	28
Blog entries	8	4	3	16	2	14	7	3	3	3	2	4	3	7
Events	403	252	358	307	323	478	113	39	109	146	75	113	190	308
Doc events	208	104	156	108	178	147	33	5	31	41	28	51	68	92
Create	69	55	50	51	50	72	11	1	7	25	10	21	28	35
Update	1	0	0	10	4	4	0	0	2	2	0	1	9	0
Read	138	49	106	47	124	71	22	4	22	14	18	29	31	57

Table 4.3: Collected Data for All Project Cases

All project participants were invited to access their respective project collaborative space or shared workspace over the Internet. In the course of their activities, they generated events on content objects that were stored as platform meta-data (see Table 4.3). The three different types of events stored in the SW are ‘create’, ‘update’ and ‘read’ events. In all project cases, the most interesting events are ‘create’ and ‘read’, because they give an idea about the numbers of created folders, documents and concepts, as well as read access numbers. They also provide links between those who are creating folders or documents and those who are accessing them in order to re-use their substance into new content objects.

4.3.1 Log Data Project Case P01

In order to fulfil confidentiality and security rules, every project participant was invited to join the online shared project space. In this case, five team members were registered as SW platform users (see Table 4.3). Altogether, team members generated more than 400 events and 77 content objects. Of these, 69 were document files and 8 were blog entries, uploaded in 12 folders. There were more than 200 document events: 69 ‘create events’, 1 ‘update event’ and 138 ‘read events’.

The bar graph below (see Figure 4.8) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that project participant U11 made the most significant contribution in the context of the shared project space in creating or reading content objects. This user appeared to be the project leader. Three other project participants, U12, U13 and U14, significantly contributed to the shared project space, while the contribution of participant U15 was insignificant.

The insignificant level of events in the ‘update’ category is explained by the fact that most project teams uploaded new versions with different names; if instead they had activated the versioning control while keeping the same name, this would have dramatically reduced the number of create events and increased the number of update events by the same value. The single update event shows that they did eventually find out how to put their final document under version control, and had time to update this document only once.

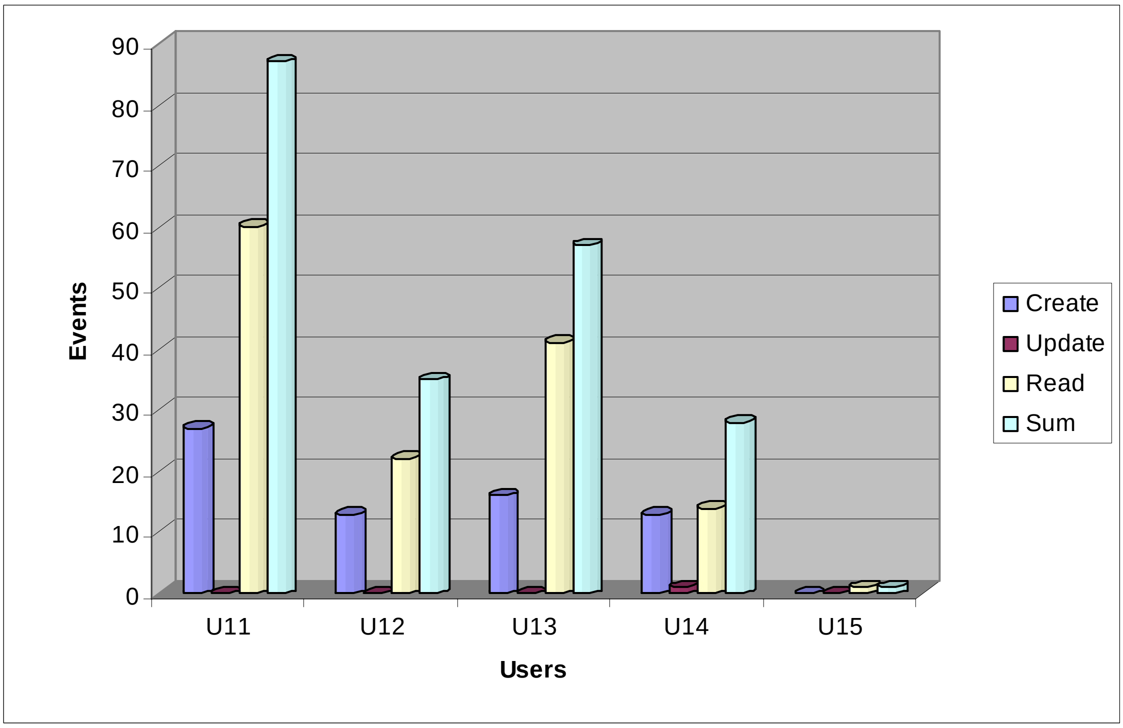


Figure 4.8: Project Case P01 Events per Type and per User

4.3.2 Log Data Project Case P02

This case presents a similar profile to case P01, with four participants registered as SW platform users (see Table 4.3). Altogether, team members generated 252 events and 59 content objects. Of these, 55 were document files and 4 were blog entries, uploaded in 8 folders. There were 104 document events: 55 ‘create events’, 0 ‘update events’ and 49 ‘read events’.

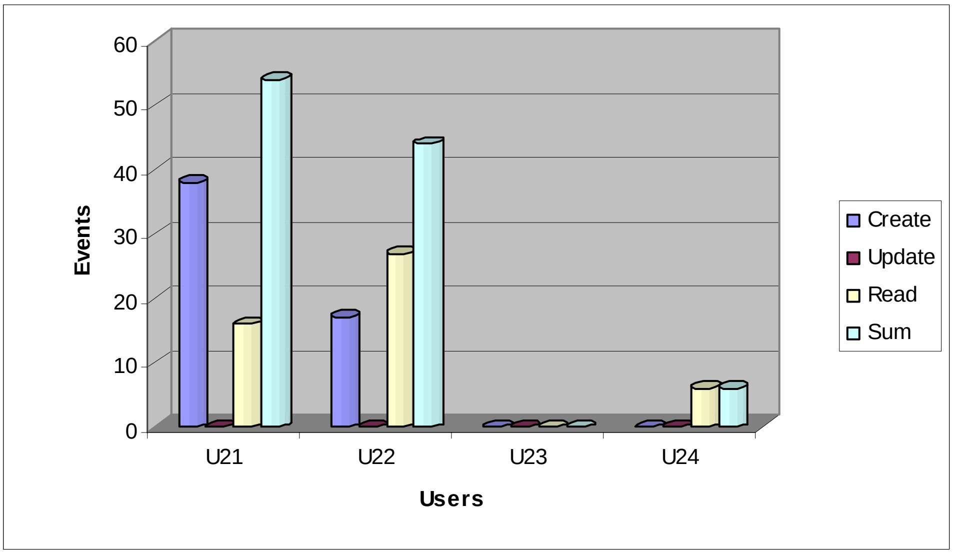


Figure 4.9: Project Case P02 Events per Type and per User

The above bar graph (see Figure 4.9) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U21 made the most significant contribution in the context of the shared project space in creating or reading content objects. This user appeared to be the project leader. Only one other project participant, U22, significantly contributed to the shared project space, while one participant, U24, contributed only by reading uploaded documents. Finally, the contribution of one user, U23, was insignificant.

4.3.3 Log Data Project Case P03

In this case eight participants were registered as SW platform users (see Table 4.3). Altogether, team members generated 358 events and 39 content objects. Of these, 36 were document files and 3 were blog entries, uploaded in 17 folders. Out of 156 document events, 50 were ‘create events’, 0 were ‘update events’ and 106 were ‘read events’.

The following bar graph (see Figure 4.10) illustrates the number of events per type and per user as well as a cumulative sum of all events. It is clear from the graph that user U33 made the most significant contribution in the context of the shared project space in creating and reading content objects. This user appeared to be the project leader. Three other project participants, U31, U32 and U34, significantly contributed to the shared project space, while participants U35 and U36 contributed mainly by reading uploaded documents.

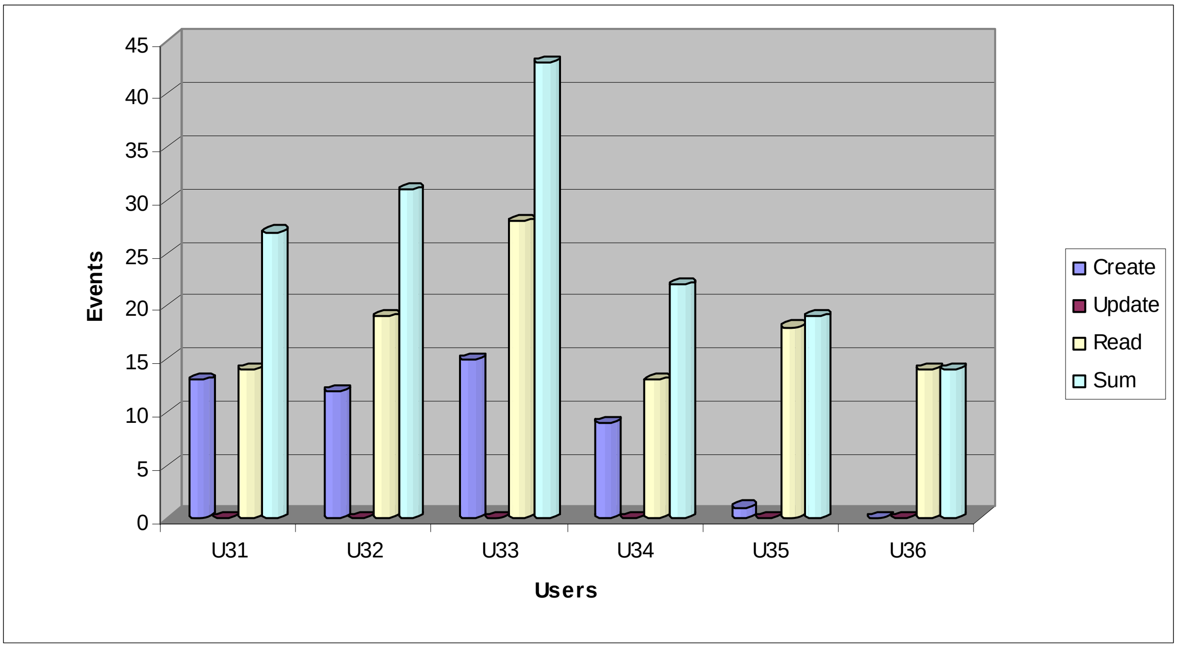


Figure 4.10: Project Case P03 Events per Type and per User

4.3.4 Log Data Project Case P04

In this case five participants registered as SW platform users (see Table 4.3) generated 307 events and 48 content objects. Of these, 32 were document files and 16 were blog entries, uploaded in 10 folders. There were 108 document events: 51 create events, 10 update events and 47 read events.

Interestingly, in this case, project participants generated 10 update events. This demonstrates that they reached the appropriate level of knowledge on how to use the versioning feature on the SW platform. This meant that they created fewer documents corresponding to new versions, which explains the 32 files compared to the 16 blog entries. If they had not used the versioning or generated any update event, they would have created 32 files and 10 blog entries, a total of 42 content objects.

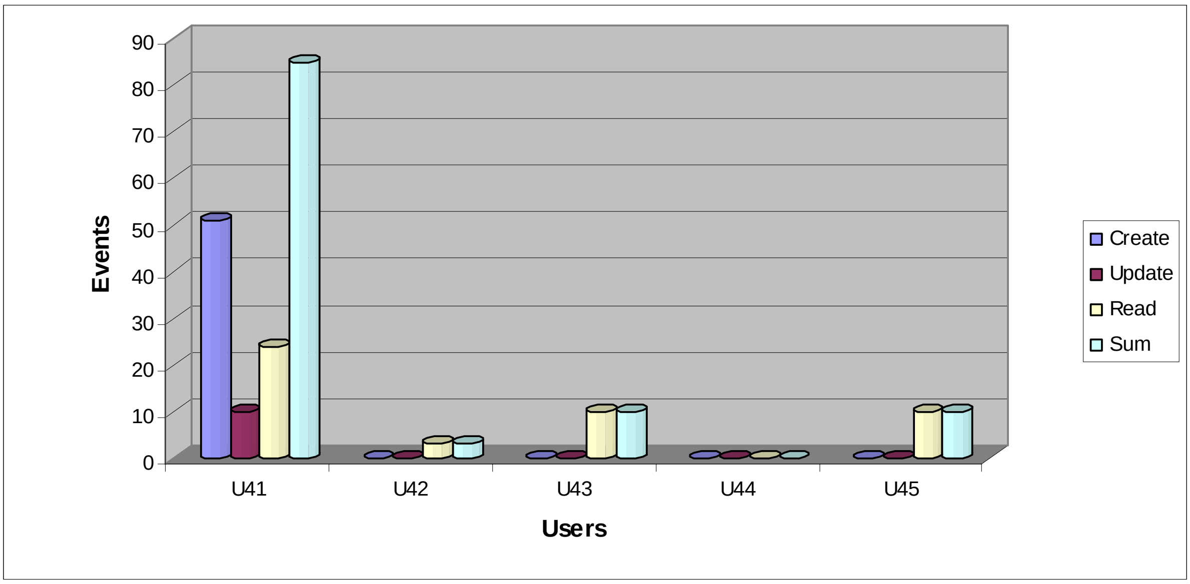


Figure 4.11: Project Case P04 Events per Type and per User

The above bar graph (see Figure 4.11) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U41 made the most significant contribution in the context of the shared project space in creating, updating and reading content objects. This user appeared to be the leader of the shared project space, as no other participant made a significant contribution in terms of document creation. One project participant, U44, made an insignificant contribution, while three others, U42, U43 and U45, contributed solely by reading uploaded documents. In this case, the team had decided that only one participant would be allowed to create folders and upload (create) documents on the SW platform.

4.3.5 Log Data Project Case P05

In this case seven participants registered as SW platform users (see Table 4.3) generated 323 events and 54 content objects. Of these, 52 were document files and 2 were blog entries, uploaded in 10 folders. Out of 178 document events, 50 were create events, 4 were update events and 124 were read events.

The following bar graph (see Figure 4.12) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that U52 made the most significant contribution in the context of the shared project space by creating, updating and reading content objects. This user appeared to be the project leader. Three other project participants, U51, U53, and U55, significantly contributed to the shared project space while three participants, U54, U56 and U57 contributed only by reading uploaded documents.

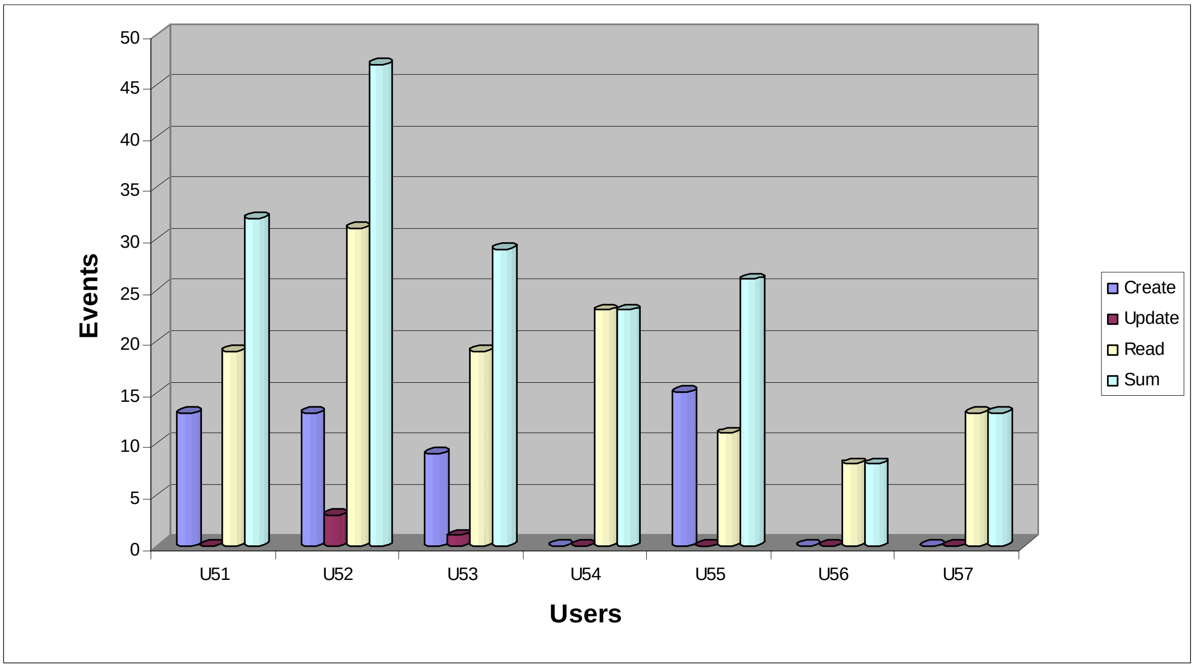


Figure 4.12: Project Case P05 Events per Type and per User

4.3.6 Log Data Project Case P06

This case presents another kind of profile, with eight participants registered as SW platform users (see Table 4.3). Altogether, they generated 478 events and 95 content objects. Of these, 81 were document files and 14 were blog entries, uploaded in 20 folders. There were 147 document events: 72 create events, 4 update events and 71 read events.

The following bar graph (see Figure 4.13) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U65 made the most significant contribution in the context of the shared project space by creating, updating and reading content objects. This user appeared to be the project leader. Four other project participants, U61, U63, U64 and U66, significantly contributed to the shared project space while two participants, U62 and U67, contributed only by reading uploaded documents.

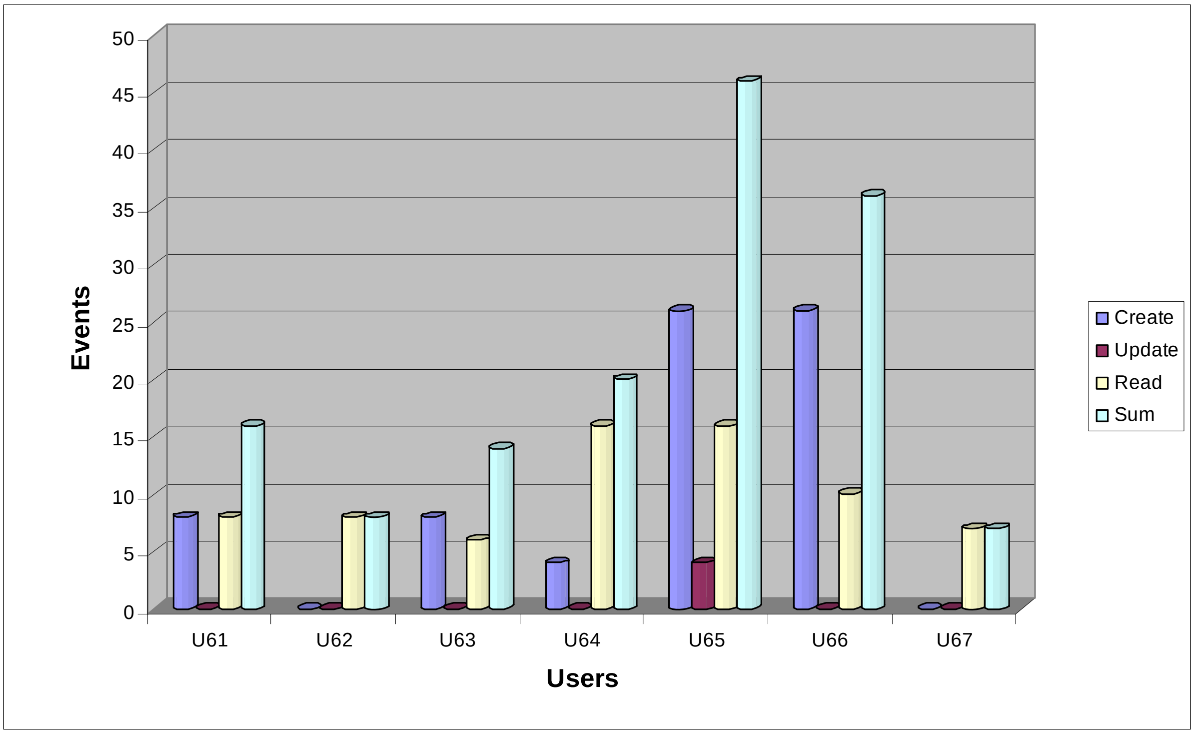


Figure 4.13: Project Case P06 Events per Type and per User

4.3.7 Log Data Project Case P07

In this case seven participants registered as SW platform users (see Table 4.3) generated 113 events and 18 content objects. Of these, 11 were document files and 7 were blog entries uploaded in 7 folders. Out of 33 document events, there were 11 create events, 0 update events and 22 read events.

The following bar graph (see Figure 4.14) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U71 made the most significant contribution in the context of the shared project space by creating and reading content objects. This user appeared to be the project leader. Three other project participants, U72, U73 and U75, contributed mainly by reading uploaded documents. Finally, the contribution of user U74 was insignificant.

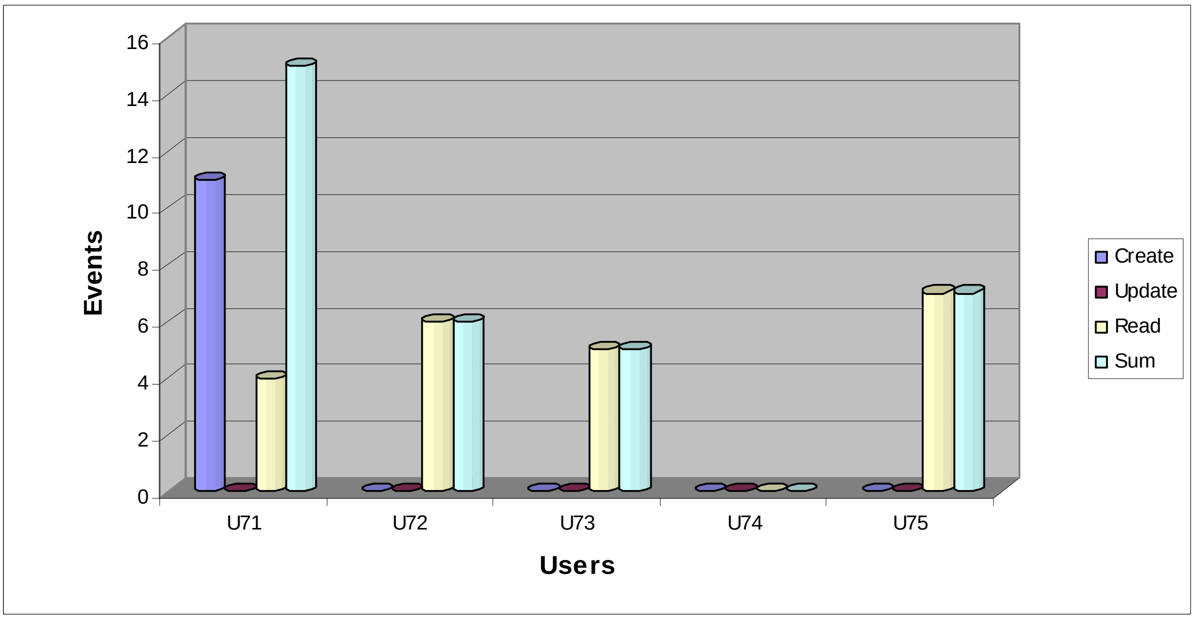


Figure 4.14: Project Case P07 Events per Type and per User

4.3.8 Log Data Project Case P08

This case presents a profile of very low content object production. Six participants registered as SW platform users (see Table 4.3) generated 39 events and only 4 content objects, comprising 1 document file and 3 blog entries, uploaded in 1 folder. There were 5 document events: 1 create event, 0 update events and 4 read events.

The following bar graph (see Figure 4.15) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. This project team decided to use another SW platform, where it was not possible to get log data. Only one user, U81, created and read content objects. Three other project participants, U82, U83 and U84, contributed only by reading the uploaded documents. Unfortunately, the team's decision to use another SW platform, despite the recommendation to use the same one as the other projects, means that this case is not viable.

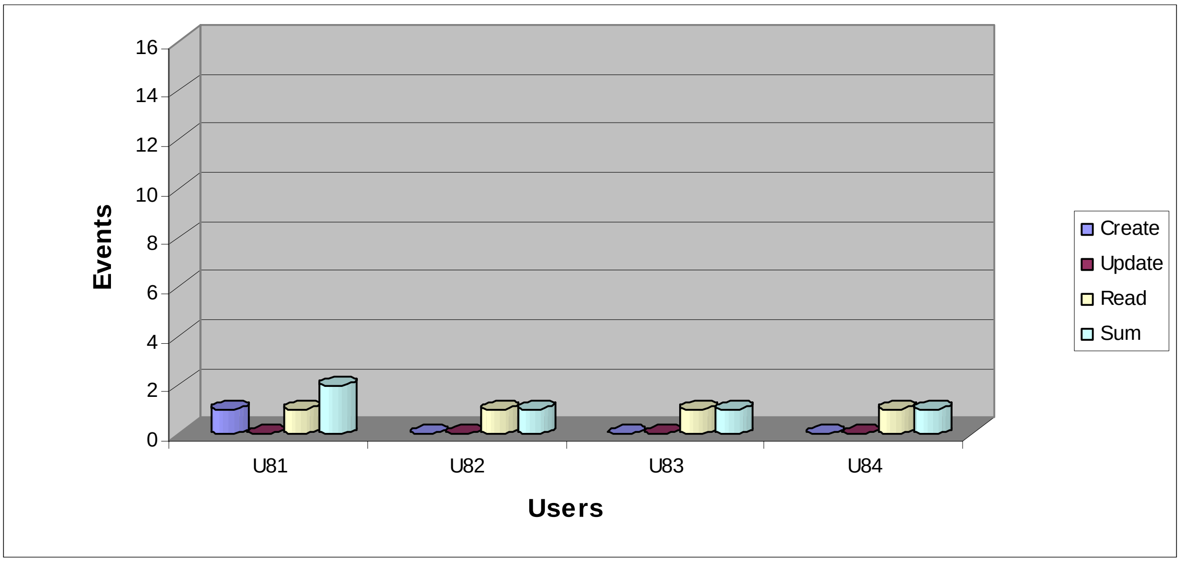


Figure 4.15: Project Case P08 Events per Type and per User

4.3.9 Log Data Project Case P09

This is another case with low content object production. Five participants registered as SW platform users (see Table 4.3) generated 109 events and only 10 content objects. Of these, 7 were document files and 3 were blog entries, uploaded in 2 folders. There were 31 document events: 7 create events, 2 update events and 22 read events.

The following bar graph (see Figure 4.16) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U91 made the most significant contribution in the context of the shared project space by creating, updating and reading content objects. This user appeared to be the project leader. The four other project participants, U92, U93, U94 and U95, contributed mainly by reading uploaded documents.

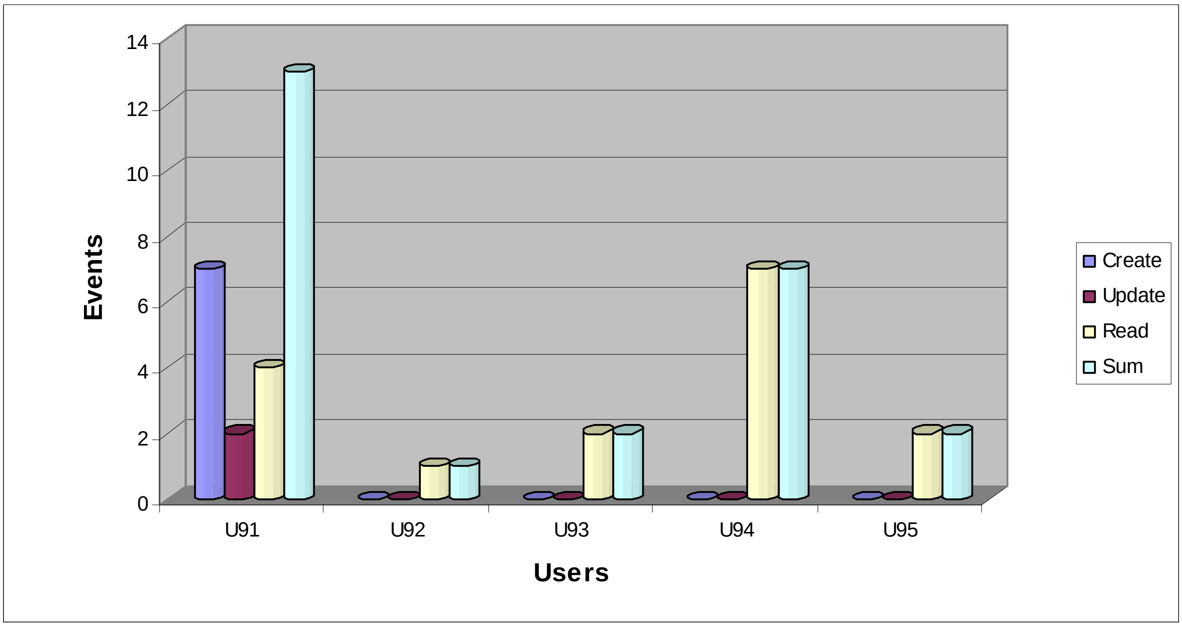


Figure 4.16: Project Case P09 Events per Type and per User

4.3.10 Log Data Project Case P10

This case presents a profile of high content object production, with only four participants registered as SW platform users (see Table 4.3). Altogether, project participants generated 146 events and 28 content objects. Of these, 25 were document files and 3 were blog entries, uploaded in 7 folders. There were 41 document events, comprising 25 create events, 2 update events and 14 read events.

The following bar graph (see Figure 4.17) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U103 made the most significant contribution in the context of the shared project space by creating and reading content objects. This user appeared to be the project leader. Two other project participants, U101 and U102, significantly contributed to the shared project space, with participant U101 also updating documents. One participant, U104, contributed only by reading uploaded documents.

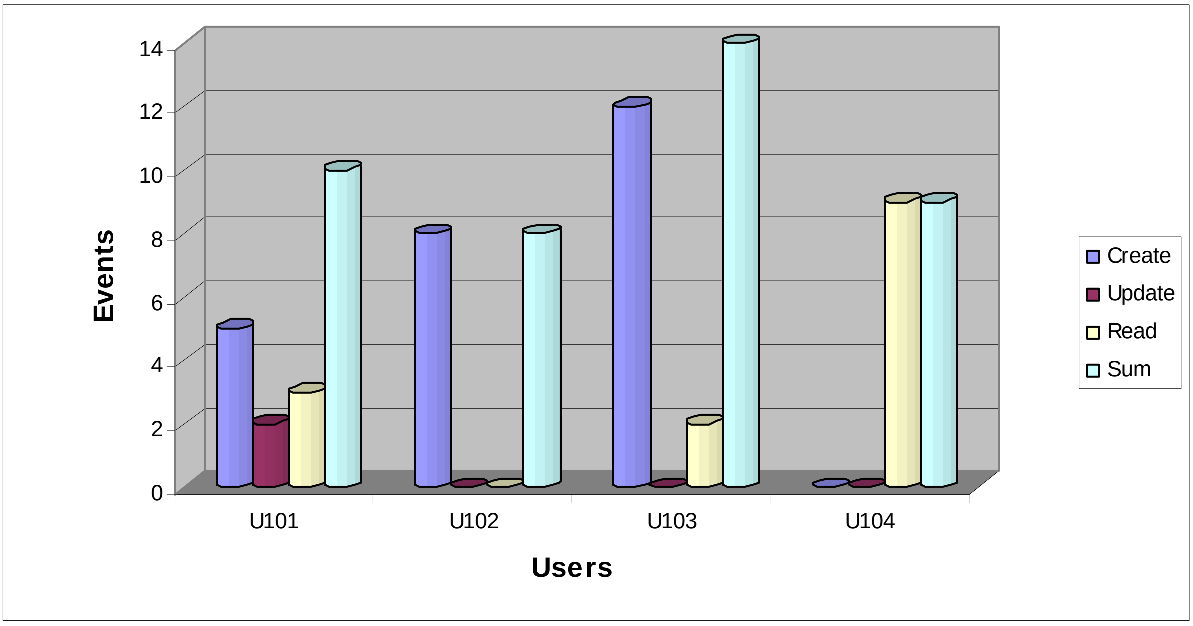


Figure 4.17: Project Case P10 Events per Type and per User

4.3.11 Log Data Project Case P11

This case presents a profile with a moderate degree of produced content objects. Five participants registered as SW platform users (see Table 4.3) generated 75 events and 12 content objects. Of these, 10 were document files and 2 were blog entries, uploaded in 4 folders. There were 28 document events: 10 create events, 0 update events and 18 read events.

The following bar graph (see Figure 4.18) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U113 made the most significant contribution in the context of the shared project space by creating and reading content objects. This user appeared to be the project leader. Two other project participants, U111 and U112, significantly contributed to the shared project space, while two participants, U114 and U115, contributed mainly by reading uploaded documents.

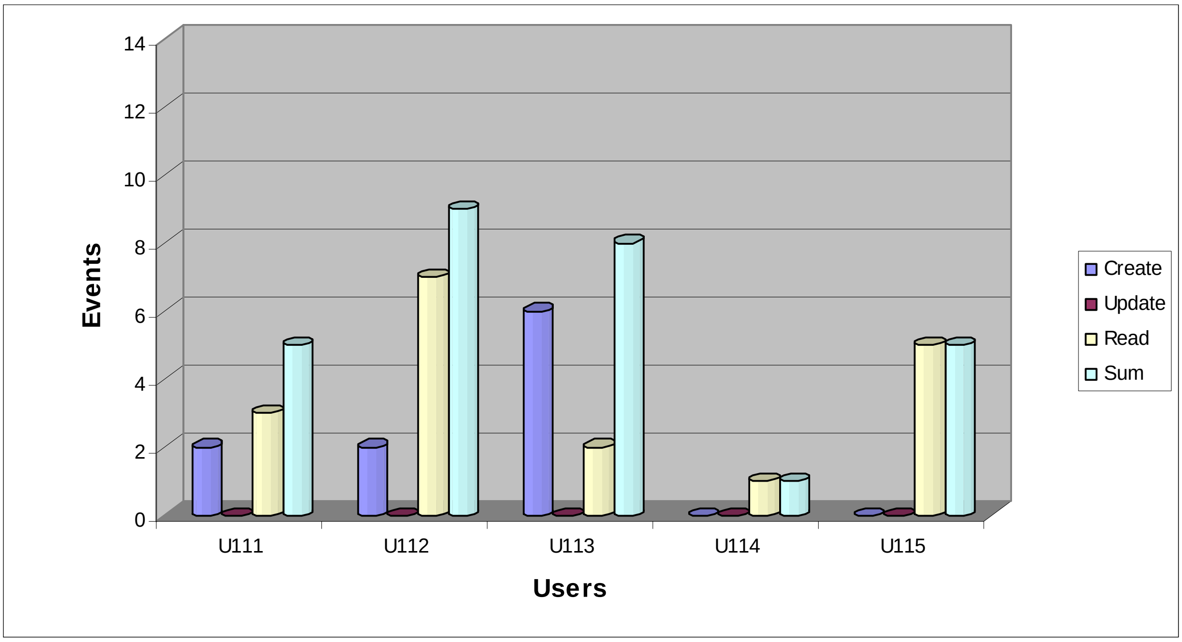


Figure 4.18: Project Case P11 Events per Type and per User

4.3.12 Log Data Project Case P12

This case also presents a profile with a moderate degree of produced content objects. Four participants registered as SW platform users (see Table 4.3) generated 113 events and 25 content objects. Of these, 21 were document files and 4 were blog entries, uploaded in 5 folders. There were 51 document events, comprising 21 create events, 1 update event and 29 read events.

The following bar graph (see Figure 4.19) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U122 made the most significant contribution in the context of the shared project space by creating, updating and reading content objects. This user appeared to be the project leader. Two other project participants, U121 and U123, significantly contributed to the shared project space, while one participant, U124, contributed only by reading uploaded documents.

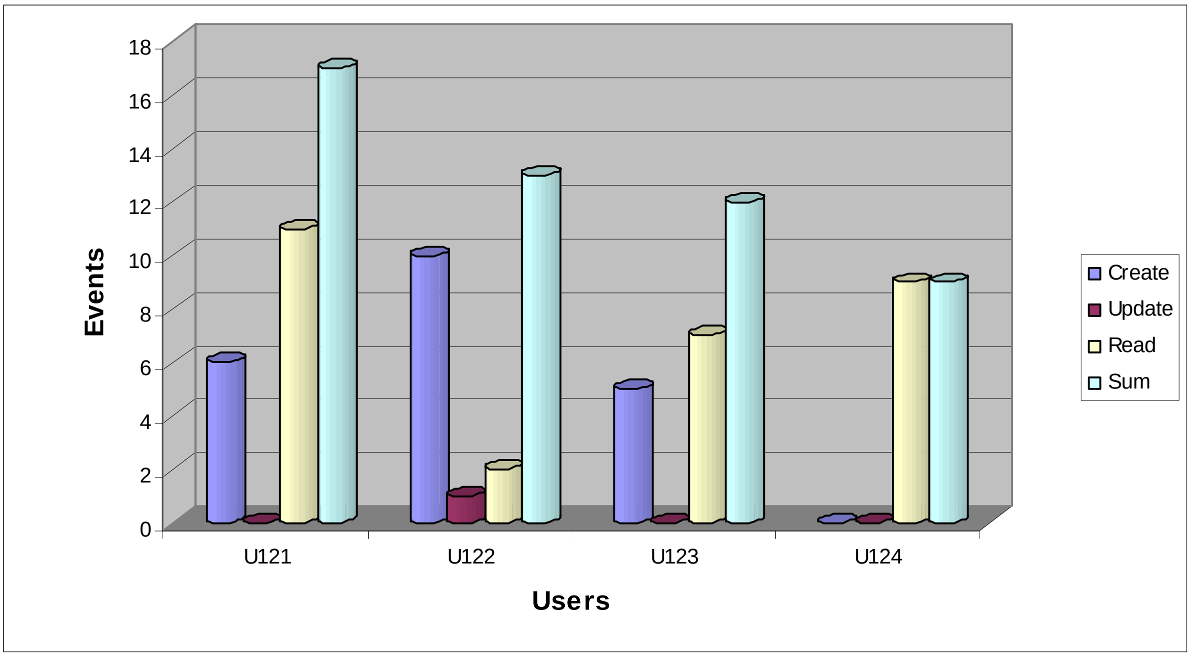


Figure 4.19: Project Case P12 Events per Type and per User

4.3.13 Log Data Project Case P13

This case presents a profile of high content object production. Four participants registered as SW platform users (see Table 4.3) generated 190 events and 39 content objects. Of these, 36 were document files and 3 were blog entries, uploaded in 14 folders. There were 68 document events: 28 create events, 9 update events and 31 read events.

The following bar graph (see Figure 4.20) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U132 made the most significant contribution in the context of the shared project space by creating, updating and reading content objects. This user appeared to be the project leader. Two other project participants, U131 and U134, contributed mainly by reading uploaded documents, although U131 also created documents. Finally, participant U133 made an insignificant contribution.

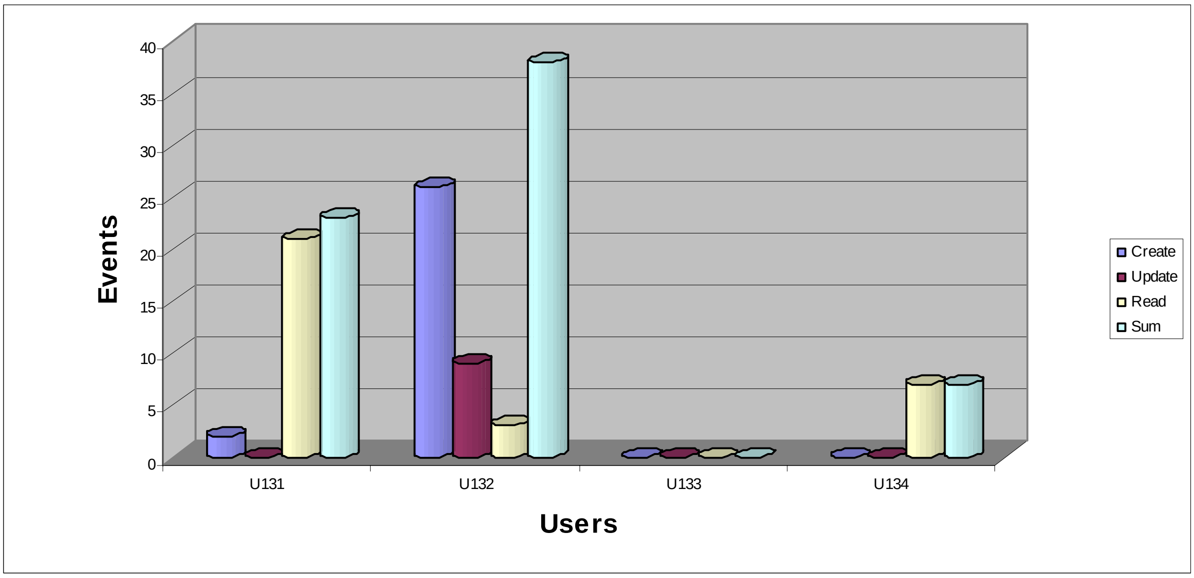


Figure 4.20: Project Case P13 Events per Type and per User

4.3.14 Log Data Project Case P14

This case presents a profile of reasonably high content object production. Nine participants registered as SW platform users (see Table 4.3) generated 308 events and 35 content objects. Of these, 28 were document files and 7 were blog entries, uploaded in 17 folders. There were 92 document events, comprising 35 create events, 0 update events and 57 read events.

The following bar graph (see Figure 4.21) provides a view of the number of events per type and per user, as well as a cumulative sum of all events. It appears that user U146 made the most significant contribution in the context of the shared project space by creating and reading content objects. This user appeared to be the project leader. Five other project participants, U141, U142, U143, U144 and U148, significantly contributed to the shared project space while two participants, U147 and U149, contributed mainly by reading uploaded documents. Finally, user U145 made an insignificant contribution.

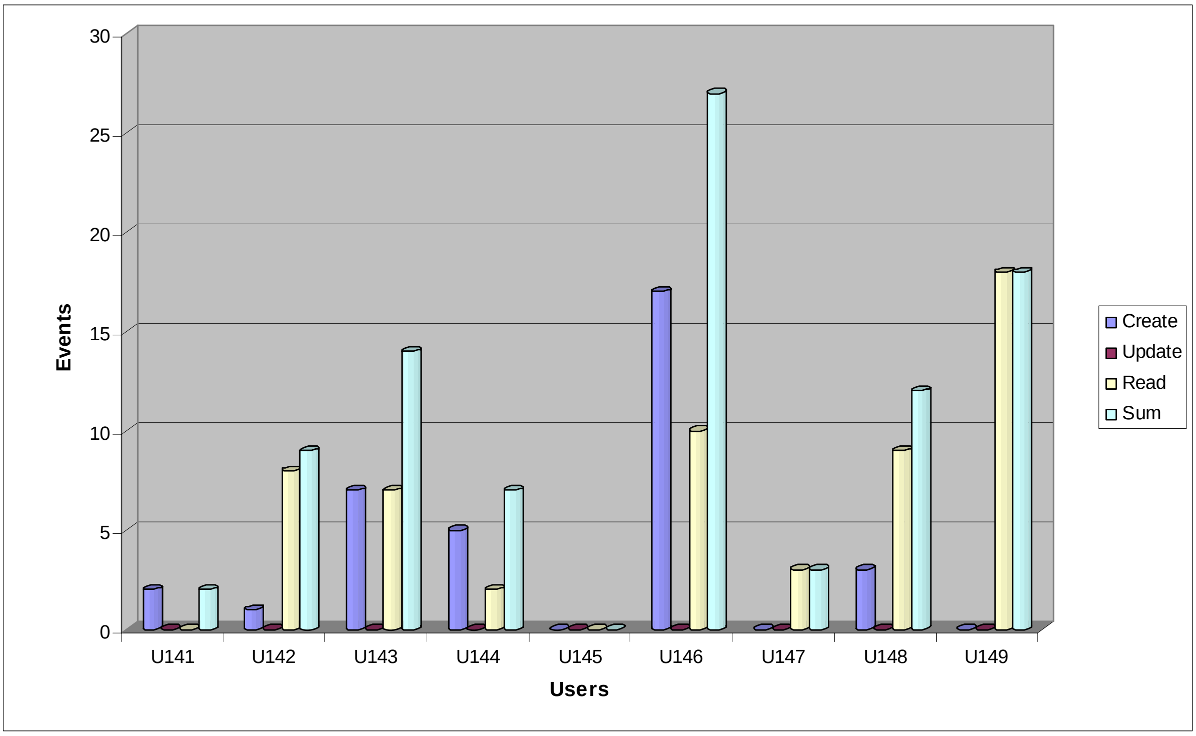


Figure 4.21: Project Case P14 Events per Type and per User

4.4 Summary

The above results show that only one project case, P08, was not significant for this study, because it had too few created documents and events. Project cases P07, P09 and P11 were not as significant as the other cases, again because they had too few created documents. While some project teams managed to find the versioning control feature of the SW platform, others did not find it until later in the progress of their project, which is the main explanation for the small number of ‘update’ events.

Chapter 5. Data Analysis and Discussion

Research is to see what everybody else has seen, and to think what nobody else has thought. - Albert Szent-Gyorgyi

This chapter analyses the survey findings on collaboration barriers, and classifies them into three categories according to their respective impacts. It also presents the analysis of the focus group interviews and comparative cases log data, and compares what participants said they had done (FGI) with what they really did (log data). The chapter discusses the different distance types within each specific dimension, summarising the discussion through the four dimensions of the CDF. Finally, it discusses the outcome in terms of resulting collaboration performance for all projects, explores the possibility of confronting distance factors with CWE, and introduces a comparison with other relevant surveys and studies on collaboration.

5.1 Survey Analysis

Among the 25 collaboration barriers mentioned in this survey, five barriers rated as having 'major impact' were considered by respondents to be most significant. Next, 15 barriers rated as having 'average impact' were considered to be significant. Finally, four barriers rated as having 'minor impact' were considered by respondents to be less significant.

5.1.1 Major Impact Barriers

Figure 5.1 below shows that of those barriers rated as having a major impact on collaboration performance, three received an absolute majority of votes. Two barriers, namely 'lack of clear leadership' (73%) and 'lack of mutual trust' (65%), were considered by respondents to be the most significant by far.

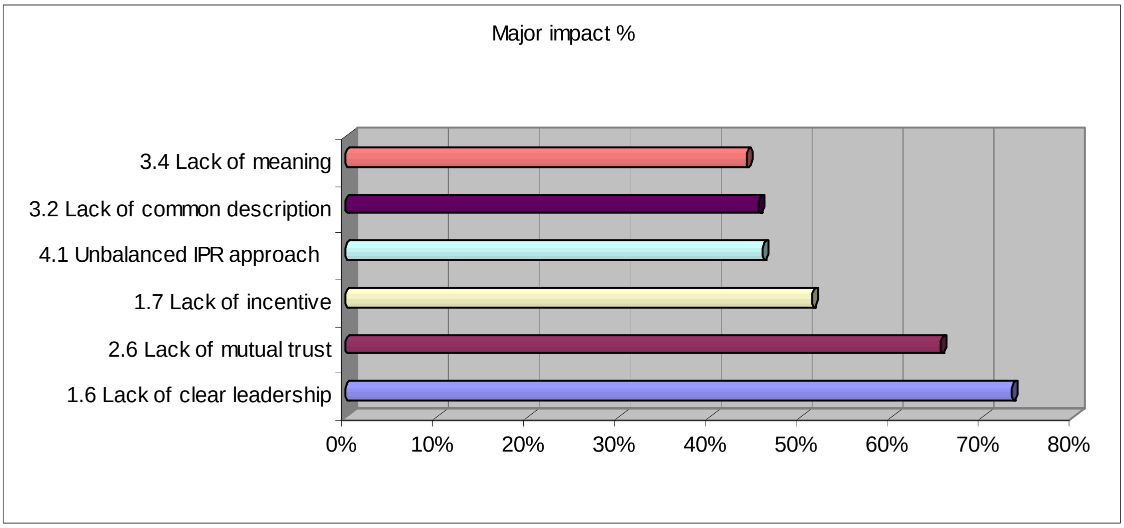


Figure 5.1: Major Impact Barriers

The third, 'lack of incentive', also received an absolute majority of votes with 51%. This is logical because the 'lack of incentive' governs the collaborative attitude of group members. In this survey, lack of clear leadership was mentioned as a potential barrier, contributing to increased organisational distance, partly disabling shared purpose, vision, goals and objectives among distributed group members.

Lack of mutual trust has been described as increasing relational distance, leading to weak ties among group members. In the literature, leadership and trust are the most frequently mentioned collaboration factors, often seen as conditioning collaboration effectiveness. According to Lipnack and Stamps (1997, page 173): 'Virtual teams and networks demand more leadership not less.' As for trust in teams, they assert that: 'In the networks and virtual teams of the Information Age, trust is a need to have quality in productive relationships.'

Figure 5.1 confirms previous conclusions on the paramount importance of leadership and trust in distributed collaboration. Therefore, good questions for CWE researchers and developers might be: 'In what way can ICT support leadership and trust within a distributed collaboration?' and 'What is the most appropriate trust model for supporting eCollaboration?'

Three barriers, 'unbalanced IPR approach' (46%), 'lack of common description' (45%) and 'lack of meaning' (44%) received close to a majority of votes as having a major impact (see Figure 5.1). While ownership (IPR) is rarely mentioned in relevant published studies, experienced people such as the survey respondents place it in the top four most significant factors impeding collaboration performance. Lack of common description corresponds to a lack of shared knowledge and sense-making that makes mutual understanding difficult to achieve. Roschelle (1992) argues that shared knowledge and meanings constitute the essence of collaboration, because they condition the reaching of mutual understanding.

5.1.2 Average Impact Barriers

Fifteen barriers received an absolute or near majority as having an average impact (see Figure 5.2). Four of these, 'unbalanced technological usage and expertise' (56%), 'different investment regulations' (55%), 'lack of contextualised operational mode' or 'lack of context awareness' (51%), and 'different contractual settings' (53%) achieved an absolute majority, meaning that respondents considered them to be quite significant factors impeding collaboration performance. One, 'lack of common usage and norms', received 50% of the votes.

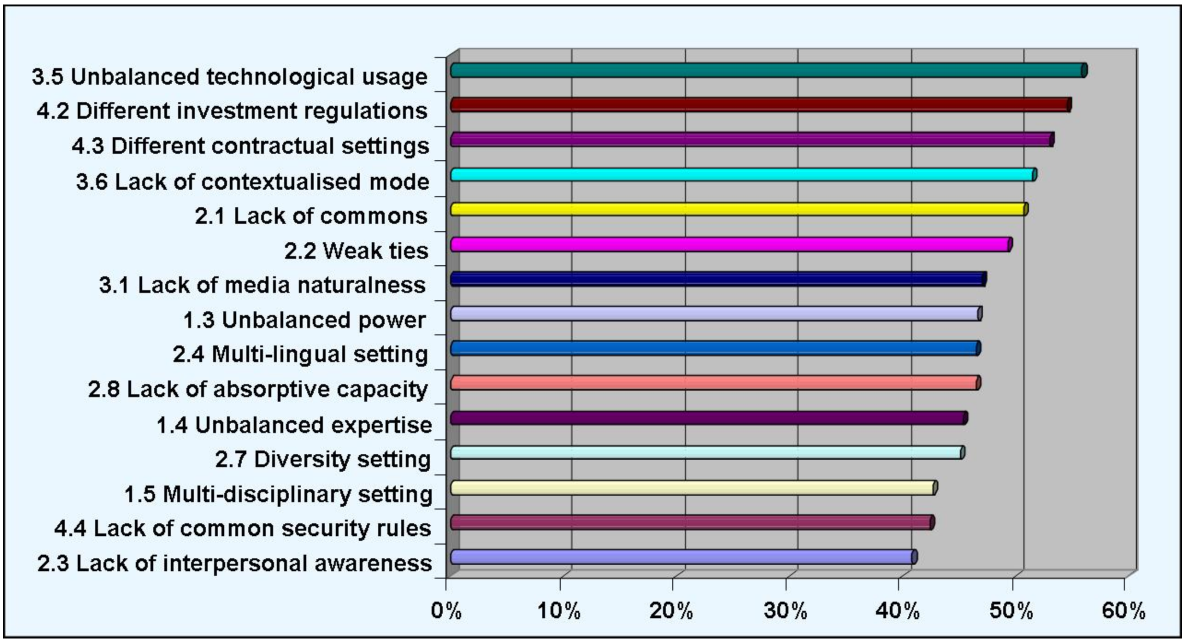


Figure 5.2: Average Impact Barriers

The 10 remaining barriers in this group, 'weak ties among individuals' (49%), 'lack of media naturalness' (47%), 'unbalanced expertise in decision making processes' (46%), 'lack of absorptive capacity' (46%), 'diversity setting' (46%), 'multi-lingual setting' (45%), 'multi-disciplinary setting' (44%), 'lack of common security rules' (42%) and 'lack of interpersonal awareness' (41%), received close to a majority.

5.1.3 Minor Impact Barriers

Four barriers, 'individuals operating in different time zones or flexi time mode (variable work schedule) creates temporal, organisational and institutional distance', 'multi-platform setting (e.g. type of devices, OS,) creates referential distance', 'emotional behaviour creates emotional distance' and 'geographical dispersion of individuals (no physical collocation) creates spatial, organisational and institutional distance', received close to a majority as having a minor impact (see Figure 5.3). They were considered by respondents to be less significant factors impeding collaboration performance.

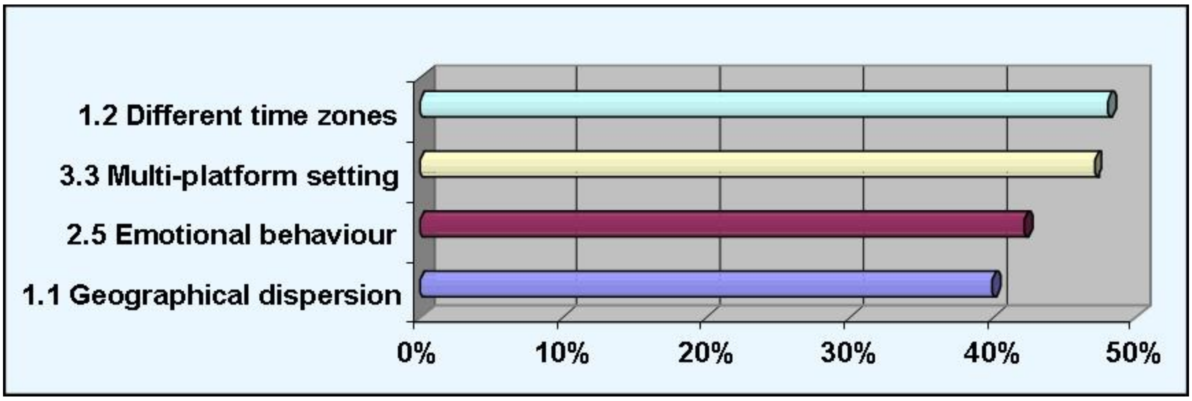


Figure 5.3: Minor Impact Barriers

Most of the respondents seemed to be convinced of the benefits of flexible work arrangements, such as remote working from home, travelling environment (e.g. train, plane or hotel), meeting place or event location. Such arrangements are already being implemented, often based on the motivation of cost-cutting and increased productivity due to less wasted time. For example, there is no need for the knowledge worker to travel every day to the office, as he could decide to carry out his tasks from his home office, customers' sites or even suppliers' premises. This has a clear benefit for the organisation in terms of cost-cutting and increased mobility, and for employees in terms of freedom and self-organisation.

In fact, a large majority of experienced people, such as the survey respondents, believe that future online shared workspaces will better integrate social, learning and work activities. This is due especially to flexible working time, allowing knowledge workers to decide to engage in social activities or take learning breaks over the Internet as needed.

5.1.4 Analysis per Collaborative Distance Dimension

The tables below present the various factors leading to collaboration barriers, organised according to the four dimensions of the Collaborative Distance Framework. In the first table, the corresponding collaborative distance types are indicated for all collaboration barriers categorised by dimensions (see Table 5.1).

Collaboration Barriers Factors	Collaborative Distance types	Dimensions
1.1 Geographical dispersion	Spatial	Structural
1.2 Different time zones	Temporal	
1.3 Unbalanced power	Configurational	
1.4 Unbalanced expertise	Configurational	
1.5 Multi-disciplinary setting	Organisational	
1.6 Lack of clear leadership	Organisational	
1.7 Lack of incentive	Institutional	
2.1 Lack of commons	Cultural	Social
2.2 Weak ties	Relational	
2.3 Lack of interpersonal awareness	Relational	
2.4 Multi-lingual setting	Lingual	
2.5 Emotional behaviour	Emotional	
2.6 Lack of mutual trust	Relational	
2.7 Diversity setting	Cognitive	
2.8 Lack of absorptive capacity	Cognitive	
3.1 Lack of media naturalness	Technological	Technical
3.2 Lack of common description	Conceptual	
3.3 Multi-platform setting	Referential	
3.4 Lack of meaning	Semantic	
3.5 Unbalanced technological usage	Technological	
3.6 Lack of contextualised mode	Contextual	
4.1 Unbalanced IPR approach	Ownership	Legal
4.2 Different investment regulations	Financial	
4.3 Different contractual settings	Contractual	
4.4 Lack of common security rules	Contractual	

Table 5.1: Collaboration Barriers and Corresponding Distance Types

In the second table, factors are rated according to the survey results. Factors are categorised as ‘most significant’ (value 3), ‘significant’ (value 2) or ‘less significant’ (value 1) in impeding collaboration performance (see Table 5.2). This gives a good indication of factors in each dimension that require further research and development.

From the table it appears that mutual trust, leadership and collaboration incentives require further improvement, for example the creation of new distributed and participative organisation forms or a trust model for collaboration and a set of incentives based on interpersonal rather than individual productivity. Even now, individual productivity is considered a holy grail by most organisations.

The table shows that geographical dispersion, and especially different time zones, are no longer considered as significant factors impeding collaboration performance. This is due to recent ICT improvements such as Internet broadband connection, Web tools and free communication via the Internet, which reduce or remove entirely the cost of distant communication.

Other factors too have become less significant because of progress in ICT and experience in using that technology to organise temporary physical collocation with social activities. This leads to the building of interpersonal relationships among participants at a more appropriate level of trust. The majority of factors are located within the previously discussed categories, especially in the social and legal dimensions, which require implementation of appropriate features within the current SW technology.

Factors	Dimensions	Most significant	Significant	Less significant
1.1 Geographical dispersion	Structural			X
1.2 Different time zones				X
1.3 Unbalanced power			X	
1.4 Unbalanced expertise			X	
1.5 Multi-disciplinary setting			X	
1.6 Lack of clear leadership		X		
1.7 Lack of incentive		X		
2.1 Lack of commons	Social		X	
2.2 Weak ties			X	
2.3 Lack of interpersonal awareness			X	
2.4 Multi-lingual setting			X	
2.5 Emotional behaviour				X
2.6 Lack of mutual trust		X		
2.7 Diversity setting			X	
2.8 Lack of absorptive capacity			X	
3.1 Lack of media naturalness	Technical		X	
3.2 Lack of common description		X		
3.3 Multi-platform setting				X
3.4 Lack of meaning		X		
3.5 Unbalanced technological usage			X	
3.6 Lack of contextualised mode			X	
4.1 Unbalanced IPR approach	Legal	X		
4.2 Different investment regulations			X	
4.3 Different contractual settings			X	
4.4 Lack of common security rules			X	

Table 5.2: Rating of Collaboration Barriers by the Survey Respondents

5.1.5 Structural Dimension

Two of the seven factors of the structural dimension, ‘lack of clear leadership’ and ‘lack of incentive’, were rated as the most significant collaboration barriers (see Figure 5.4: 3: most significant; 2: significant; 1: less significant) impeding collaboration effectiveness and efficiency. Two other factors, ‘geographical dispersion’ and ‘different time zones’, were rated as less significant barriers, meaning that the survey respondents were satisfied that they could overcome them with the use of appropriate ICT.

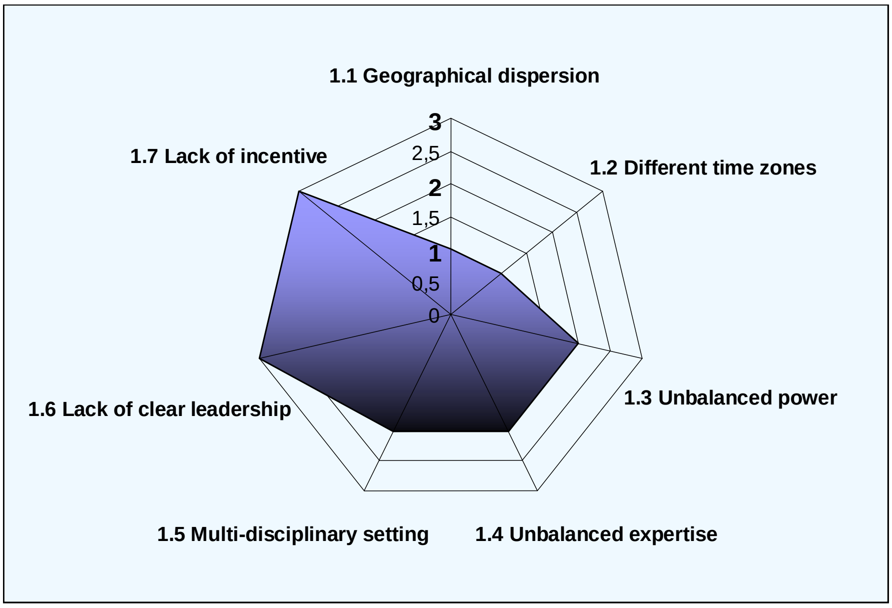


Figure 5.4: Rating of Collaboration Barriers of the Structural Dimension

The three remaining factors, ‘unbalanced power’, ‘multidisciplinary setting’ and ‘unbalanced expertise’, were rated as significant barriers that are not satisfactorily overcome by current techniques, methods and tools.

5.1.6 Social Dimension

Within the social dimension, lack of mutual trust was rated as the most significant factor impeding collaboration performance, especially effectiveness. Most of the other factors were rated as having a significant impact, but more specifically upon effectiveness rather than efficiency (see Figure 5.5: 3: most significant; 2: significant; 1: less significant). Finally, emotional behaviour was rated by the survey respondents as having a less significant impact.

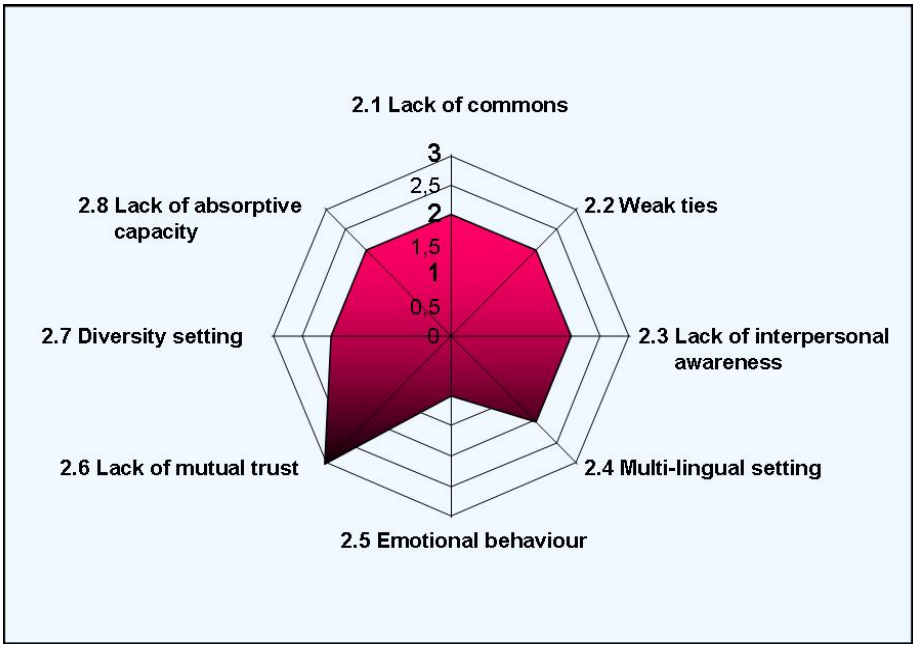


Figure 5.5: Rating of Collaboration Barriers of the Social Dimension

5.1.7 Technical Dimension

Within the technical dimension, lack of common description and meaning were rated as having the most significant impact on collaboration performance. Lack of commons corresponds to the notion of shared knowledge, while lack of meaning corresponds to the notion of sense-making (see Figure 5.6: 3: most significant; 2: significant; 1: less significant); together these form the basis for reaching a mutual understanding. It was previously argued by Roschelle (1992) that mutual understanding is the essence of collaboration. The remaining problem is to identify what constitutes the collaboration engine.

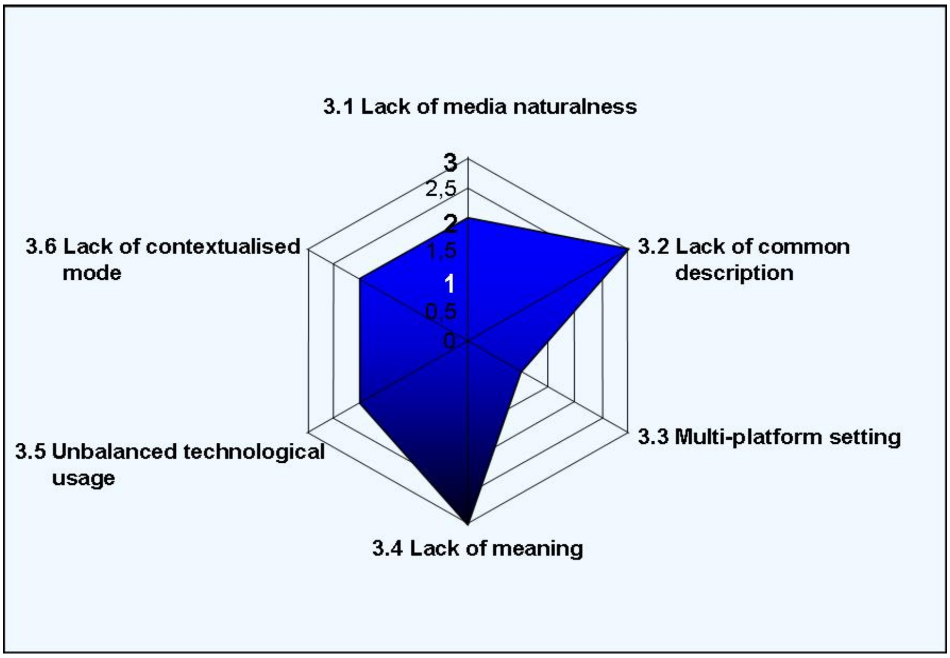


Figure 5.6: Rating of Collaboration Barriers of the Technical Dimension

By contrast one factor, 'multiplatform setting', was rated as having a less significant impact on collaboration performance, while the remaining three factors were, not surprisingly, rated as having a significant impact.

5.1.8 Legal Dimension

Within the legal dimension, the most prominent factor appears to be an unbalanced IPR approach, whereby collaborating partners have different approaches and objectives in terms of ownership. Among the experienced people who responded to this survey on collaboration barriers, this factor of ownership was perceived as one of the most significant impacts on collaboration performance (see Figure 5.7: 3: most significant; 2: significant; 1: less significant).

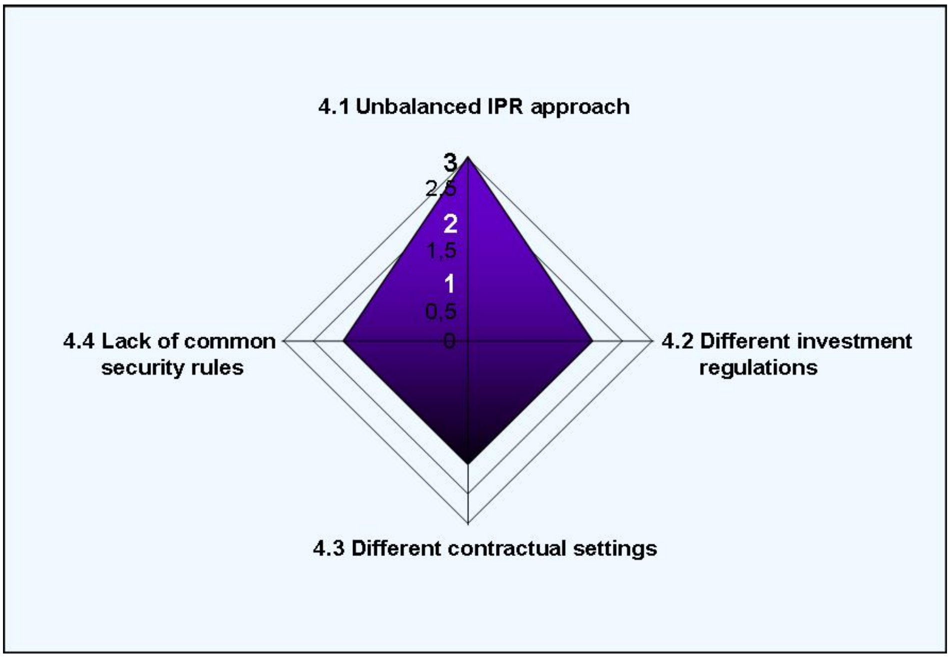


Figure 5.7: Rating of Collaboration Barriers of the Legal Dimension

Other factors such as shared security rules, contractual settings and investment regulations were rated as having a significant impact. However, it should be noted that all these factors directly impeded the effectiveness of collaboration rather than its efficiency (see Table 5.2).

5.2 Concluding Remarks on the Survey

Interestingly, this survey indicates that the most significant factors impacting collaboration performance impede effectiveness rather than efficiency. By contrast, the four factors rated in this survey as less significant impede efficiency, although two of them require ICT to solve the effectiveness aspect. One is considered to improve efficiency in the case of potential conflicts when emotional aspects are too deeply embedded in business activities.

It does seem logical that effectiveness factors are rated as most significant, because they determine the readiness for collaboration. For example, it is well known in the international project area that gathering participants from different countries, each of whom will have their own regional and institutional culture and language, creates a wide collaborative distance. In this context, collaboration effectiveness will not be ensured until they collectively decide to build a common culture and use a common vocabulary.

Efficiency factors relate more to technical and organisational support where appropriate methods, techniques and especially new ICT environments compress various distance types. Within the social and legal dimensions, there is currently a clear lack of ICT support. Hence there are plenty of opportunities to create innovative ICT tools and environments. With regard to the technical dimension, the two factors rated as most significant correspond to shared knowledge and meanings. These lead to mutual understanding, which is recognised as the essence of collaboration (Roschelle, 1992). From this we can infer that lack of mutual understanding implies a lack of collaboration effectiveness. Hence, it is unlikely to produce a successful collaboration.

5.3 Focus Group Analysis

5.3.1 Insight from the Focus Group Interviews

While the daily e-mail reporting systematic activity events was criticised by participants as flooding their e-mail boxes, they recognised the importance of being kept aware of what others were doing in real-time. In the same way, most of them acknowledged the usefulness of seeing progress through the evolving common project structure and growing number of documents.

Table 5.3 below presents the ratings for the use of collaboration tools for compressing or bridging the various distance types as expressed during the focus group interviews (FGI). The value model (from 3 to 0) for all distance types is as follows: fully compressed or bridged by the use of technology (value 3), only partially compressed or bridged (value 2), not satisfactorily compressed or bridged and collaboration technology simultaneously introduces other distance types (value 1), not at all compressed or bridged (value 0).

Distance types	Dimension	P01	P02	P03	P04	P05	P06	P07	P08	P09	P10	P11	P12	P13	P14
Configurational	Structural	3	2	3	3	2	3	2	1	2	2	1	2	2	3
Institutional		3	2	3	2	2	2	1	1	2	2	1	2	3	3
Organisational		3	2	3	2	2	2	2	1	1	2	2	2	3	3
Spatial		3	3	3	3	2	3	2	1	2	2	2	2	2	3
Temporal		3	2	3	3	2	3	2	1	2	2	1	2	2	3
Cultural	Social	2	2	2	3	2	3	1	1	1	2	1	2	2	2
Emotional		2	1	2	2	1	2	2	1	1	1	1	1	1	2
Lingual		2	1	3	2	2	2	3	1	3	2	1	1	2	3
Relational		2	2	2	2	2	2	1	1	2	2	1	2	3	3
Cognitive		2	2	3	2	3	3	3	1	2	2	1	2	3	3
Conceptual	Technical	2	1	2	2	1	1	2	1	2	2	1	2	3	3
Contextual		1	1	2	2	2	2	2	1	2	2	1	2	2	2
Referential		2	2	3	3	2	2	1	1	2	2	1	2	3	3
Semantic		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Technological		3	2	1	2	2	2	1	1	1	2	2	2	2	2
Ownership	Legal	2	1	1	2	2	1	1	1	2	2	1	1	1	2
Financial		1	1	1	1	1	1	1	1	1	1	1	1	1	1
Contractual		2	1	2	2	2	2	1	1	1	1	1	1	1	2

Table 5.3: FGI ratings for the Use of Technology for Compressing Distances

Project participants appreciated the obligation to use a common structure to upload their documents, as it enabled a shared set of concepts. However, they also criticised this aspect by saying that it would be valuable for each member to design his own structure in order to have a less cognitive workload.

They also appreciated the democratic aspect of an online Shared Workspace platform where all members had the same level of information and access to the same data without any risk of information retention. During focus group interviews, it was often stated that ‘everyone has access to up-to-date information’ without having to waste time asking other team members about the location of the latest version of a document. Hence one can infer that this technology has a positive impact on collaboration efficiency because it allows team members to have a shared and secure location where they can upload and share content objects in an effective and efficient way. This confirms the feeling expressed by most of the project teams regarding the benefit of using this technology in a physically or virtually collocated space.

In the discussion about preference for e-mailing over group blogging, it appeared that most of the participants preferred to use an instant messaging tool to support synchronous rather than asynchronous interactions. However, when necessary, they preferred e-mail rather than group blogging as an asynchronous communication tool, in particular because they had easier access to e-mail. They also claimed that uploading a document into the Shared Workspace by ‘drag and drop’ was faster, and much more reliable, than sending an attached document by email. A few participants did express an interest in group blogging to compile a project history and chronology of events. They also emphasised that the involvement of more external participants would have encouraged more teams to experience this blogging technology. Finally, a large majority of participants recognised the complementarily of Shared Workspace and group blogging technologies.

In terms of collaborative distance, almost all participants commented that these technologies were useful to overcome collaboration barriers by compressing distances, especially spatial, temporal and organisational distance types. They also declared that cognitive, relational, emotional and cultural distances were to some extent bridged. Although emotional and relational distance types were not heavily discussed during the interviews, they were mentioned as a way to start a relationship remotely with someone too shy for live interaction. One participant said that it helped to resolve a conflict, without stating clearly what kind of conflict.

While this empirical study confirms that technologies compress several types of collaborative distance, they can also introduce other types of distance because of the possible disparity in technology skills and lack of interoperability.

5.4 Cases Comparison

5.4.1 Introduction to Cases and Distance Factors

The analysis of data collected during the project cases confirmed the potential negative impact of distance factors on the process of reaching a mutual understanding. Individuals who cannot properly understand each other cannot operate as an effective collaboration team; hence, they cannot be efficient in achieving their group objectives. Clearly, distance factors impede mutual understanding and shared meanings that determine the capacity to build shared knowledge and collective or social intelligence for undertaking appropriate decisions.

Every time team members upload documents on their Shared Workspace, this leads to the sharing of explicit knowledge. Complementarily, when team members communicate through either face-to-face meetings or electronic audio means such as call or Web conferences, that leads to the sharing of tacit knowledge. By contrast, when they communicate tacit knowledge through electronic written means such as instant messaging, e-mailing, blogging and tagging, that tacit knowledge becomes progressively more explicit. This typically happens when individuals categorise or classify content objects in order to be able to find them more quickly without any significant cognitive load. This study revealed that team activities, such as defining and sharing the categorisation of content objects, involved consensus building among team members to reach a proper level of shared meaning and mutual understanding. The description of shared concepts necessitated the application of sense-making mechanisms. It also confirmed that individuals from the same discipline are able to quickly reach a mutual understanding because they use the same vocabulary and embedded meanings. Institutional distance factors such as migration tides and brand new techniques and tools can disable this ability, as explained by Nordstrom and Vahlne (1992), and Vahlne and Wiedersheim-Paul (1977). Often vocabularies evolve over time, which inevitably impedes the progress towards shared meanings and mutual understanding.

This study also intends to confirm another crucial benefit of sharing explicit and tacit knowledge among group members, whereby the more participants share knowledge, the higher their level of trust. As described by Luft and Ingham (1955), this sharing through exposing and soliciting feedback, increases the size of the 'arena', the area of mutual understanding. The larger the arena, the more productive the interpersonal relationship. Hence this is considered a progressive cognitive mechanism to build trust among participants.

In addition to examining how collaboration technology and tools compress the well-known spatial and temporal distance types, one of the objectives of this study is to explore how far technologies such as online Shared Workspace and group blogging contribute to overcome other collaboration barriers in compressing or bridging other distance types.

5.4.2 A Synthetic View on All Project Cases

The table below presents an integrated synthetic view of collected data for each project case as introduced in the previous chapter. Project teams comprised four to six team members from different disciplines, plus external participants such as representatives of project customers and external experts. A quarter of the participants were located in the Virtual Reality Centre in Laval. The other three quarters were located in Angers; of these, one third specialised in Agro-Biology, another third in Strategic Information and another in Innovation Management.

Projects	Members	Folders	Files	Files/Folders	Blog Entries	Project Event	Events/Memb	Doc Events	Create	Update	Read
P01	5	12	69	5.8	8	403	80.6	208	69	1	138
P02	4	8	55	6.9	4	252	63	104	55	0	49
P03	6	17	36	2.1	3	358	59.7	156	50	0	106
P04	5	10	32	3.2	16	307	61.4	108	51	10	47
P05	7	10	52	5.2	2	323	46.1	178	50	4	124
P06	8	20	81	4.1	14	478	59.8	147	72	4	71
P07	7	3	11	3.7	7	113	16.1	33	11	0	22
P08	6	1	1	1	3	39	6.5	5	1	0	4
P09	5	2	7	3.5	3	109	21.8	31	7	2	22
P10	4	7	25	3.6	3	146	36.5	41	25	2	14
P11	5	4	10	2.5	2	75	15	28	10	0	18
P12	4	5	21	4.2	4	113	28.3	51	21	1	29
P13	4	14	36	2.6	3	190	47.5	68	28	9	31
P14	9	17	28	1.6	7	308	34.2	92	35	0	57
Total	**79**	**130**	**464**	**3.6**	**79**	**3214**	**40.7**	**1250**	**485**	**33**	**732**

Table 5.4: Resulting Log Data for the 14 Project Cases

Altogether there were 79 registered participants contributing with six external experts to the 14 project cases (see Table 5.4). Project participants used desktop computers available in the computer rooms when they were physically present at ISTIA Innovation (University of Angers) in Angers and Laval. They used laptops during meetings taking place outside ISTIA Innovation and their own desktop computer or laptop when working from home or other remote locations. On the one day per week (project day) when project participants were collocated at the university, spatial distance and temporal distance did not necessarily exist, except when some of them were dedicated to specific tasks taking place outside ISTIA Innovation. The project day was not necessarily the same for all Master's degree students.

Folders and Files

The bar graph (Figure 5.8) below presents the project members with their corresponding folders, files and blog entries in their online project Shared Workspace. Files were the content objects or documents used or produced during the various project tasks. This figure shows three categories of cases:

- Non Representative Cases < 20 files: P07, P08, P09 and P11
- Average Representative Cases > 20 files and < 50: P03, P04, P10, P12, P13, P14
- High Representative Cases > 50: P01, P02, P05 and P06

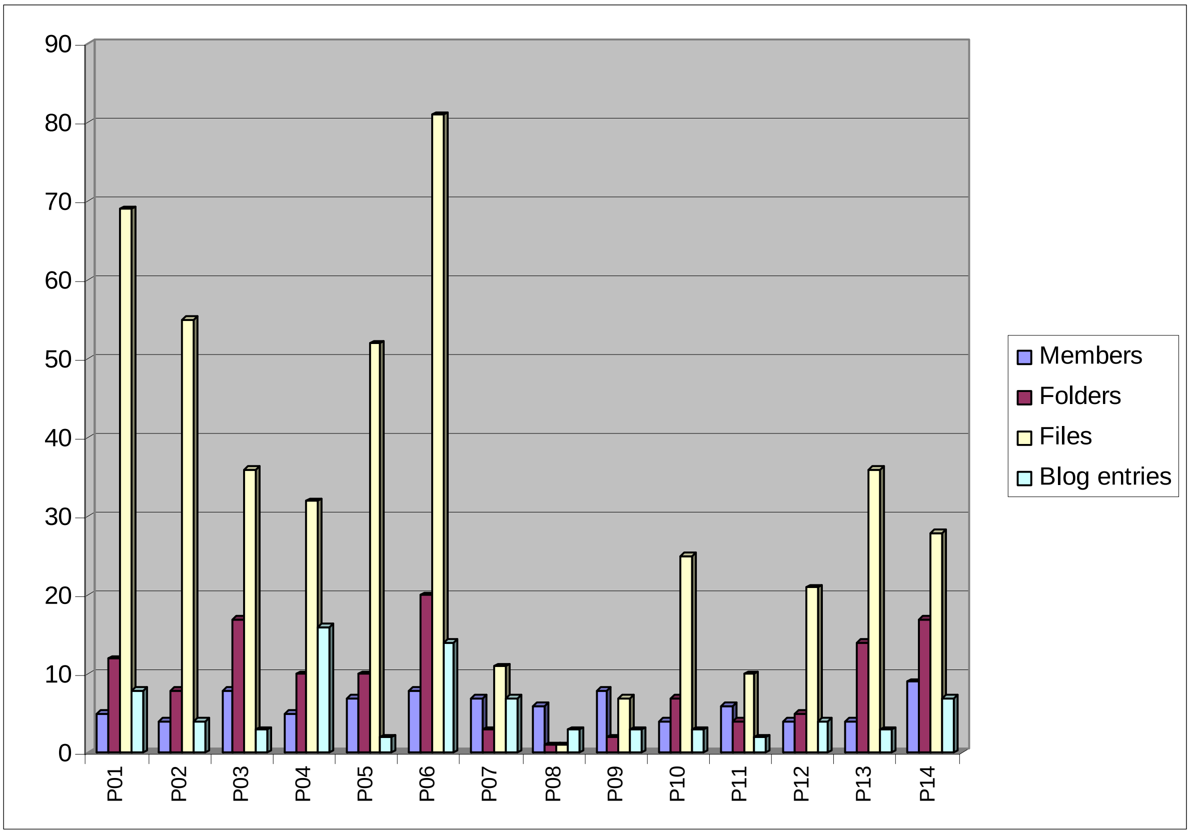


Figure 5.8: Bar Graph of All Project Cases Production

The low number of files in 'Non Representative Cases' (NRC) makes any log data analysis of the creation of folders and documents difficult. This is especially true for P08, which produced just one file and one folder, indicating that this project team did not actually use the online Shared Workspace tool. For the other NRC, the number of files ranged from seven to eleven documents, again too low to take their log data into consideration.

The 'Average Representative Cases' (ARC), which had from 21 to 36 files and from 5 to 17 folders, can be recognised as being sufficiently populated in terms of containers and content objects for analysis.

The 'High Representative Cases' (HRC), with from 52 to 81 files and from 10 to 20 folders, can be recognised as being highly populated in terms of containers and content objects for analysis.

Project Events

The bar graph (Figure 5.9) below represents the project events and corresponding document events generated in the online project Shared Workspace. Project events represent operations such as creating a folder and inviting members. Document events correspond to create, update and read events generated by users when accessing content objects. This figure shows four categories of cases:

- Non Representative Cases < 50 events: P08
- Low Representative Cases > 50 & < 150 events: P07, P09, P10, P11 and P12
- Average Representative Cases > 150 & < 300 events: P02, P04 and P14
- High Representative Cases > 300 events: P01, P03, P05 and P06

The low number of project events in 'Non Representative Cases' (NRC) makes any log data analysis difficult. This is especially true for P08, which produced only 39 events, confirming that this project team did not use the online Shared Workspace tool.

The 'Low Representative Cases' (LRC), which had from 50 to 150 project events, can be recognised as being sufficiently populated for analysis.

The ‘Average Representative Cases’ (ARC), with from 150 to 300 project events, can be recognised as being appropriately populated for analysis.

The ‘High Representative Cases’ (HRC), which had from 300 to 500 project events, can be recognised as being highly populated for analysis.

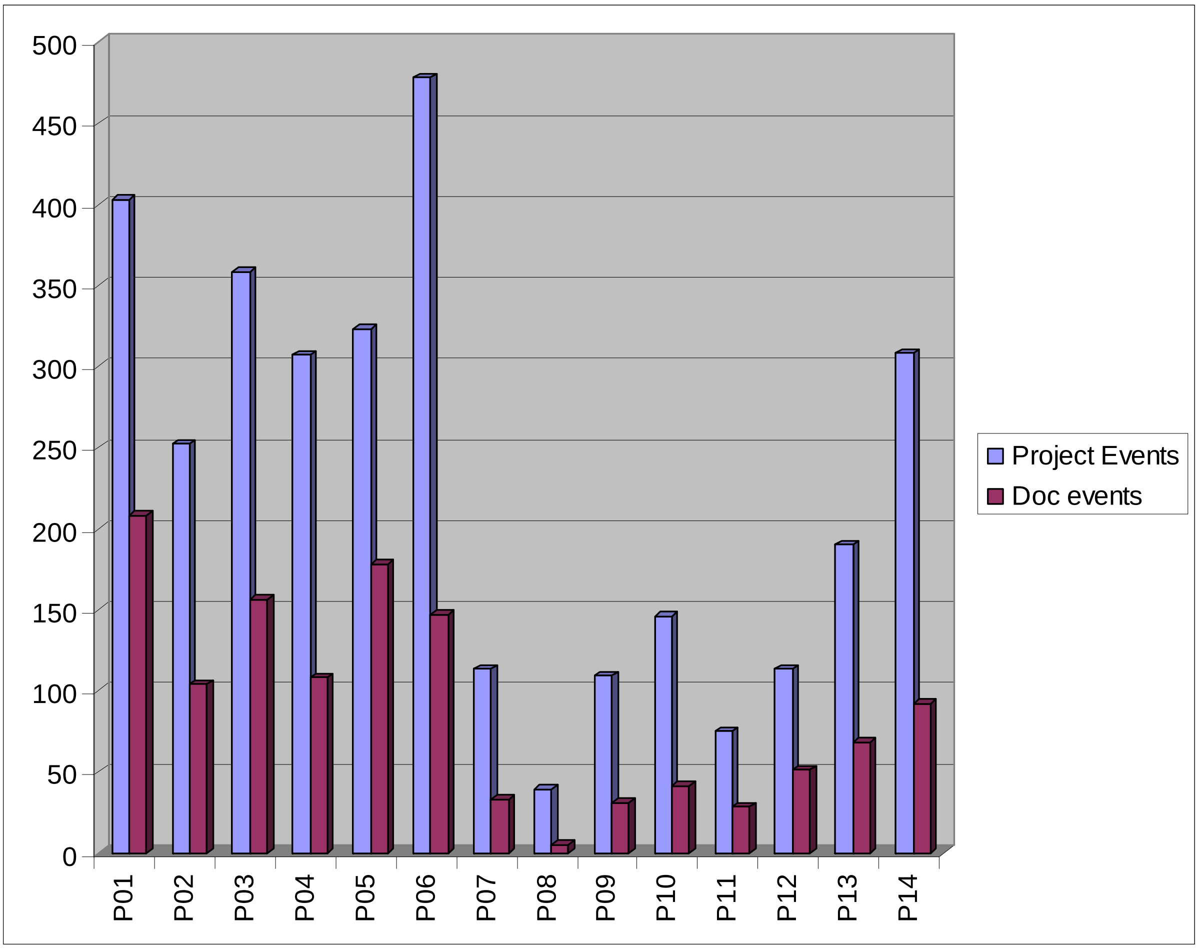


Figure 5.9: Bar Graph of All Project Cases Events

Create, Update & Read Events

The bar graph (Figure 5.10) below represents the document operation events in each online project Shared Workspace. Operation events generated within an online project SW represent operations such as creating, updating and reading a content object. The figure shows four categories of cases:

- Non Representative Cases < 50 events: P07, P08, P09, P10 and P11

- Low Representative Cases > 50 & < 100 events: P12, P13 and P14
- Average Representative Cases > 100 & < 150: P02, P04 and P06
- High Representative Cases > 150: P01, P03 and P05

The low number of operation events in 'Non Representative Cases' (NRC) makes any log data analysis difficult. This is especially true for P08, which had only 5 events, confirming that this project team did not use the online Shared Workspace tool.

The 'Low Representative Cases' (ARC), which had from 50 to 100 project events, can be recognised as being sufficiently populated for analysis.

The 'Average Representative Cases' (ARC), which had from 100 to 150 project events, can be recognised as being appropriately populated for analysis.

The 'High Representative Cases' (HRC), which had from 150 to 210 project events, can be recognised as being highly populated for analysis.

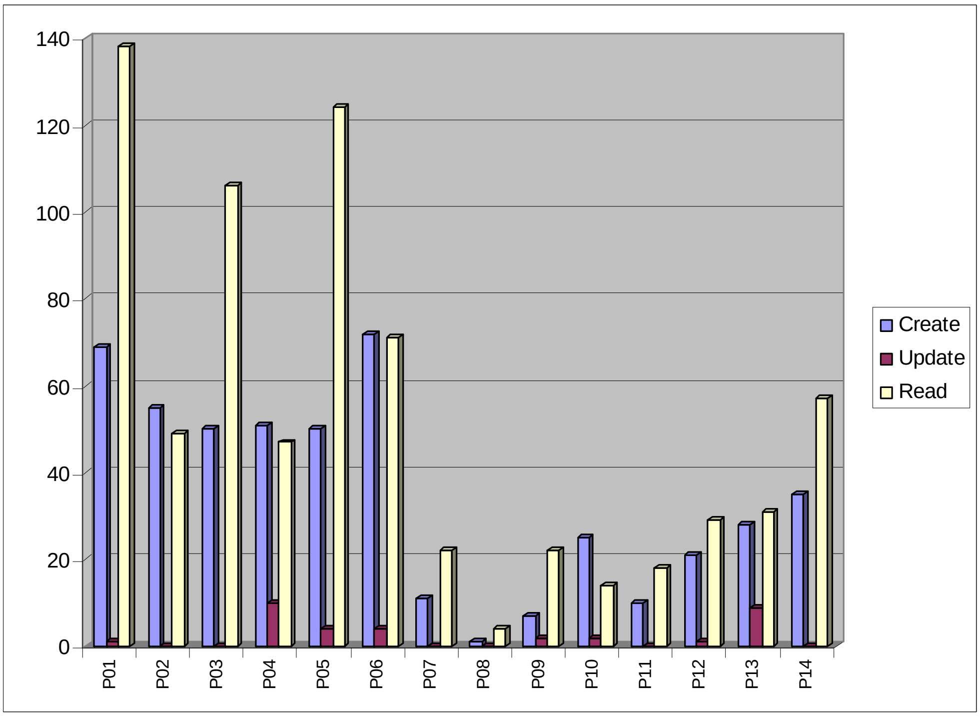


Figure 5.10: Bar Graph of All Project Cases Create, Update and Read Events

5.4.3 Analysis of Project Cases

Within this case comparison, it is proposed to define a set of elements (various project team activity types) for evaluating the impact of various distance factors on the elaboration of shared meaning and mutual understanding. All elements presented in the table below (see Table 5.5) are related to one or more collaborative distance dimensions.

- Value = 0: No real activity
- Value = 1: Low activity level
- Value = 2: Average activity level
- Value = 3: High activity level

Projects	Central storage	Classification	Structuration	Usage types	Interaction	Activity model	Blogging
P01	3	1	3	3	3	1	2
P02	3	1	2	2	3	1	1
P03	2	3	3	3	3	3	1
P04	2	2	2	3	3	1	2
P05	3	1	2	3	2	2	1
P06	3	2	3	3	3	1	2
P07	1	2	1	2	1	2	2
P08	0	0	1	1	1	1	1
P09	0	2	1	2	2	3	1
P10	1	2	2	2	2	2	1
P11	1	2	1	1	1	1	1
P12	1	2	2	2	2	1	1
P13	2	2	3	2	2	3	1
P14	1	3	3	3	2	3	2

Table 5.5: Level of Project Team Activity for Each Category

However, it should be noted that project case P08 chose to use another SW platform, from which it was unfortunately not possible to get a log file to collect usage data. This project team is a special case since they uploaded only the resulting final deliverables on the SW platform.

The correlation between the different collaborative distance types and activity types from all project teams are presented in the table below (see Table 5.6):

- 'Central storage' shows the degree to which each project group shared documents to overcome configurational, organisational, spatial and temporal distances that are part of the structural dimension.

Distance types	Dimension	Central storage	Activity model	Classification	Structuration	Usage types	Interaction	Blogging
Configurational	Structural	X		X		X		X
Institutional			X					
Organisational		X		X	X	X		
Spatial		X				X	X	X
Temporal		X				X	X	X
Cultural	Social		X	X	X			
Emotional								X
Lingual			X					X
Relational			X				X	X
Cognitive			X	X	X		X	X
Conceptual	Technical		X	X	X		X	
Contextual			X			X		X
Referential			X				X	
Semantic								
Technological		X						X

Table 5.6: Correlation of Distance Types with Activity Types

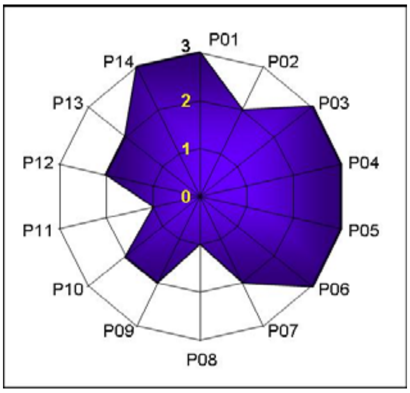
- 'Activity model' reveals the degree to which each project group discussed and agreed on the use of a common project process in terms of a functional model used for producing Pert and Gantt diagrams. This element is strongly related to the overcoming of configurational and organisational distances because it specifies who is responsible for producing which outputs. At the same time, this provides the basis for constituting groups of individuals corresponding to task allocation, which induces necessary interactions. This should help to overcome relational, cultural and lingual barriers. The formalisation of a functional activity model provides a useful concept mapping which bridges cognitive, referential, contextual and conceptual distances.

- 'Classification' shows the degree to which each project group discussed and agreed on the approach to categorise shared documents in order to bridge configurational, organisational, cultural, cognitive and conceptual distances.
- 'Structuration' presents the degree to which each project group discussed and agreed on structuring Shared Workspace folders horizontally or vertically in order to bridge organisational, cultural, cognitive and conceptual distances.
- 'Usage type' reveals the degree to which each project group used its online project Shared Workspace to bridge configurational, organisational, space, time, cultural, cognitive, conceptual and contextual distances.
- 'Interaction level' reveals the degree to which each member of each project team accessed shared documents in order to bridge distances of space and time. Interactions taking place among team members bridged cultural and relational distances by progressively building ties, hence bringing more confidence and trust among group members based on each individual's contribution to shared information and knowledge. Furthermore, the use of shared document structuration and concepts contributed to shorter cognitive, conceptual, and referential distances.
- 'Blogging level' reveals the degree to which each member of each project team asynchronously communicated information related to the project, which bridged

configurational, spatial and temporal distances as well as cultural, lingual, relational, emotional and cognitive distances, but also contextual and technological distances.

5.4.4 Shared Workspace Tool

Collected data show that, in some cases, team members were intensively using their project Shared Workspace, where they uploaded most if not all the documents they used or created. In other cases, teams made only minimal use of their project Shared Workspace. It is possible to identify three main types of cases, corresponding to minimal, higher, and more intensive use of the project Shared Workspace.



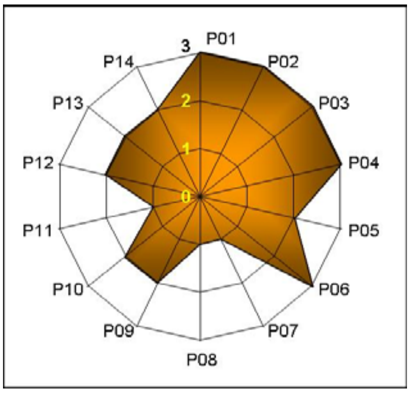
Usage Level

Usage types:

- Value = 1: Low: 10 < Minimum Usage < 100: P08 and P11
- Value = 2: Medium: 100 < Appropriate Usage < 300: P02, P07, P09, P10, P12 and P13
- Value = 3: High: 300 < Intensive Usage: P01, P03, P04, P05, P06 and P14

5.4.5 Interaction on Documents

The ratio of events divided by the number of members indicates the interaction level per member within each project team. It is possible to identify three main types of interaction level: low, medium and higher, as follow:



Activity Level

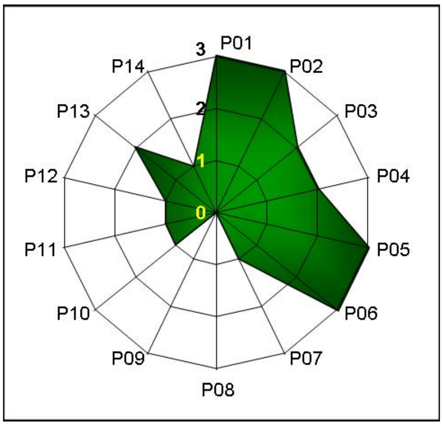
Interaction levels:

- Value = 1: Low: 5 < Minimum Activity < 20
- Value = 2: Medium: 20 < Appropriate Activity < 60

- Value = 3: High: 60 < Intensive Activity

5.4.6 Shared Project Storage

Log data also provides an indication as to whether a team used their project Shared Workspace as a kind of central storage, allowing team members immediate access to up-to-date shared documents whenever necessary and from any location through an Internet connection. This central storage on the SW was the only way in which team members could share documents remotely. The number of files uploaded into their SW clearly indicates whether a team benefited from the online central storage. In a structured approach, three main levels of central storage were defined. In the figure, the first level indicates non-usage, the second corresponds to an appropriate usage, while the third level relates to a more solid usage.

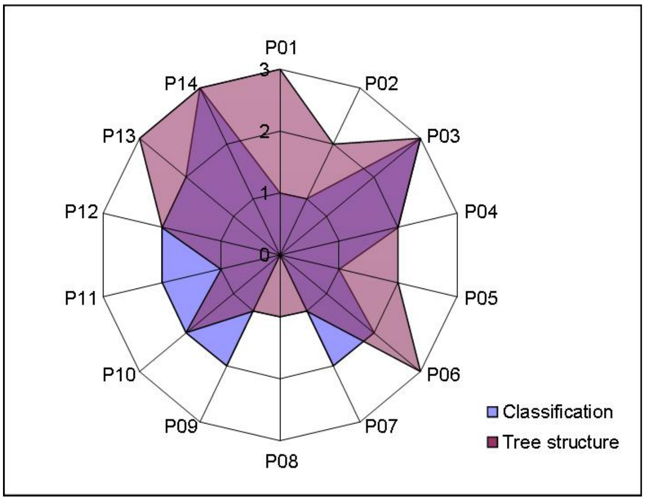


Usage Type

Central Storage:

- Value = 1: Low: 10 < Insignificant usage < 30
- Value = 2: Medium: 30 < Appropriate usage < 50
- Value = 3: High: 50 < Solid usage

5.4.7 Document Classification and Structuration



Classification and Structuration Levels

Interestingly, most of the project teams adopted a folder tree structure for the classification of the documents. However, team members did not spontaneously share the same view regarding the most appropriate structure. Some of them classified documents according to their maturity level, while others classified on the basis of project work packages. This observation leads to the conclusion that it might be better to personalise the structure of the folders according to individuals' preference. Nonetheless, it is possible to identify three main levels of document classification based on the tree structure of folders. The first level represents a flat level without any tree structure; the second corresponds to a tree structure of a single layer of folders, while the third level represents a double layer of folders.

Classification:

- Value = 1: Low (Reasonable): 5 < ratio documents/folders < 7
- Value = 2: Medium (Dense): 2 < ratio documents/folders < 5
- Value = 3: High (Very Dense): ratio documents/folders 2

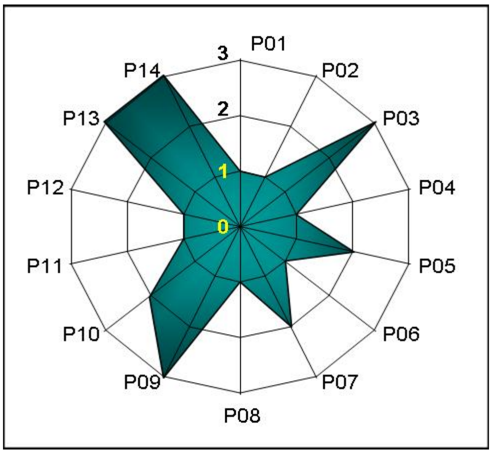
Structuration:

- Value = 1: Low: Depth = 0
- Value = 2: Medium: Depth = 1
- Value = 3: High: Depth = 2

5.4.8 Shared Workspace Folder Labels

All project cases developed Activity Functional Diagrams that represent the agreed activity model of the project process. Each team started with a context diagram specifying the provided inputs and expected outputs of the project. They had the opportunity to specify resources, as well as some specific constraints representing potential controls. From the context diagram, they prepared a tree diagram representing the various levels of decomposition diagrams. Finally, they derived a first decomposition level diagram from the context diagram. Based on context and first decomposition diagrams, they then derived the second level of decomposition diagrams from the various activity boxes represented within the first decomposition level.

As expected, team members did not all see their project process in the same way. There were as many views as participants. Their first job was to reconcile these different views and considerations into a single agreed process view. In some cases this discussion was dominated by a strong personality. In other cases the discussion was more participative. Unfortunately, the polling function of the Shared Workspace tool was not used by any of the groups; hence there were no log data available from decisions taken by project teams.



Folders Structure

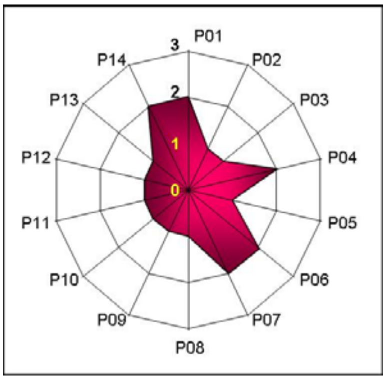
With regard to the alignment of the project process with the structuration of the project SW, there was a great deal of discussion within most of the groups. Some team members had folder names reflecting project activities included in the project process (e.g. work package names, task names), while others had a folder name which corresponded to the level of completion of documents (e.g. draft, final). Other teams decided to name folders according to the type of documents (e.g. final report, activity diagrams). Several project teams ended up with a combination of the above approaches.

Activity Model:

- Value = 1: Type = 1: folder names based on the type of documents
- Value = 2: Type, Activity & Maturity = 3: folder names based on the maturity level of documents
- Value = 3: Activity = 2: folder names based on activity names given in the IDEF0 diagram

5.4.9 Asynchronous Communication

Communication among project team members was based mainly on regular face-to-face meetings and the use of online communication tools, both synchronous and asynchronous, such as instant messaging (MSN) and e-mailing (Outlook). A new online communication capability was provided through the group blogging that was available directly within the Shared Workspace tool. Most of the FGI participants declared during the interviews that they were not aware of the availability of a group blogging tool, although the group blogging technique was mentioned during a specific course on collaboration tools. It was presented as semi-private blogging for groups such as project teams, in contrast with traditional individual blogging tools. It was also explained that group blogging provides the capacity for team members to write blog entries and to comment on entries created by others. However, it appeared that team members did not spend much time trying this new collaboration tool.



Group Blogging

Group Blogging:

- Value = 1: Low: 1 < number of entries < 5
- Value = 2: Medium: 5 < number of entries < 20
- Value = 3: High: 20 < number of entries

5.4.10 Insight from Log Data

Project team profiles were elaborated with the log data collected on the Shared Workspace platform. Each project team profile was based on the measured activity level of created documents, generated events and registered users. The values in the table below (see Table 5.7) correspond to the computed profile of each project team according to activities that corresponded to each distance type mentioned in Table 5.5 and Table 5.6. Such computed profiles are intended to indicate the extent to which different distance types have impacted the activity level of project teams. The applied rule is: '*The higher the measured activity level, the less significant the impact of the distance type.*' By contrast: '*The lower the measured activity level, the more significant the impact of the distance type.*'

A radar graph was then produced for each distance type, integrating the activity level of the different project teams, as the goal was not to evaluate the performance of each project team but rather to evaluate the impact generated by the various collaborative distance types. These radar graphs are used in the next chapter to compare what focus groups stated in terms of distance types with what they had actually done.

It should be noted that four distance types, including three from the legal dimension, did not get any team profile because there were no relevant collected data. For example, there was no ontology based activity that could justify a profile for the semantic distance type. Similarly, there was no activity dedicated to, or at least relevant to, ownership, financial or contractual distance types. This explains the label 'not applicable' given to these specific distance types.

Distance	Dimensions	Project P01	Project P02	Project P03	Project P04	Project P05	Project P06	Project P07	Project P08	Project P09	Project P10	Project P11	Project P12	Project P13	Project P14
Configurational	Structural	2,25	1,75	2,25	2,25	2,00	2,50	1,75	0,50	1,25	1,50	1,25	1,50	1,75	2,25
Institutional		1,67	1,33	3,00	1,67	1,67	2,00	1,67	0,67	2,00	2,00	1,33	1,67	2,67	3,00
Organisational		2,50	2,00	2,75	2,25	2,25	2,75	1,50	0,50	1,25	1,75	1,25	1,75	2,25	2,50
Spatial		2,75	2,25	2,25	2,50	2,25	2,75	1,50	0,75	1,25	1,50	1,00	1,50	1,75	2,00
Temporal		2,29	1,86	2,57	2,14	2,00	2,43	1,57	0,71	1,57	1,71	1,14	1,57	2,14	2,43
Cultural	Social	2,75	2,25	2,25	2,50	2,25	2,75	1,50	0,75	1,25	1,50	1,00	1,50	1,75	2,00
Emotional		2,00	1,00	1,00	2,00	1,00	2,00	2,00	1,00	1,00	1,00	1,00	1,00	1,00	2,00
Lingual		1,50	1,00	2,00	1,50	1,50	1,50	2,00	1,00	2,00	1,50	1,00	1,00	2,00	2,50
Relational		2,00	1,67	2,33	2,00	1,67	2,00	1,67	1,00	2,00	1,67	1,00	1,33	2,00	2,33
Cognitive		2,00	1,60	2,60	2,00	1,60	2,20	1,60	0,80	1,80	1,80	1,20	1,60	2,20	2,60
Conceptual	Technical	1,75	1,25	2,50	1,75	1,50	2,00	1,75	0,75	1,75	1,75	1,25	1,50	2,25	2,75
Contextual		2,00	1,33	2,33	2,00	2,00	2,00	2,00	1,00	2,00	1,67	1,00	1,33	2,00	2,67
Referential		2,00	2,00	3,00	2,00	2,00	2,00	1,50	1,00	2,50	2,00	1,00	1,50	2,50	2,50
Semantic		1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Technological		2,50	2,00	1,50	2,00	2,00	2,50	1,50	0,50	0,50	1,00	1,00	1,00	1,50	1,50

Table 5.7 : Estimated Values of Project Activity Level Corresponding to Each Distance Type

5.4.11 Insight from Cases Log Data and FGI Data Overlap

The analysis of the 14 FGI was conducted in order to identify the respective level of perceived impact for each focus group, while the analysis of the SW platform log data of the 14 project cases led to the production of a specific radar graph for each distance type as a measured impact. By selecting the same type of graph with the same scale for evaluating the impact of each type of collaborative distance on the 14 focus groups (FGI) and on the corresponding 14 project cases (LD), it was possible to compare the perceived and measured impacts, shown by the overlapping of the respective FGI and LD radar graphs. The correlation with the outcome of the survey is clear, because each dimension with its respective distance types corresponds to one or more collaboration barriers, confirming the previous comparison.

5.5 Introducing the Evaluation of Collaborative Distance

The following sections discuss the evaluation for each collaborative distance type as perceived by the project teams (FGI) and as interpreted with the activity level (LD). The results are presented in radar graphs with FGI and LD overlapped shapes, since this is the most appropriate graphic representation to get an intuitive overview of how a distance type was compressed or bridged to overcome collaboration barriers. According to the scale in the radar view, 'the higher the value, the more the distance type was compressed or bridged'. By contrast, 'the lower the value, the less the distance type was compressed or bridged'.

Possible values for each project case (FGI or LD shape) in the radar graphs are as follow:

- Value = 3: This distance type was fully compressed or bridged.
- Value = 2: This distance type was only partially compressed or bridged.
- Value = 1: This distance type was not satisfactorily compressed or bridged and collaboration technology simultaneously introduced other distance types.
- Value = 0: This distance type was not at all compressed or bridged.

The following radar graphs present two overlapping shapes for each distance type. The shape in the background corresponds to the interpretation of the data collected during the focus group interviews (FGI). The one in the foreground corresponds to the interpretation of the data collected on the Shared Workspace platform (LD).

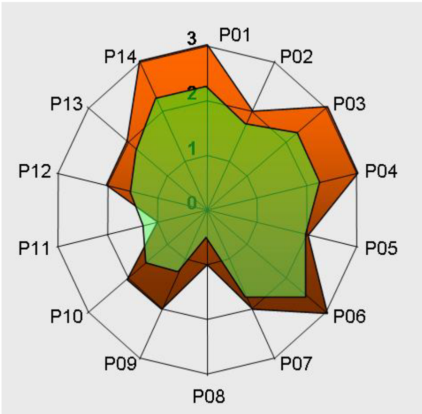
When the FGI and LD shapes are homothetic with a dilation or contraction remaining in the same value, the two shapes are similar. If the FGI and LD shapes are similar then the recorded activities on the Shared Workspace (LD) are estimated as correlating to the findings of the interviews (FGI). In other words, this confirms that participants did actually do (LD) what they said they had done (FGI).

The dilation or contraction of the FGI shape, in the event of similarity with the LD shape, provides some insight about whether the project team was optimistic (dilation) or pessimistic (contraction).

5.6 Structural Dimension

5.6.1 Configurational Distance

In contrast to the outcome of the survey on collaboration barriers, all the project teams except two (P08 and P11) declared that they were not impacted by the barrier 'unbalanced power'. This is explained by the fact that project teams made up of students do not face a hierarchical context in the decision process. They were more impacted by the barrier 'unbalanced expertise', since they had to partly revise their choices based on guidance and suggestions by external experts and reviewers.

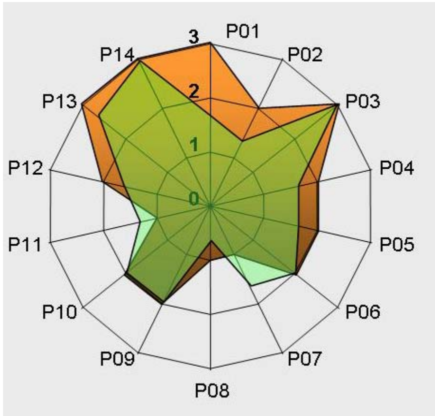


Configurational Distance Radar Graph FGI and Log-data shapes

Interestingly, there is no big contrast between the FGI and LD radar profiles because their shapes are homothetic enough to be considered similar. However, it should be noted that the dilation of the FGI shape compared with the LD shape reveals that interviewees were optimistic. Clearly, their level of activity was lower than they had claimed during the interviews. However, the measured level of activity from the log data is an average estimation of several activity types that are considered to be impacted by configurational distance (see Table 5.4).

5.6.2 Institutional Distance

Most of the project teams found that they were not highly impacted by factors related to national or regional institution culture. However, several teams reported during the interviews that factors such as collaboration styles, behaviour and incentives were not understood and appreciated among all participants in the same way. During the first project review, they realised that customer satisfaction is a vital project objective that should be part of team culture. This was interpreted by several project teams as a need to have motivation and incentive truly shared among participants.



Institutional Distance Radar Graph FGI and Log-data shapes

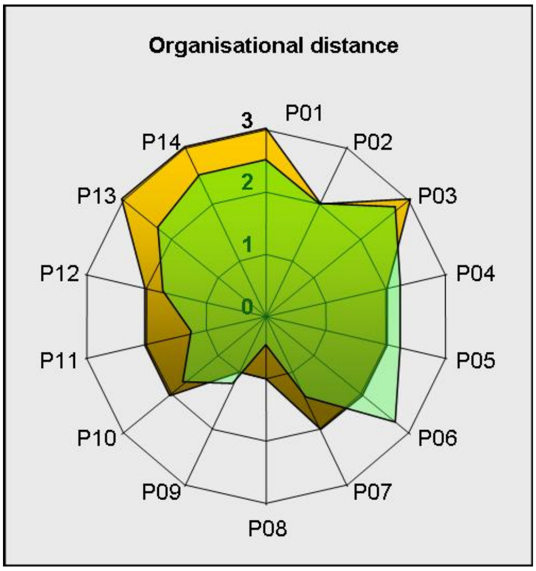
Observation of the FGI values compared to those of the LD shapes reveals some contrasting situations, especially for P01 and P02. This situation is explained by the basic folder labels used by these two teams, highlighting the difficulties faced in agreeing on a more elaborated model, due to institutional factors such as different education, culture, collaboration styles and behaviour. Furthermore, the dilation of the FGI shapes compared with the LD shapes reveals that P01 and P02 interviewees were much too optimistic.

Interestingly, ‘lack of incentive’ was rated by the survey respondents as the third most significant barrier; while with the exception of P08 and P11, project participants reported that even where collaboration styles, behaviour and incentives were not identical, ‘lack of incentive’ did not have a significant impact.

5.6.3 Organisational Distance

Observation of the values corresponding to the LD shape reveals that only two of the teams, P03 and P06, had a maximum score on the corresponding activity levels. The value ratio of activities potentially impacted by organisational distance, such as central storage, classification, structuration and usage, shows that eight project teams had an average level of activity.

Four project teams concluded that organisational distance was properly bridged through the use of both activity modelling and Shared Workspace. In contrast, two project teams, P08 and P09, estimated that this distance type was not properly addressed. Overall, the FGI and LD radar shapes are sufficiently homothetic to be considered similar. The dilation of the FGI shape, compared with the LD shape, reveals that eight project teams were optimistic during the interviews. By contrast, the dilation of the LD shape shows that three project teams were pessimistic.

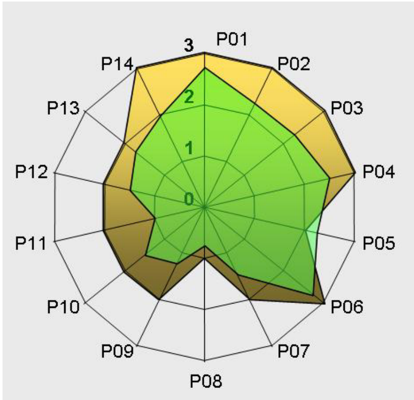


Organisational Distance Radar Graph FGI and Log-data shapes

'Multidisciplinary setting', rated by the survey respondents as a significant barrier, did not greatly impact project teams, except P09 and P08. This was explained during the interviews as a benefit of using both activity modelling and Shared Workspace, which ensured an appropriate level of mutual understanding among project participants. While 'lack of leadership' was rated by the survey respondents as the most significant barrier, project teams did not report any problematic situations during the interviews. The fact that each project team had elected its own project, work package, task and deliverable leaders confirms the rule that distributed collaboration demands more leadership and not less (based on Lipnack and Stamps' findings on Virtual Teams). Finally, it is worth noting that project coordination was satisfactorily conducted by the respective project leaders.

5.6.4 Spatial Distance

Six project teams stated during the interview that they were satisfied with the level of compression of the spatial distance, because the current available ICT contributed quite well to overcoming the barrier of geographical dispersion (see the FGI shape. However, seven project teams said that spatial distance was only partially bridged, because the lack of media-naturalness and unbalanced technological usage created technological distance. The media naturalness theory introduced by Kock and D'Arcy (2002) explains that this phenomenon of frustration occurs because not all human senses are engaged in online (e.g. video, Web) conferencing. In particular, this point highlights the weakness in synchronous communication when it occurs through the use of the current available technology. Furthermore, the project teams mentioned that the use of the SW platform introduced social distance types such as the lack of a shared social space.



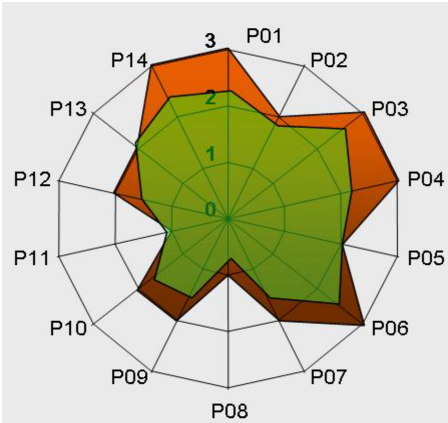
Spatial Distance Radar Graph FGI and Log-data shapes

'Geographical dispersion' was rated by survey respondents as one of the least significant collaboration barriers. While finding that unbalanced technological usage and lack of media-naturalness are consequences of using ICT in this situation, this study confirms that the spatial distance type is satisfactorily compressed when participants are sufficiently trained.

Observation of the values corresponding to the FGI and LD shapes shows that a majority of project teams (six) have an average level of activity. There is no large contrast between the FGI and LD radar profiles because their shapes are homothetic enough to be considered similar. However, it should be noted that the dilation of the FGI shape compared with the LD shape reveals that interviewees were optimistic.

In contrast with the findings of our survey, Cummings and Kiesler (2003), based on a previous study on multidisciplinary distributed collaborations, argued that spatial distance had a negative impact on both collaboration effectiveness and efficiency due to difficulties faced in communication and coordination. However, communication and collaboration technologies have rapidly evolved, so that, for example, the WEB 2.0 has brought social computing (Hoschka & Prinz, 1998) into higher usage through social networking and online mass collaboration (e.g. Wikipedia).

5.6.5 Temporal Distance



Temporal Distance Radar Graph FGI and Log-data shapes

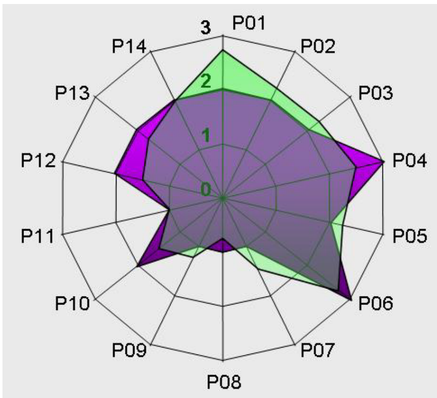
Five project teams declared themselves satisfied with the level of compression on this distance type because available ICT, especially all asynchronous technologies, contributed significantly to overcoming the potential impact of temporal barriers. By contrast, seven project teams had a different perception, declaring only a partial bridging of this distance type. While it was repeated that the use of the SW platform introduced other distance types such as social and technological distances, only two project teams, P08 and P11, declared that this distance type was not bridged at all. This could be explained by their low level of usage of the Shared Workspace platform. However, it should be noted that people operating within different time zones cannot have synchronous communication. This means that all interactions must be conducted asynchronously, as in the context of mass collaboration when people contribute to Wikipedia. To be successful in overcoming this distance type all project stakeholders operating in an asynchronous way must be properly trained and experienced.

The barrier 'different time zones' was rated by survey respondents as one of the less significant collaboration barriers. This study confirms that a temporal barrier could be overcome by the current available technologies. The extensive use of technologies simultaneously introduced social and technological distances, which could be partly bridged by appropriate training and temporary physical collocation with social activities to enable ties among team members.

5.7 Social Dimension

5.7.1 Cultural Distance

Only two project teams, P04 and P06, said that cultural distance was properly bridged by the Shared Workspace creating a common culture in terms of project coordination and monitoring, and ICT usage. However, it should be noted that because participants within these two focus groups originated from the same region, they had a common homogeneous cultural profile. This could explain their appreciation, in contrast with the survey finding that 'lack of commons', a cultural distance type, was rated as a significant barrier. Indeed, a large majority of the project teams declared that this distance type was only partially bridged, due to the lack of social activities, and four project teams reported that this distance type was not bridged at all. This could be related to their low level of usage of the Shared Workspace platform.

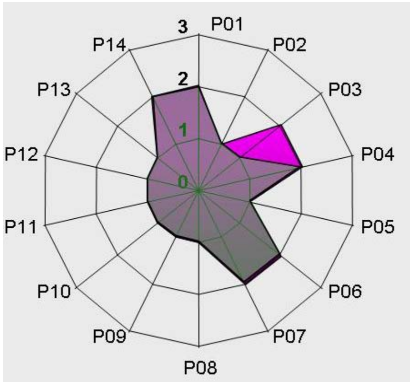


Cultural Distance Radar Graph FGI and Log-data shapes

Interestingly, FGI and LD radar shapes are sufficiently homothetic to be considered similar. However, it should be noted that the dilation of the FGI shape compared with the LD shape for P04, P10, P12 and P13, reveals that interviewees were optimistic during the focus group interviews. Clearly, their actual level of activity was lower than they claimed during the interviews. Four other project teams, P01, P02, P03 and P05, have a contraction of the FGI shape, which highlights that they were pessimistic during the interviews.

5.7.2 Emotional Distance

Six of the project teams declared that the SW platform created more emotional distance. In fact, no project team said that this distance was satisfactorily bridged. Participants from two project teams explained that the availability of emoticons in instant messaging (e.g. Skype) or webmail did not provide a satisfactory approach to bridging emotional distance. All the other project teams considered that this emotional distance was not bridged at all.



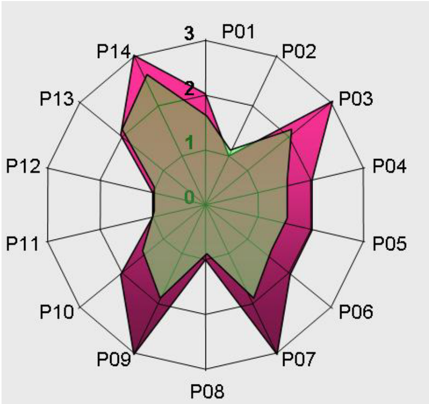
Emotional Distance Radar Graph FGI and Log-data shapes

Emotional distance is a very specific case. While everyone has his own emotional capital influencing the decision-making process, it should be noted that emotional aspects are not necessarily perceived as mandatory. Indeed, many participants considered that it was not legitimate to engage in emotional aspects during business communication, while others wished to exclude emotions, especially in conflicts or negotiation activities. Moreover, during the focus group interviews it was frequently mentioned that emotional distance is a positive aspect for people who are too shy or too emotive to be exposed to conflict situations. 'Emotional behaviour' was rated by survey respondents as one of the less significant collaboration barriers.

Interestingly, the similar shapes show that there is no big contrast between the FGI and LD radar profiles. Only one project team, P03, was revealed to be more optimistic during the interview compared with the real activity level throughout the project duration. This study confirms that emotional distance is not properly bridged by the current collaboration technology and does not necessarily need to be.

5.7.3 Lingual Distance

Four of the project teams found that the SW platform bridged the lingual distance among group members because the tool was available in their respective mother tongues. They recognised that there could be a problem when there is a need to learn from one another, for example when someone in the team has mastered a tool, if participants do not share a common language. Four other project teams declared that this type of distance is not bridged at all and mentioned that the best solution would be a universal automatic translator. They failed to consider the interpretational aspect of translation that could pollute or, more accurately, distort the original message. It is widely recognised that there is no guaranty of the validity of a text when transposed into different languages. Finally, the remaining six project teams said that lingual distance was partially bridged by the SW platform, but that at the same time other types of distances, such as social, cultural and technological, were increased.



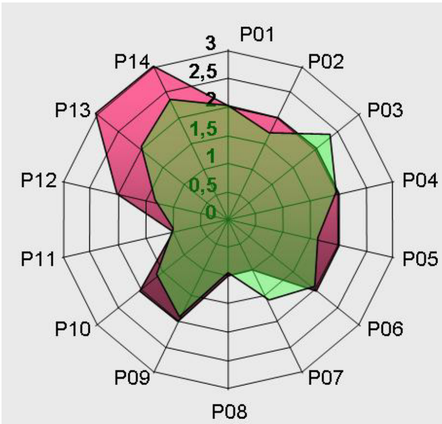
Lingual Distance Radar Graph FGI and Log-data shapes

In the survey, 'multi-lingual setting' was rated by respondents as a significant collaboration barrier. It has been demonstrated previously that projects conducted within an international setting significantly increase the integration cost and coordination burden (Pallot & Hof, 1999).

The observation of the values corresponding to the FGI and LD shapes shows that they are sufficiently homothetic to be considered similar. Nonetheless, it appears that most of the project teams were optimistic during the FGI, compared to the values estimated from the compiled activities.

5.7.4 Relational Distance

Only two of the project teams declared that the SW platform satisfactorily bridged relational distance among team members. Where it did so, this was due mainly to the use of new features such as online presence, expectation awareness and group blogging. While the large majority of project teams said that relational distance was partially bridged, for the reasons mentioned above, the SW platform lacked an online social application (e.g. serious gaming engaging participants to get to know each other better). Only three project teams were in favour of using another Web application to tackle this issue of interpersonal relationships (e.g. social networking such as Linked-In or Facebook). During the interviews all the project teams acknowledged that ICT helped to start new interpersonal relationships, especially for shy people. This explains the success among young adults of the famous Meetic Web application. They also mentioned that live interactions, supported by Web conferencing tools (e.g. Skype), document sharing and group blogging, helped to maintain strong ties, increasing the level of mutual trust and group cohesiveness.



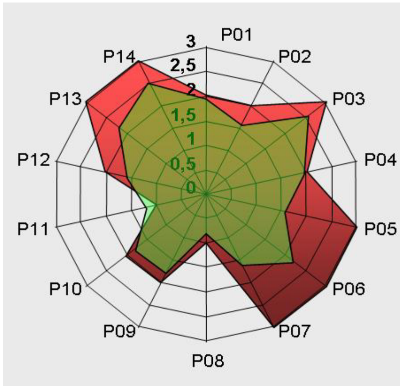
Relational Distance Radar Graph FGI and Log-data shape

‘Lack of mutual trust’ was rated by survey respondents as the second most significant collaboration barrier.

This study confirms that relational distance remains insufficiently bridged by the current available technologies. The values corresponding to the FGI and LD shapes show that they are homothetic enough to be considered similar. Nonetheless, comparison between them shows that four of the project teams were optimistic during the interviews.

5.7.5 Cognitive Distance

Six of the project teams agreed that cognitive distance was properly bridged by the systematic use of the SW platform, because this helped the team members in formalising and memorising project structures (functional activity model, folder tree, folder labels, WBS, OBS). These kinds of structures allow team members, even newcomers, to easily identify where to find needed content objects and where to upload new content objects, and to decide who is responsible for what. Another group of six project teams estimated that cognitive distance was only partially bridged, the benefit just described being tempered by the fact that the use of the SW platform simultaneously introduced social and technological distance types. Only two of the project teams, P08 and P11, declared that this distance type was not satisfactorily bridged, but they did not provide any explanation.



Cognitive Distance Radar Graph FGI and LD shapes

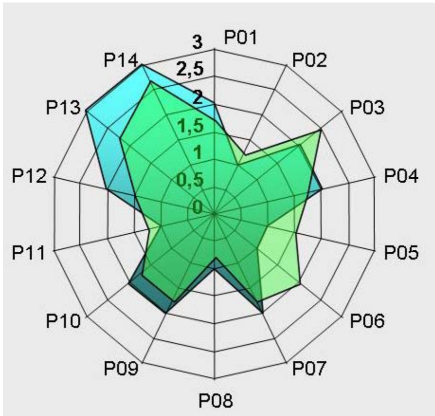
‘Diversity setting’ and ‘absorptive capacity’ were both rated by survey respondents as significant collaboration barriers. While this study confirms that cognitive distance is only partially bridged by the current available technologies, Nooteboom claimed that diversity is beneficial, enhancing group creativity and innovativeness.

The values corresponding to the overlapping FGI and LD shapes show that they are only partly homothetic, and so cannot be considered as similar. Three teams in particular, P05, P06 and P07, were very optimistic during the interviews compared to a lower level of actual activity.

5.8 Technical Dimension

5.8.1 Conceptual Distance

Only two of the project teams declared that the use of a SW platform properly bridged conceptual distance among team members. Seven of the project teams found that the use of the SW platform partially bridged this distance type through the systematisation of a common vocabulary (e.g. folder labels, tagging of the blog entries) while simultaneously introducing other distance types such as relational and technological distances. By contrast, another group of five project teams estimated that this distance type was not bridged at all by the use of a SW platform and that, in some cases, even more distance was created (e.g. additional cognitive distance). This was explained during the interviews as an imposition on team members to comply with and use certain structures defined by others, such as a folder tree.



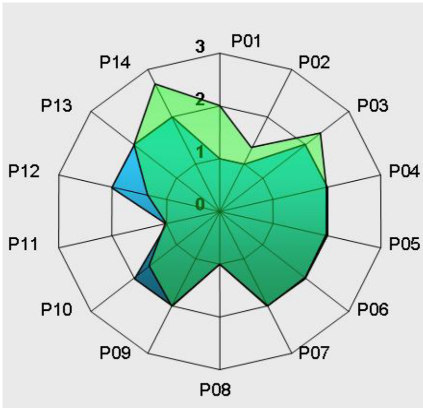
Conceptual Distance Radar Graph FGI and LD shapes

It was claimed that extra cognitive effort was required to identify where the content objects were located. One participant suggested using flexible structures, such as several folder trees designed by everyone through the use of tags and categories. Interestingly, 'lack of shared description' was rated by survey respondents as the fifth most significant collaboration barrier.

This study confirms that while conceptual distance is partly bridged by the current available technologies, this still depends on the technology skills of participants. The values corresponding to the overlapping FGI and LD shapes show that they are sufficiently homothetic to be considered similar. While five project teams were optimistic during the interviews compared to a lower level of actual activity, three project teams were rather pessimistic, as shown by the LD shape.

5.8.2 Contextual Distance

Although none of the project teams said that the use of a SW platform bridged contextual distance among team members, ten of them recognised that this distance type was partially bridged. By contrast, four of the project teams argued that the working context was too complex to be bridged by the SW platform. However, they recognised that sharing context information is vital for team members in order to work more efficiently (Neck & Manz, 1994). Some of the participants said that sharing a working context would be beneficial to reduce the cognitive effort required of individual members to situate themselves into the group activities and to help one another. Not surprisingly, 'lack of contextualised mode' was rated by survey respondents as a significant collaboration barrier.



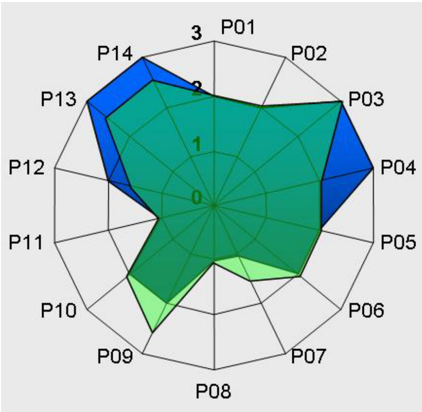
Contextual Distance Radar Graph FGI and LD shape

This study confirms that the contextual distance was partly bridged by the available technologies, which allow sharing of contextual information among project participants. This collaboration technology feature is named 'context awareness' in the CSCW scientific community (Gross & Prinz, 2003). Observation of the values corresponding to the overlapping FGI and LD shapes shows that they are homothetic enough to be considered similar. While only two project teams, P10 and P12, were optimistic during the interviews compared to a lower level of actual activity, four project teams, P01, P02, P03 and P14, were rather pessimistic, as shown by the LD shape.

5.8.3 Referential Distance

Referential distance impacted project activities such as activity model, classification and structuration. Four of the project teams declared that using a SW platform bridged this type of distance, since it was possible to identify content objects in the shared project space through the use of tags. Tagging provided a categorical reference type for selecting specific shared documents. Seven of the project teams said that technology partly bridged this distance type by providing referential links, but it simultaneously created other types such as technological distance. The remaining three project teams, P07, P08 and P11, argued that using a SW platform did not bridge this type of distance, although they did not provide an explanation.

Interestingly, 'multiplatform setting' was rated by survey respondents as one of the least significant collaboration barriers. In a multiplatform context, there are no standard references. By contrast, in the Internet context, references are provided in the standard form of URL.

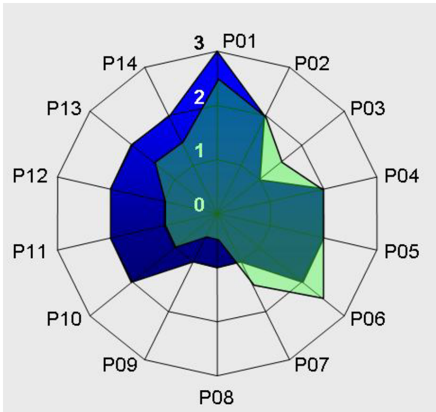


Referential Distance Radar Graph FGI and LD shapes

While this study confirms that referential distance is of paramount importance for the correlation of content objects and for determining their relevance, as described by Fuchs-Kittowski and Köhler (2005), available technologies only partly bridged this distance type. The values corresponding to the overlapping FGI and LD shapes show that they are sufficiently homothetic to be considered similar. While four project teams were optimistic during the interviews, compared to a lower level of actual activity, two project teams, P07 and P09, were rather pessimistic, as shown by the LD shape.

5.8.4 Technological Distance

Interestingly, there is a contrast between the FGI and LD radar profiles because their shapes are not homothetic enough to be considered similar. However, it should be noted that the shift of the LD shape compared with the FGI shape reveals that interviewees of height project teams were optimistic while interviewees of three project teams were pessimistic. Only one of the project teams, P01, concluded that technological distance could be bridged by bringing in a common technology platform such as SW. Comparing the use of a SW platform with the use of a collection of non interoperable tools they stated that the more they experienced this SW technology, the less they felt technological distance among team members. It should be noted that this project team made the greatest use of the SW platform, with about 80 content objects created and more than 400 generated events. By contrast, four project teams said that every time a new technology was brought in, it created even more technological distance among team members due to the difference in technology skills. This may explain why several project teams had, at most, one member using the SW platform for the rest of the group. This kind of behaviour was also observed over the course of the project. The remaining nine project teams declared that while the use of the SW platform partially bridged technological distance, it simultaneously introduced social distance.



Technological Distance Radar Graph FGI and LD shapes

‘Unbalanced technological usage’ and ‘lack of media-naturalness’ were both rated by survey respondents as significant collaboration barriers.

This study confirms that the use of technologies to compress or bridge some distance types simultaneously introduced others, such as social and legal distances. This confirms

Mulder's (2002) argument that distributed group members should have a mutual understanding of how to use collaborative technologies.

5.9 Legal Dimension

This section is based solely on the survey and FGI findings, as the legal dimension could not be fully experienced in the context of student projects.

5.9.1 Ownership Distance

None of the project teams stated that ownership distance was bridged by the use of the SW platform. In fact, they had no concrete experience with this type of distance, although the Master's Degree in Innovation does include a course on the protection of Intellectual Property Rights (IPR), patenting and copyrighting. While eight project teams estimated that the issue of ownership distance was not tackled at all by the use of a SW platform, the six that perceived this distance type to be partly bridged based their conclusion on the fact that most of the needed information (e.g. who has an idea, who has created a new concept) is embedded inside the documents stored on the SW platform. However, in order for the platform to become a real IPR management application intended to manage ideas ownership within a group of individuals, a specific data mining must be put in place. Interestingly, in the debate about the software tracking all participants' actions across the SW platform, another concern emerged regarding privacy and fears of a 'Big Brother' syndrome.

'Unbalanced IPR approach' was rated by survey respondents as the fourth most significant collaboration barrier. This confirms the paramount importance of having a technology able to manage ownership, at least in the context of creative commons or science commons, as suggested by Ristau Baca (2006).

5.9.2 Contractual Distance

Six project teams estimated that the SW platform partially answered the need to bridge contractual distance, offering a way for participants to adopt a set of common rules covering financial, security, confidentiality and privacy aspects (legal and ethical contractual aspects being enforced by local regulations). The remaining eight project teams declared that this contractual distance type was not handled at all by the use of a SW platform, but did not provide any explanation for this view. Interestingly, some participants mentioned that their project customers asked questions about security, IPR and privacy issues in direct relation to the use of the SW platform.

‘Different contractual settings’ and ‘lack of common security rules’ were rated by survey respondents as significant collaboration barriers. This study confirms that while technologies can be used to compress or bridge different distance types, this simultaneously introduces other distance types such as contractual distance, particularly with regard to security, IPR and privacy issues within the legal dimension.

5.9.3 Financial Distance

This distance type was addressed only in the survey on collaboration barriers, as it was impossible to implement it in the context of student projects. ‘Different investment regulations’ was rated by survey respondents as a significant collaboration barrier. It is widely recognised that financial investments for innovation often depend on local regulations on investment for R&D.

5.10 Summary of Discussion on Distances

This section summarises the findings and analysis of the survey on collaboration barriers, the focus group interviews and the log data of the 14 project cases for each dimension of the CDF. A comparison of the evaluation of each distance type and collaboration technology for compressing or bridging the distance is provided in the following figure (see Figure 5.11). The bar graph on the left hand side of the figure corresponds to the combined survey rating of each factor into the distance type to which it belongs. The bar graph on the right hand side of the figure presents the FGI and log data rating of the distance type as bridged by the collaboration tools used. Overall, in terms of barriers and distances, the legal dimension was considered the most difficult, with an average score of 2.3, followed by the technical dimension with 2.2, then the structural dimension with 1.9, and finally, social distance with 1.8. While the legal dimension is revealed as the toughest collaboration barrier, there is a clear lack of empirical research addressing IPR, investment regulations, security and privacy policies in the context of collaboration for supporting open innovation.

There is also a lack of technology development for tracking ideas ownership (copyrighting) and privacy, although such technology could be implemented when people are operating within an e-collaboration context. This situation explains the evaluation of corresponding distances as unsatisfactorily bridged by technology. Surprisingly, while the technical dimension comes second, the social dimension ranks fourth, where the inverse situation might have been expected. This might indicate that technology users are disappointed by the lack of sense-making features in the current collaboration tools, which would explain the high rating of conceptual and semantic distances.

The rating of contextual distance indicates a need for more contextual awareness features, while the technological distance reveals a crucial need for more intuitive and customisable tools. By contrast, the development of social computing, combined with the current deployment of a plethora of Web 2.0 social media applications, counter-balances the evaluation of the social dimension, especially because project participants were Digital Natives. Finally, the structural dimension ranks third, mainly due to the high rating of institutional and organisational distances. It should be noted that while an enterprise's policy on the use of social media applications becomes part of the institutional distance, the organisational distance increases as project teams are enlarged with external, often outsourced, disciplines as proposed by the open innovation strategy. All of that puts pressure on leadership and team cohesiveness. As mentioned earlier, virtual teams demand more team cohesiveness and leadership, not less.

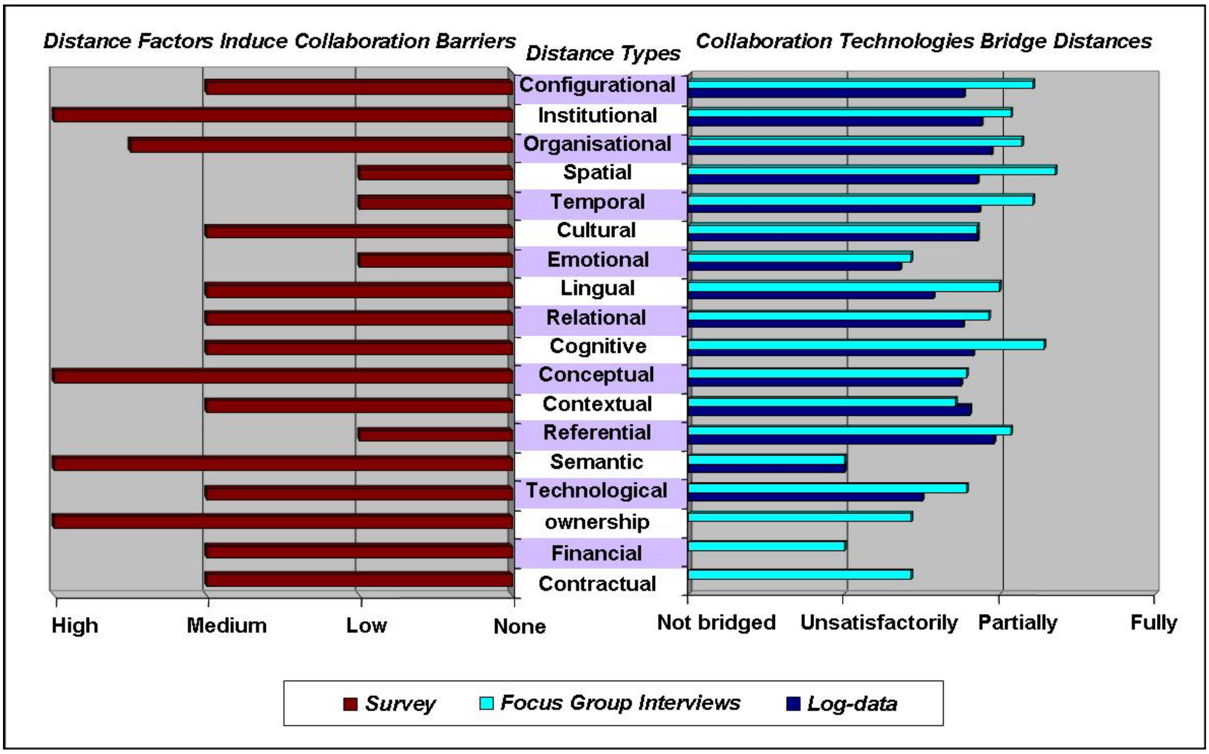


Figure 5.11: Comparison of Collaboration Barriers and Technologies

5.10.1 Structural Dimension

Two factors, geographical dispersion and different time zones, were rated the lowest barriers and shortest distances, and their corresponding spatial and temporal distances were considered as more than partially compressed. However, neither of these two distance types were evaluated as fully compressed by technology, probably due to the ‘out of sight, out of mind’ context. This situation impedes a sense of belonging and team cohesiveness, as indicated in the issue ‘Working Environment’ included in Table 2.2, comparing face-to-face and virtual collocation.

By contrast, while ‘lack of incentive’ was rated as one the highest collaboration barriers and a longer distance, its corresponding institutional distance type was evaluated as partially bridged. One might infer that technology does not bring any incentive, but instead raises a supplementary barrier in terms of technology skill. In fact this is not the case, since every team member and leader can visit the shared workspace to look at the recorded contributions of other members; therefore, they can assess the collaborative attitude and contributions of everyone. It is even possible for every involved project stakeholder to get a list of the most active collaborators.

The organisational distance factors ‘lack of clear leadership’ and ‘multidisciplinary setting’ were rated as highest and medium barriers respectively, resulting in one of the longest distances. This distance type was evaluated as partially bridged by technology due to available features on the SW platform such as shared knowledge objects, folder structuration and expectation awareness. The two remaining factors, ‘unbalanced power in decision making’ and ‘unbalanced expertise’, aspects of configurational distance, were both rated as medium barriers resulting in a medium distance, which was evaluated as partially bridged by technology. This could be explained by the degree of transparency of the decision process implemented by the project teams and by the involvement of diverse competences.

5.10.2 Social Dimension

Within the social dimension, ‘lack of mutual trust’ was rated as one of the highest barriers, and this together with ‘weak ties’ and ‘interpersonal awareness factors’ accounted for the relational distance. This medium rated distance was considered as partially bridged by technology. For example, interpersonal awareness plays an important role in collaboration effectiveness, because each team member has to know what the others are doing and what kind of problems they are facing, so that he can self-organise, adjusting his own contributions and anticipating which tasks must be given priority. In a previous empirical study, Erickson called this form of awareness ‘social translucence’ (Erickson & Kellogg, 2000).

Interestingly, ‘emotional behaviour’ was rated as one of the lowest barriers; hence emotional distance ranks as one of the shortest distances that was evaluated as unsatisfactorily bridged by technology. However, Damian (2002) in a case study about distant negotiation revealed that holding meetings within computer-mediated distributed settings did not result in a decrease of performance. Indeed, Damian argues that the ability to better sense emotional states within face-to-face meetings brings a risk of impeding the negotiation process.

‘Diversity setting’ and ‘absorptive capacity’ result in a medium-sized cognitive distance, considered in this study as partially bridged by technology. This is mainly due to the use of group tagging and folder structuration available on the SW platform. Finally, ‘lack of commons’ and ‘multi-lingual setting’ were also rated as medium-sized barriers, resulting in cultural and lingual distance respectively. Interestingly, both were considered as partially bridged by technology. While the SW platform was used to create a common project culture, nothing really explains how the technology used was able to partially bridge the lingual distance, except the fact that the platform was operating in various languages.

5.10.3 Technical Dimension

‘Lack of common description’ and ‘lack of meaning’ were rated among the highest barriers, resulting respectively in conceptual and semantic distances that were considered partially and unsatisfactorily bridged by technology. While lack of common description corresponds to the notion of shared knowledge, lack of meaning corresponds to the notion of sense-making; together they form the basis for reaching a mutual understanding. Roschelle and Teasley (1995) argued that the construction of shared meaning is the very essence of collaboration. Another factor, ‘multiplatform setting’, was rated as a medium-sized barrier, resulting in the referential distance that was considered as partially bridged by technology. ‘Media naturalness’ and ‘technological usage’ were also rated as medium-sized barriers and resulted in technological distance, which was considered as almost bridged by technology.

Finally, ‘contextual awareness’ resulted in contextual distance, which was considered as partially bridged by technology.

5.10.4 Legal Dimension

The most prominent legal dimension factor appears to be ‘unbalanced IPR approach’, whereby collaborating partners have different approaches and objectives for ownership. Among the experienced people who responded to this survey on collaboration barriers, this factor of ownership was considered one of the highest collaboration barriers. Other factors such as ‘shared security rules’, ‘contractual setting’ and ‘investment regulations’ were rated as medium barriers. The resulting distances were considered to be unsatisfactorily bridged by technology.

5.11 Discussion on Project Teams’ Collaboration Performance

Due to the mixed mode of collocation, project teams could not rely solely on face-to-face interaction (McDonough et al., 2000). Therefore, team members had to interact electronically through the use of synchronous and asynchronous tools. Within the project objectives, each team was required to produce several deliverables, where members had to contribute in order to achieve good quality outcomes. The development of the deliverables was realised on the SW, which implies a number of created content objects and a higher number of generated events. The more generated events from all team members, indicating that all team members were contributing to the development of the content objects, the higher the collaboration effectiveness. The larger the gap between the numbers of created content objects and generated events, indicating that team members were properly contributing (i.e. reading, reviewing, commenting, editing) to each other’s work, the higher the interpersonal productivity level. In project cases with lower collaboration efficiency, only a few team members generated events, and not necessarily on the content objects developed by others. The extreme case would be a project team in which each team member developed content objects alone, without any interactions with the rest of the team, revealing a 'zero' collaboration effectiveness.

In addition to using SW log data to evaluate the collaboration effectiveness and efficiency, it was decided to make observations on team members' respective understandings, cohesiveness and interpersonal relationships during each review meeting. Project review meetings were intended to assess the respective quality of the projects (functional model, Pert and Gantt diagrams), their current progress and the deliverables (both draft and final versions), as well as the operative mode of project teams. All review meetings resulted in qualitative evaluations of each project team, which were then combined with the quantitative evaluations generated with the use of the SW log data. The resulting ratios of collaboration effectiveness and efficiency are presented in Figure 5.12, showing that project teams P01, P03 and P05 outperformed the other teams. To some degree, P02 and P04 also outperformed the majority of the other teams. It should be noted that project teams from P01 up to P05 intensively shared information about their practices and experiences during informal discussions, which allowed teams to save time by re-using what was working and by not repeating mistakes. Ultimately, they created a common project culture based on the sharing of practice and experience; this contributed to bridging institutional, configurational and organisational distances, and greatly increased both their collaboration effectiveness and efficiency. The lower efficiency ratio teams, P06 to P14, operated entirely without communicating with other teams. As a result, they wasted time by repeating mistakes already made by other teams, and were unable to save time by re-using successful practice.

One example of re-using performing practices occurred during the first review meeting, when the review panel introduced to project team P03 the notion of collectively elaborated project progress summary. During the following review meeting, this practice was disseminated to teams P01, P02, P04 and P05. After a while, students explained that this practice had been informally discussed during a coffee break and that several teams were sufficiently open-minded to experiment with and adopt it. This reveals that getting a user experience of a performing practice often leads to its adoption.

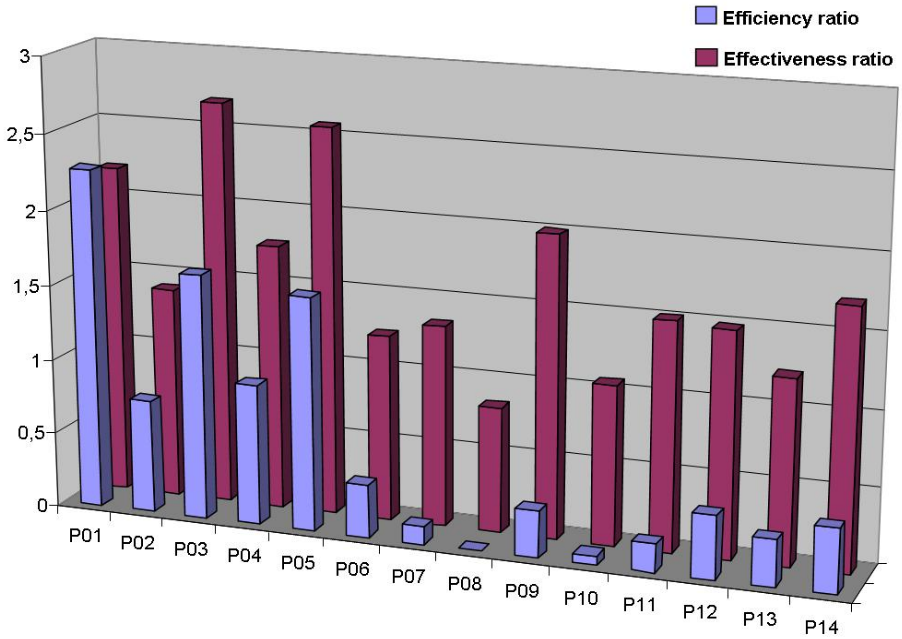


Figure 5.12: Collaboration Effectiveness and Efficiency of Project Teams

In terms of collaboration effectiveness, project teams P01, P03 and P05 outperformed the other teams, followed by P09, P14 and P04. Three other teams, P02, P11 and P12, had average effectiveness. The remaining project teams scored below the average, especially P08. A possible explanation for the much lower efficiency level of team P09 compared to their level of effectiveness, is that team members tried to use simultaneously two different SW platforms (Googledoc and BSCW). This led to great confusion in terms of content object versioning, and hence, wasted time, greatly impeding the team's efficiency level. The 'zero' level of efficiency of the P08 is explained by the fact that contrary to the instruction to use the same SW platform (BSCW), they decided to use another platform, where it was not possible to get log data. This team also shows a low level of effectiveness, far below the average level. This is explained by the attitude of some of team members, which contributed to a non collaborative climate in which they remained a group of individuals working separately without any motivation. It should be noted that out of 14 project cases, only one was finally unable to form a team despite all the instructions, techniques, methods and tools being provided in advance. Teams that had members with a lower technology skill, impeding an appropriate use of the SW, had a lower efficiency ratio.

The performance figure also shows that, with the exception of P08, all project teams had a satisfying effectiveness ratio compared to their efficiency ratio. This situation could be explained by the inclusion of training on shared collaboration techniques and methods, which led to the development of a common project process model, facilitating mutual understanding among team members. It appears that when team members develop a common model, it leads to shared mental models, clarifying the shared understanding of tasks. Previous studies have illustrated the positive role of shared mental models on team performance (Cannon-Bowers et al., 1993; Mathieu et al., 2000; Espinosa et al., 2002; Levesque et al., 2001; Carley, 1997; Eccles & Tenenbaum, 2004; Smith-Jentsch et al., 2005; Kleinsmann & Valkenburg, 2005). In this empirical study, the development of a project process model by project stakeholders led to shared mental models, hence to mutual understanding. It played a crucial role in bridging the cognitive distance and increased the collaboration effectiveness.

With regard to the efficiency ratio, one can observe two groups. One group, comprising teams numbered P01 to P05, were the most skilled in the use of technology. Therefore, they outperformed a second group, comprising teams numbered P06 to P14, who were less skilled in using collaboration technology and tools. This illustrates the important effect of technology distance, which also explains project stakeholders' reluctance to use the SW platform. It should be noted that no specific training in the use of the SW platform was provided to the project teams. As teams P01 to P05 were sharing practices and experiences, the deeper technology skills of some members were disseminated to others within the informal community. This illustrates the importance of team members' absorptive capacity. Furthermore, the expected intuitivity level of the SW user interface did not meet expectations compared to current Web 2.0 applications, to which students are accustomed.

5.12 Confronting Distance Factors with CWE

Table 5.8 below presents the CWE tools and technologies contributing to the overcoming of collaboration barriers. The table represents a matrix with a list of factors on the vertical axis and a list of tools on the horizontal axis. The matching of factors and tools is based on the findings of the focus group interviews and research work carried out during the ECOSPACE project. A detailed description of Web-based applications, including advantages and disadvantages, has been presented in a previous paper (Pallot & Bergmann, 2010).

It frequently appears in the literature that different types of contexts, such as social settings, spatial locations, time zones, tools and technologies in use, and activity types, play a crucial role in group cognition, behaviour and task coordination, whereby everyone involved in a collaboration context tries to adapt his behaviour according to the current situation. This has been characterised as 'swarm intelligence' (Dorigo & Stützle, 2004) or the 'stigmergic approach' (Elliott, 2006) where activities of ants are driven by pheromones. Hence, 'social awareness' and 'presence awareness' are interesting aspects to observe in terms of their impact on the performance of the collaborative work performed. There are already a number of tools offering presence awareness for users who wish to know who else is online in the same application, but very few propose social awareness. For example, BSCW[16] is the only CWE that allows the sharing of expectations in terms of actions to be undertaken by specific team members. This is fundamentally different from traditional workflow tools, as it does not enforce the tasks, but rather lets team members adjust themselves to the current situation. This kind of expectation

[16] http://public.bscw.de/

awareness feature, being part of social awareness, is typically well-suited to supporting coordination and leadership in distributed collaboration. It also fits well with the concept of social translucence, defined by Erickson (2000) as ‘digital systems that support coherent behaviour by making participants and their activities visible to one another’.

In this study, social awareness corresponds to behavioural adaptation in various situations, as it is about not only what people know or become aware of, but also what people consequently deduct and do. This fits perfectly with the concept of social intelligence (Goleman, 2006), which combines social awareness (what we sense) and social facility (what we do). In fact, social awareness is about sensing the inner state of one another in order to understand related feelings and thoughts, as well as specific social situations. Goleman (2006) argues that it includes various elements such as primary empathy, the ability to feel with others and sense non-verbal emotional signals; attunement, the ability to listen with full receptivity; empathetic accuracy, the ability to understand another person's thoughts, feelings and intentions; and finally, social cognition, the ability to know how the social world works.

Goleman (2006) also stated that social facility builds on social awareness to allow smooth, effective interactions, rather than simply sensing how we feel, think or intend to act toward one another. Included in this are elements such as synchrony, the ability to interact smoothly at the non-verbal level; self-presentation, the ability to present ourselves effectively; influence, the ability to shape the outcome of social interactions; and concern, the ability to care about others' needs and act accordingly.

During the project cases, it was found that most of the participants were satisfied by the use of the provided collaboration technologies to overcome distance factors. This was especially true for spatial and temporal distances, but also applied to some degree to cognitive, cultural, and emotional distance. Counter-intuitively, emotional and social distances were also mentioned as providing an opportunity to remotely start a relationship with someone who is too shy or too emotional to interact live in a face-to-face situation. One participant explained that emotional distance had greatly helped to overcome a conflict, without explaining clearly the type of conflict but describing a situation in which one group member wished to impose his own view rather than having a more consensus building approach.

However, the project case participants found that collaboration tools increased the social distance and introduced technological distance due to unbalanced technology skills and lack of media-naturalness. Team members also acknowledged the great benefit of online content storage on the shared workspace, where documents are available at any time from any location as long as there is an Internet connection available. It seems that some of them even enjoyed working remotely from home, enabled by Internet access to up-to-date documents, and started to work outside normal operating hours.

Most of the participants preferred to use instant messaging tools as synchronous rather than asynchronous communication. However, when necessary, they used e-mail as an asynchronous communication tool rather than group blogging, chiefly because it was considered easier to get access to e-mail than to blogging.

Dimensions	Distance Factors (due to the lack of)	WebConf	IM	Whiteboard	SW	Forum	Blogging	Tagging	Wiki	eMailing	VR & AR	MWC	*Polling*	*Semantic*	*Modelling*	*Workflow*	*SN*	*SG*	*EA*	*EN*
Structural	Collocation (shared-space)			X	X				X		X									
	Group Communication	X	X			X	X			X										
	Coordination				X				X							X			X	X
	Leadership				X				X				X					X	X	
	Incentive				X				X								X	X	X	X
	Cohesiveness				X				X									X	X	
	Shared vision				X				X				X		X			X		
	Interoperability													X	X					
	Balanced decision	X											X					X		
	Synch. interactions	X	X	X																
	Asynch. interactions				X	X	X		X	X										
Social	Shared culture					X	X	X	X						X		X	X		
	Mutual understanding			X				X			X			X	X		X	X	X	
	Trusted relationships						X										X	X	X	
	Context awareness										X	X							X	X
	Social translucence						X	X	X										X	X
	Interpersonal relationships						X	X									X	X	X	
	Social interactions	X		X		X	X						X				X	X		
	Emotional awareness	X	X				X				X						X	X		
Technical	Absorptive capacity		X				X				X							X		
	Shared references				X			X	X								X			
	Technology skill										X							X		
	Shared meanings			X	X		X	X	X					X	X					
	Shared relevance				X			X	X						X		X			X
	Correlation							X						X						X
Legal	Common IPR				X				X											
	Common Privacy Rules				X				X											
	Common Security Rules				X				X											

Table 5.8: Collaboration Tools Mitigating the Impact of Distance Factors on Collaboration Performance (Adapted from Pallot and Bergman, 2010)

In the above Table 5.8, the symbol 'X' indicates mitigation of impacts by collaboration tools. The following abbreviations are used:

- EA: Expectation Awareness
- EN: Events Notification
- IM: Instant Messaging
- MWC: Mobile Wearable Computing
- SN: Social Networking
- SG: Serious Gaming
- SW: Shared Workspace
- VR & AR: Virtual Reality & Augmented Reality.

Many students claimed during the focus group interviews that uploading a document into the shared workspace by 'drag and drop' was faster and much more reliable than sending an attached document by e-mail. A few participants acknowledged interest in group blogging for getting a project history and chronology of events, but re-emphasised that more external participants would have encouraged more teams to experience a project blog. Finally, a large majority acknowledged the complementarity of SW and group blogging technologies.

Intuitive user interfaces (e.g. drag and drop) with social as well as personalisation features are crucial ingredients for successful adoption of CWE. However, social translucence, social awareness and social intelligence are also related to specific working contexts. They are all features expected by users for enhancing collaboration performance, especially in a distributed context.

Another interesting aspect is that most of the participants considered collaborative platforms to be useful if, and only if, project team members are in a distributed situation. However, users were becoming progressively more aware of types of collaborative distance other than the famous spatial one, and were beginning to recognise that collaborative platforms could also be useful in a physically collocated situation. This constitutes an opportunity for ICT developers to extend the aura of a place as well as of an object for a person[17].

5.13 Comparison with other Surveys and Studies

5.13.1 AllCollaboration.com Study on Collaboration

A recent study carried out by the allcollaboration.com website sought to understand and assess current practices in, and the future outlook on, collaboration. Over 450 respondents participated in the survey, between January and February 2010. Respondents came from all

[17] Concerning VR and AR the aura of an object is the combination of its cultural and personal significance for a user or group of users. 'Cultural significance' refers to the shared meaning for a community. 'Personal significance' refers to the individual associations that the place or object may have for a particular user.

levels and functional areas and from a wide range of organisations of various sizes from diverse industries, with some concentration in consulting, and from different regions, although chiefly North America. While there are some differences in emphasis, the general findings and conclusions are consistent across most of these groups. Respondents were asked to assess their collaboration experiences and offer guidance on making collaborative efforts more effective.

The study found that the success of collaboration projects requires getting right a range of old-fashioned basic elements, such as applying the good principles of project management to dispersed teams (see Figure 5.13 and Figure 5.14). These findings also reinforce the view that collaboration requires a holistic approach comprising shared and valued objectives, right mix of people and skills, basic project management discipline, and collaboration tools that are appropriate for the context.

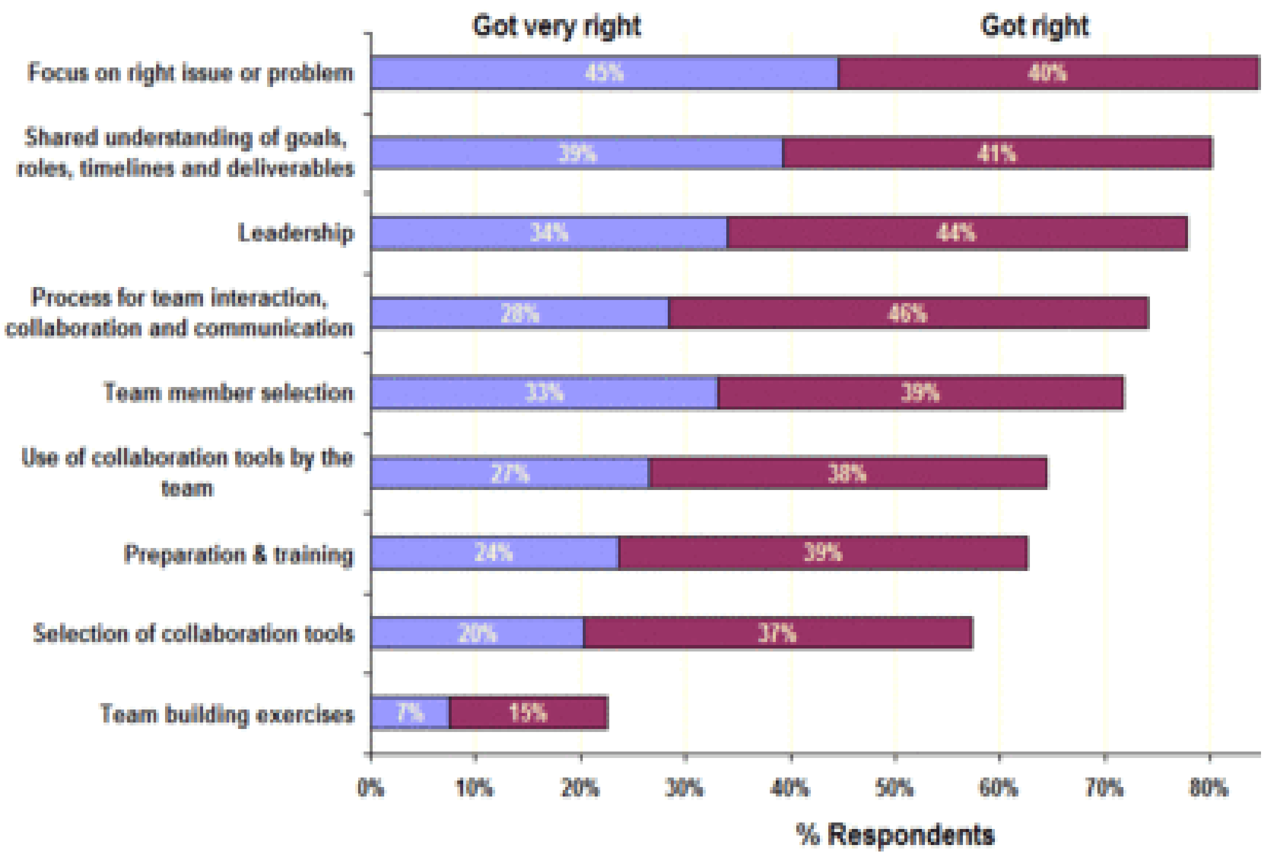


Figure 5.13: Elements Contributing to Collaboration Success or Failure

(source: allcollaboration.com, 2010)

Participants argue that getting the old-fashioned basics right is critical. The most important advice on effective collaboration offered by the respondents is to define goals, roles, timelines and deliverables clearly, communicate the process and progress frequently and clearly, and select team members who bring real knowledge and expertise. Key challenges to effective collaboration include organisational culture and priorities, and collaboration process and tools.

Survey respondents evaluated e-mail, audio conferencing, file sharing, and Web conferencing as being the most effective collaboration tools. Despite their perceived potential, instant messaging (IM), discussion forums, wikis, and video conferencing rate among the least effective for collaboration. There appears to be little connection between current widespread use of a tool and its effectiveness for collaboration. IM is widely known and fairly easy to use, yet it scored low on the effectiveness measure for collaboration and highest for being ineffective. Selection of the correct tools, and proper training, are identified as potential areas for improvement.

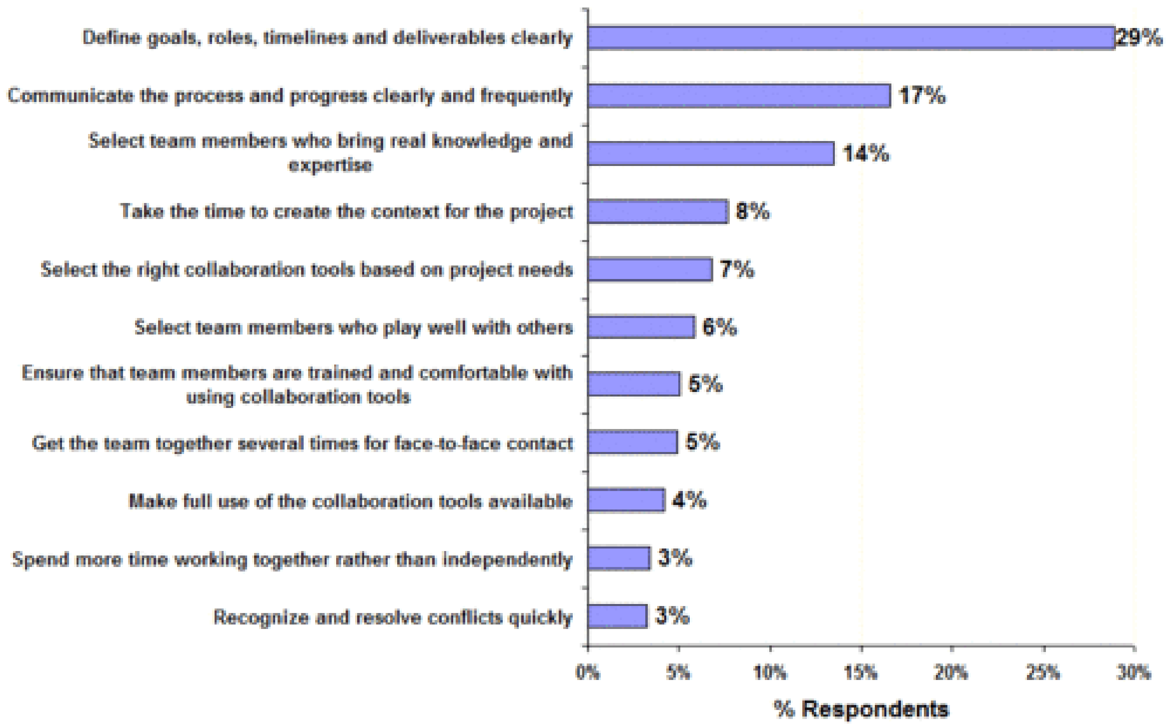


Figure 5.14– Most Important Advice for Effective Collaboration

(allcollaboration.com, 2010)

5.13.2 Study on Virtual Teams

Siebdrat et al.'s (2009) study on virtual teams revealed that the overall effect of dispersion is not necessarily detrimental, and that dispersed teams can actually outperform groups that are physically collocated. The authors argue that virtual (distributed) collaboration must be managed in specific ways in order to succeed, and that much depends on a team's task-related processes, including those that help coordinate work and ensure that each member is contributing fully. They also found that even small degrees of dispersion (e.g. different rooms and floors in the same building) can substantially affect team performance. Finally, they found that managers should carefully consider the social skills and self-sufficiency of the potential members of a virtual team. In terms of opportunities offered by distributed collaboration, they list heterogeneous knowledge resources, cost reduction, access to diverse skills and experience, knowledge about diverse markets and a 'follow the sun' working strategy. In terms of difficulties they list language differences, cultural incompatibilities, harder to establish 'common ground', fewer (or even no) synchronous face-to-face interactions and harder to achieve good teamwork (see Figure 5.15 and Figure 5.16).

Siebdrat et al. studied 80 software development teams from 28 labs worldwide (including Brazil, China, Denmark, France, Germany, India and the United States). The labs varied in size (employing between 20 and 5,500 software developers), and each team contained up to nine members. A total of 392 managers, team leaders and team members participated in the study, and data from multiple respondents were used to ensure the validity of results and to overcome common method bias.

The authors found that:

Teams with a high level of task-related processes (such as those that help ensure each member is contributing fully) outperform teams with a low level. The difference becomes particularly acute the more dispersed the team is. Moreover, virtual teams with high levels of task processes are able to outperform collocated teams with similar levels of those same processes despite the physical separation of their members. That is, the overall effect of dispersion can be beneficial, depending on the quality of a team's task-related processes.

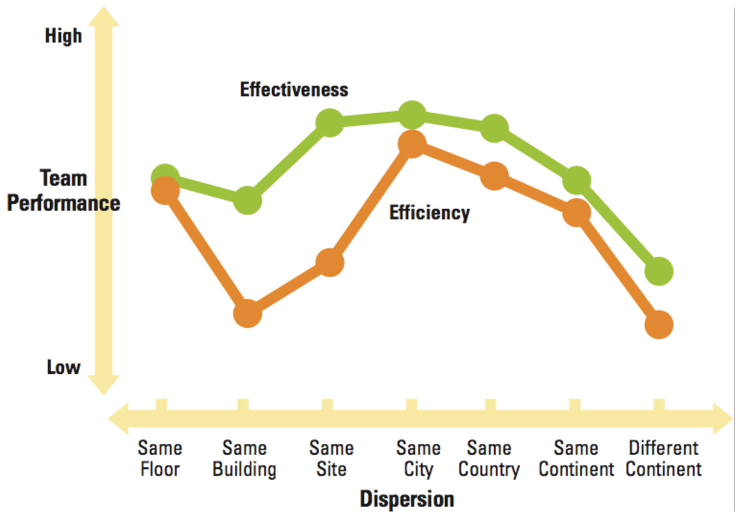


Figure 5.15: Team Performance Depends on the Degree of Dispersion

(Siebdrat et al., 2009)

Siebdrat et al. also argue that:

Team performance tends to drop with increasing member dispersion. But sometimes even a low level of dispersion (namely, members working on different floors in the same building) can have a surprisingly large effect, especially with respect to a team's efficiency.

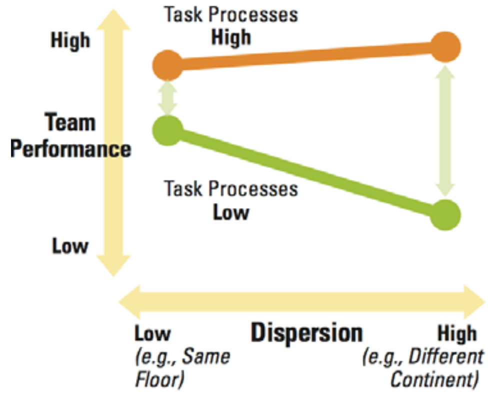


Figure 5.16: - Team Performance Depends on the Degree of Task-related Processes

(Siebdrat et al., 2009)

5.13.3 Cisco Studies on Collaboration

Collaboration Nations

This study, conducted by InsightExpress for Cisco, investigates the benefits of and challenges to successful collaboration in medium to large enterprises with more than 250 employees. The study, carried out between October and November 2009, surveyed 2,023 end users and 1,011 information technology decision makers from 10 countries around the world. It found that 96% of IT managers and end users recognise that collaboration tools have a role to play in the future success of their business. Of those surveyed, 77% of IT managers expected investment in collaboration tools to increase between the time of the study and October 2010, and 56% expected their spending on collaboration tools to increase by 10% or more.

Productivity and efficiency were identified as the primary benefits of increased collaboration by 69% of regular users of advanced collaboration tools such as video and Web conferencing, as these were considered to help them complete tasks at work more efficiently. While around 52% of surveyed organisations prohibit the use of social media applications or similar collaboration tools at work, 50% of users admitted to ignoring such prohibition at least once a week. Around 27% of users admitted to changing the settings on corporate devices to get access to prohibited applications. In terms of collaboration benefits, 45% of users pointed to improved productivity and efficiency, 40% stated that they received assistance in solving pending issues, and 31% gained faster decision making. The three most desired attributes of a device or application were ease of use (58%), the ability to communicate anywhere and at any time (45%), and finally, features and functionality (37%). Users mentioned that elements of corporate culture can inhibit their ability to collaborate successfully. While around 46 % felt that all decisions were made by people at the top of their organisations, 39% declared that colleagues were not willing to share information.

Collaboration Tools

In a previous research carried out in December 2008, Cisco conducted the first formal segmentation study of users of collaboration tools. The main objective was to understand how workers collaborate, which tools they use, and how they believe those tools affect productivity, innovation, and cost savings. The study surveyed 800 people in a wide variety of U.S. medium-sized and enterprise organisations, who spent at least 20% of time at work using a network-connected computer, used a mobile phone or handheld device and had participated in two collaborative activities within the past month.

The study revealed, first, that organisational culture is as important to successful collaboration as are the collaboration tools themselves. Important success factors, for about 40% of study participants, include formal collaboration processes, such as weekly group conference calls or blogging requirements, and effectiveness tracking. In addition, the study found that collaboration is directly correlated with rewards, as 50% of respondents said that their company rewards collaboration with bonuses and other rewards. Not surprisingly, respondents were wholly in favour of tools and training, stating that successful organisations provide collaboration tools and the training needed to use them effectively.

Second, the study found that employees regard collaboration as influencing success. The vast majority of respondents said that collaboration is critical or important to their success at work. Work practices are more collaborative today than they were two years ago, according to 75% of respondents. After the ever favoured e-mail, phone conferencing remains the most frequently used tool for synchronous collaboration. In addition, among the study respondents, more than 75% used electronic calendaring and Web conferencing, 68 % used video conferencing, and about 40% used wikis and blogs. Interestingly, respondents declared that they used collaboration tools more often for productivity rather than for innovation. This finding was confirmed for almost every tool (see Figure 5.17).

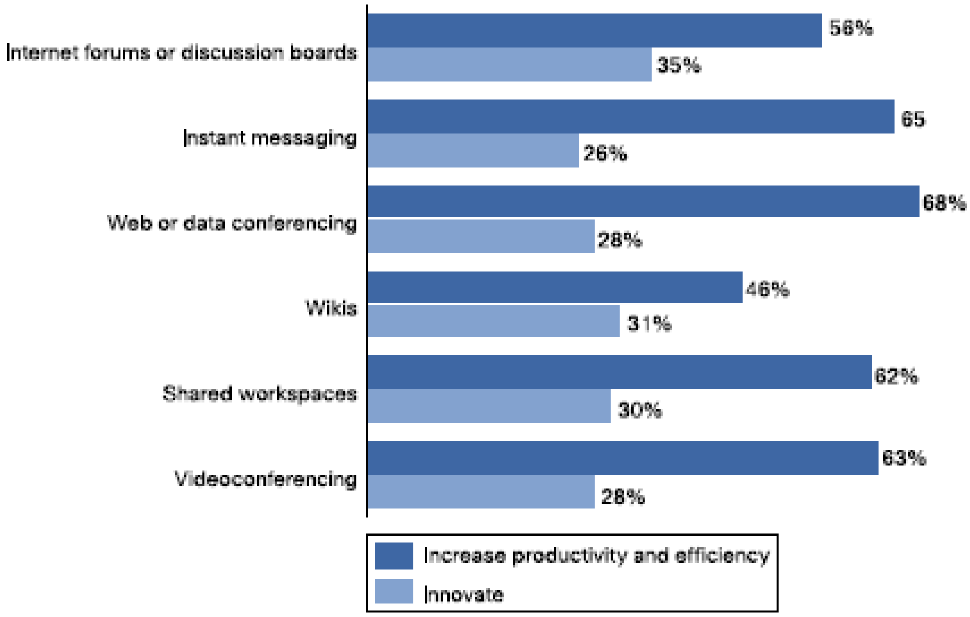


Figure 5.17: – Collaboration Tools used for Productivity rather than Innovation

(Cisco, 2008)

The top three uses of collaboration tools are daily project work, business process improvement, and new product development. An example of business process improvement would be when a salesperson on the phone with a customer can use instant messaging with a colleague to get an answer that helps close the sale.

This Cisco collaboration segmentation study suggests that organisations experience the greatest productivity benefits from collaboration when personal attitudes and organisational culture are considered as important as collaboration tools. Another important criterion is that the people and groups to whom collaboration tools are introduced should share positive collaboration characteristics. In this study, these people were managers or supervisors, had held their job position for 3 to 10 years, and were already using Web 2.0 tools at home. Organisations must encourage executives to model the desired collaboration practices. Another crucial aspect is the rewarding of collaboration by including it in performance reviews, offering rewards for successful outcomes, or both. Management should also implement formal collaboration processes. Finally, organisations must provide the tools, IT support, and training needed to support collaboration.

5.14 Summary

This chapter has presented the analysis of the survey on collaboration barriers and comparative cases, and the correlation between them. While the survey reveals the top six barriers to be a mix of factors belonging to the different dimensions, the comparative cases show that distance factors of the structural dimension can be satisfactorily bridged by applying collaboration techniques and methods, plus the necessary training. The other collaboration surveys reported in this chapter confirm the anticipated importance of shared understanding, leadership, interaction process and tools, social translucence and training. Those studies reinforce the finding that the overall effect of dispersion is not necessarily detrimental. It is also recommended that managers should carefully consider the social skills and self-sufficiency of the potential members of a virtual team.

It should be stated here that all the technical solutions used for the different collocation modes are already available. However, a number of problems related to distance factors remain unresolved. In particular there are concerns about the current unbalanced IPR approach, lack of training, interoperable collaboration tools, security and privacy issues, contextual awareness, and socio-emotional intelligence. Not surprisingly, e-mail is still the most mentioned collaboration tool, far ahead of other synchronous or asynchronous interaction tools. Unfortunately, the experimentation of group blogging to set up a project blog does not provide sufficient evidence to predict whether it could supplant e-mail for communicating within a distributed collaboration project. However, this question is definitely worth a new experimentation, as it could support more social translucence. Finally, collaboration practice and experience sharing appear to be as important as collaboration tools.

Chapter 6. Conclusion

We can't solve problems by using the same kind of thinking we used when we created them. –
Albert Einstein

This chapter recaps the goals of the study and responds to the research questions, revisiting the initial propositions in order to evaluate the resulting achievements. It lists the contributions made to the body of knowledge, based on adapting existing models (Johari Window model, IPO model) and on new elaborated models (CD holistic model, collaboration process model, mutual understanding process model). Finally, it presents the lessons learned and recommendations, outlines the limitations of this study and makes suggestions for future research.

6.1 Introduction

This thesis has discussed the need to disambiguate the concepts used to represent distance factors and to group them into valid classes, and has found that the herein elaborated Collaborative Distance Framework (CDF) appears to fill this identified gap. The main idea behind the development of the CDF was to increase the level of knowledge and understanding of distance factors and their respective impacts on collaboration performance. As such, the CDF allowed us to categorise previously published empirical studies on distance factors and concurrently to identify which existing, or emerging concepts, and related technological artefacts were compressing or bridging specific collaboration distance types.

As already mentioned in the literature review, individuals entering into collaboration are facing a kind of paradox. On the one hand, close proximity among team members speeds up the process of reaching a mutual understanding; on the other hand, it simultaneously reduces the potential for creativity and innovativeness due to a lower level of diversity (Pallot, 2005). However, the comparative cases confirmed that a higher diversity level demands more cognitive effort and absorptive capacity on the part of team members in order to reach a satisfying level of mutual understanding, enabling an effective collaborative innovation.

Interestingly, this survey clearly indicates that the most significant factors affecting collaboration performance impede collaboration effectiveness rather than efficiency. The four factors rated in this survey as ‘less significant’ impacted efficiency more than effectiveness. However, two of them require ICT to solve the effectiveness aspect, while one of them improves efficiency, as in the case of a potential conflict arising when emotion intrudes too much in business activities. It seems logical that effectiveness factors are rated as the most significant, as they condition the readiness for collaboration. For example, it is well known in the international project arena that gathering participants from different countries, who have their own regional and institutional culture and mainly use their respective mother tongues, creates such a distance that collaboration effectiveness will not be ensured until they collectively decide to build a common culture and use a common language (Pallot & Hof, 1999; Pallot et al., 2000).

6.2 Responding to the Research Questions

With regard to the main question addressing the way eProfessionals maintain a satisfying collaboration performance whatever the operating mode (physical, virtual or mixed collocation), this study confirms the paramount importance of using appropriate techniques, methods and tools to sustain team effectiveness and efficiency in bridging or compressing various collaborative distance types.

Turning to the sub questions, evidence of several dimensions emerged during the literature review. While Knoben and Oerlemans (2006) pointed out the existing overlap and ambiguity among proximity concepts used in the literature of inter-organizational collaboration, this study established four dimensions and 18 collaborative distance types in the broader domain of distributed collaboration, grouped into a specific Collaborative Distance Framework (CDF). Such a conceptual framework is intended to provide a holistic view in order to disambiguate and disentangle all the distance factors through their categorisation into several types, corresponding to the 18 collaborative distance types. Distance factors do not necessarily negatively impact collaboration effectiveness and efficiency.

In this study, it was seen that ICT support provided through the software platform contributed greatly to overcoming collaboration barriers by bridging or compressing different distance types, such as spatial and temporal distances. Other distance types were partially bridged by the use of collaboration technology. However, the use of ICT also induces a specific distance type, 'technological distance', which depends on the individual participants' degree of technology background, skill, training and absorptive capacity and technology maturity level (e.g. user friendliness, interoperable collaboration services, etc).

The crucial role of mutual understanding has been revealed through the use of techniques such as OBS, WBS and IDEF0 which, as proposed by Neumann et al. (2006), greatly contribute to the development of shared mental models. Espinosa et al. (2002) demonstrated the positive effect of shared mental models on task coordination success and reduced development time. In the Johari Window model, mutual understanding appeared as the enabler of the interaction space known as ‘the arena’ (Luft and Ingham, 1955). The collaboration mechanics have been deciphered as an open spiral process of human activities, such as shared meaning, sense-making and knowledge sharing. These activities contribute to the increase of mutual understanding, which then enables the creation of new knowledge. This is said to be the essence of collaboration (Roschelle, 1992; Roschelle & Teasley, 1995).

In this research, a tentative generic model of team interaction processes was designed, based on the literature review and the above description of collaboration mechanics, where several distance factors appeared to have a specific impact on the team activities. In the case study the extended Johari Window model was presented in advance to the project participants to explain the crucial role of exposing knowledge and seeking feedback to enlarge the arena of mutual understanding, which also controls interpersonal productivity. All project cases except one (P08) reported the usefulness of this model and its power to stimulate all project team members to share knowledge and spend time on sense-making and creating shared meaning. It seems to operate like the above described shared mental models by increasing the capacity to efficiently coordinate tasks within a team (Neumann et al., 2006).

The study shows that the use of the collaboration techniques, methods and tools on social mechanisms (conversation, online presence and awareness, translucence) provided the student participants with an appropriate platform to interact successfully. The comments made by them during the focus group interviews provide evidence of participant engagement in the process of virtual team building and project knowledge sharing and address many of the distance factors identified earlier in the literature.

Positive participant feedback on personal satisfaction and team collaboration effectiveness collected during the focus group interviews provided evidence that team building and relationship development did occur properly. It is also worth noting that the relationships among the used techniques, methods and tools, appear to act as a platform for interaction, highlighting the socio-emotional processes that build team relationships, cohesion and trust. Furthermore, the general theme for successful virtual team characteristics integrates an understanding of the social mechanisms of communication and collaboration.

It is therefore suggested that, based on this participant data, that the two research questions are answered positively. The virtual team environment was perceived by the student participants to be more successful when they applied the three social mechanisms of communication and collaboration to their team building. Personal logs build stronger team relationships and engage participants in more effective teamwork, creating a balance between task achievement and working cohesively.

6.3 Propositions Revisited

A number of issues (see section 2.16) were investigated during this empirical study with regard to increasing the level of knowledge on the role of mutual understanding in the collaboration mechanics. All these issues are related to the research questions, specifically addressing the correlations between:

1. Distance factors and mutual understanding
2. Collaboration technology and mutual understanding
3. Collaboration technology and collaboration performance
4. Mutual understanding and collaboration performance

5. Mutual understanding and mutual trust.

6.3.1 Distance Factors and Mutual Understanding

Mutual understanding was reported by the focus group participants as a crucial ingredient for enabling knowledge creation. Within the social dimension it is directly affected by a number of distance factors, such as background, interpersonal relationships, usages and norms, diversity, group cognition, absorptive capacity, emotional behaviour, empathy and affectivity. As for the structural dimension, it was stated that collaboration technology allows satisfactory compression of spatial distance, and bridges temporal, configurational and organisational distances in such a way that they do not impede mutual understanding. However, it was recognised that specific training was crucial to overcome the technology induced barrier. It was also mentioned that technology could help in reducing the ambiguity in the terminology used, hence overcoming technical distance factors such as conceptual and semantic distances.

6.3.2 Collaboration Technology and Mutual Understanding

In terms of shared techniques and methods enforcing a shared understanding among team members in the comparative cases, in addition to the use of SADT and IDEF0 for process modelling, all project teams used WBS and OBS for the structuration of their respective projects (see Figure 4.7). According to the boundary object theory (Star and Griesemer, 1989), shared practices based on the use of common techniques and tools help team members to build a mutual understanding. During the focus group interviews, project participants reported that during the modelling sessions they had discussed and argued their views of the project according to their own expertise. Finally, they had agreed on an integrative common view of the project process that constituted the mutual understanding of the whole project process from mission statement to deliverables. They also reported the usefulness of the software platform for structuring all content objects according to the shared understanding of their project process. Similarly, the versioning feature was reported as important for avoiding any misunderstanding that could potentially be introduced by the use of wrong versions of content objects. Collaboration technology, more particularly the modelling techniques and tools, were recognised by project stakeholders as a crucial instrument for speeding-up mental model sharing and the reaching of mutual understanding. However, they also mentioned that it requires specific training in order to avoid the technological distance that depends on each individual's technology skill. In conclusion, there is strong correlation between collaboration technology and mutual understanding, as techniques and tools allow the design of shared mental models, inducing a larger and faster mutual understanding among team members. It appears that when team members develop a common model, this leads to shared mental models that clarify the shared understanding of tasks. Previous studies have illustrated the positive role of shared mental models on shared understanding and team performance (Cannon-Bowers et al., 1993; Mathieu et al., 2000; Espinosa et al., 2002; Levesque et al., 2001).

6.3.3 Collaboration Technology and Collaboration Performance

This empirical study reveals that while structural distances contribute to the inhibition of shared purpose, vision, goals and objectives among distributed group members, techniques, methods and tools used in the comparative cases were reported to be effective for compressing and bridging these distance types. Lack of clear leadership, a factor within the structural dimension, was confirmed by the survey respondents as the top collaboration barrier. As Lipnack and Stamps (1997, page 173) pointed out, 'virtual teams and networks demand more leadership not less'. The survey results for the structural dimension confirm previous conclusions on the paramount importance of leadership and trust in face-to-face as well as distributed collaboration. However, the comparative case study of the 14 project cases demonstrated that appropriate training on distributed project management and leadership helped all project teams to overcome this collaboration barrier. Finally, it should be noted that all project cases, except P08, used the same SW platform. They also had the same type of project within the same context of techniques and methods, and attended the same training on IDEF0, OBS & WBS and distributed project management and leadership.

Notwithstanding the above, the collaboration performance resulting from the different project cases was rather heterogeneous, with a first group of five projects outperforming a second group of nine projects. The main differentiation between the two was that the first group shared practice and experience among projects, while all the projects belonging to the second group operated in isolation. In fact, this was a first real project experience for the students involved, and it appears that the project teams in the latter group made the same mistakes and wasted time on finding solutions, while the teams of the first group avoided these traps through sharing practice and experience. Another possibility is that the first group of projects might have included more students with higher technology skills. This could explain their outperforming the second group, especially on collaboration efficiency. This argument could still be valid even if only a few technology skilled students were involved in the first group of projects, since they had this informal community of practice and experience for disseminating performing practices. Finally, the fact that there was no specific SW platform training provided could explain the heterogeneous result in terms of collaboration efficiency performance.

The resulting collaboration effectiveness performance of all project teams, except P08, appears to be more homogeneous, with a smaller difference between a first group of four projects and another group of nine projects (excluding P08), which they outperformed. In the first group, project P03 emerged as having the highest effectiveness performance; this was also the project team that claimed a satisfying user experience with their project blog (use of group blogging instead of e-mailing). The second group of projects had an average level of collaboration effectiveness performance. This more homogeneous result could be explained by the techniques, methods and tools put in place for the structuration of their project through the use of IDEF0, OBS and WBS techniques, as well as the specific coaching for the functional modelling of their project process and training on distributed project management and leadership.

6.3.4 Mutual Understanding and Collaboration Performance

Project participants very much appreciated the use of the extended Johari Window model; this made them conscious of the important role of the interaction space and the fact that it is conditioned by the amount of shared knowledge and mutual understanding. Participants in the FGI declared that they perceived the direct relation between ability to reach a mutual understanding and interpersonal productivity, as claimed by Luft and Ingham (1955). However, participants also recognised that knowledge sharing implies a collaborative attitude and a certain level of trust among team members, because there is no guarantee that someone will not claim as his own an interesting idea expressed by a colleague. They explained that tools are helpful in that when an idea is written down and saved in an archive then it is much more difficult for someone else to claim ownership.

6.3.5 Mutual Understanding and Mutual Trust

Lack of mutual trust was described as increasing relational distance, which leads to weak ties among group members. Leadership and trust are collaboration factors often mentioned in the literature. According to Lipnack and Stamps (1997, page 225): 'In the networks and virtual teams of the Information Age, trust is a need to have quality in productive relationships.' In the literature, leadership and trust appear quite often as conditioning collaboration effectiveness and efficiency. This is probably due to the fact that trust has a greater impact on collaboration effectiveness, while task and process leadership has a greater impact on the efficiency of the collaboration process. However, the level of trust greatly depends on the ability and amount of shared knowledge and strategic information (e.g. purpose, vision, goals and objectives) among distributed team members. Participants in the FGI stated that when team members uploaded content objects on the SW platform, this contributed both to broadening the knowledge sharing and to increasing the level of trust. They declared that in this kind of CWE the retention of information becomes obvious, as it is easy to see who is not contributing by sharing their collected and/or elaborated content objects (explicit knowledge). One might infer from this that the larger the knowledge sharing, the higher the mutual trust. Mutual trust is also affected by interpersonal relationships and frequency of face-to-face meeting, in compliance with the rule, 'out of sight, out of mind'. However, when collaborating with other people for the first time, there is no pre-existing interpersonal relationship. In this case, trust is progressively built through individual behaviour in terms of collaborative attitude, openness and reciprocity in the sharing. Even if it is not specifically recognised by project participants as evidence, the ability to share knowledge implies the ability to understand each other. Therefore, it seems logical to claim that mutual understanding increases the capacity of mutual trust. Nonetheless, the ability to understand team members from other disciplines requires a demanding absorptive capacity, which means a necessary level of empathy to care for and listen to others (e.g. voice of the customers).

6.4 Contribution to Knowledge

While the main objective of this study lies in characterising a holistic model of collaborative distance and providing a specific framework for researchers and ICT developers, namely the Collaborative Distance Framework (CDF), it is our hope that this framework will also help in identifying newly emerging artefacts which are able to reduce some collaboration barriers by compressing, or bridging, one or several distance types. The medium to long term goal is to achieve a collaborative distance phenomenology, relating different empirical observations of distance phenomena to one another. In reality, one distance factor might also affect other distance factors, such as interpersonal relationships impact trust and vice-versa. Therefore, networking distance factors among themselves and with observed phenomena would greatly contribute to increasing the level of understanding and would lead to a more effective and consolidated body of knowledge in this area. Furthermore, the literature review allowed us to identify a clear lack of a generic collaboration process and mechanics, which implies a need to formalise a generic collaboration process (Pallot et al., 2004) or meta-process which individuals apply when they are collaborating online. This kind of generic process would provide an opportunity to define proper metrics for better measuring the impact of distance factors on collaboration performance.

The main contributions to the body of knowledge lie in the CDF components, and comprise the following:

- A holistic model of collaborative distance showing the relationships between collaboration barriers, distance factors, distance types and collaboration technology (see Figure 2.6);
- A holistic view of collaborative distance, including four dimensions and 18 distance types for classifying all distance factors (see Figure 2.7);
- A social interaction model, based on an extended version of the Johari Window model (Luft and Ingham, 1955) that explains how to enlarge the area of mutual understanding, determining the level of interpersonal productivity for increasing creativity and innovativeness (see Figure 2.8, Figure 2.9 and Figure 2.10);
- A generic collaboration process model describing the interrelated layers of activities (see Figure 2.11);
- A logical model of the collaboration mechanics articulating the role of awareness, responsiveness, sense-making and mutual understanding (see Figure 2.12);
- A structural model integrating the generic collaboration process activities with the mechanics of collaboration (see Figure 2.13);

- A revised IPO model for the collaborative distance experiment through 14 comparative cases (see Figure 3.8);
- A generic model of a group interaction process based on the collaboration mechanics (see Figure 3.9). This model further introduces distance factors in the knowledge creation process that are intended to decipher the role of mutual understanding on collaboration performance and the way it is impacted by distance factors.

6.4.1 The Collaborative Distance Holistic View and Model

As presented in Chapter 2, the lack of a holistic view of all distance types and factors affecting collaboration effectiveness and efficiency constituted the most important gap in the existing literature that was filled by the issued CD holistic view and model. Hence, we claim that based on this CD holistic view and model it becomes possible to disentangle all factors in order to better understand their interrelationships. Furthermore, the CD holistic view and model greatly contribute to reducing the conceptual ambiguity among different concepts used in the literature, in order to facilitate the task of identifying the different types of distance and their respective roles. Finally, they allow both researchers and technology developers to compare findings among the published case studies while facilitating the study of the potential capacity of new practices and new tools for compressing or bridging distances.

6.4.2 The Collaborative Distance Framework (CDF)

The resulting CDF, through the use of its different components, enables the study of distance factors within collaboration projects, as was done with the 14 project cases through interviewing project participants and interpreting traces (log-data) issued during the use of collaboration technology.

The first step consists of identifying, classifying and relating the distance factors expressed by project participants during the interviews, using the CD holistic view and model. This step allows researchers to make some comparisons with published case studies.

The second step consists of evaluating the collaboration process and mechanics. During this step, activity traces recorded in log-data are interpreted to assess the level of social interaction among project participants, using the extended Johari Window Model. Further, the interpreted collaboration process is compared with the generic collaboration process model and then compared with the collaboration mechanics model in order to see whether the collaboration mechanics is properly articulated.

The third step consists of evaluating the project team performance in terms of collaboration effectiveness and efficiency in order to see whether collaboration barriers raised by distance factors are properly compressed or bridged by the used collaboration technology. First of all, the Input-Process-Output (IPO) model should be updated according to the collaboration tools used by the project team. If the project team uses an online Shared Workspace tool to support project activities and a Group Blogging tool to support the project communication then the IPO model would fit without any necessary modification. However, project communication could also be handled by the use of an online synchronous communication tool (e.g. Skype) to support live interactions among distributed team members. In this case, the socio-emotional process of the IPO model should be revised to take into account interpretation of the traces generated by the online synchronous communication tool. Secondly, the Group Interaction Process Model allows the researcher to interpret the impact of distance factors on the level of achieved mutual understanding according to the traces generated by the use of the collaboration tools.

The interpretation of traces generated by the use of collaboration tools (log-data) provides a satisfying quantitative evaluation. As for the qualitative evaluation, we recommend assessment of the quality of the content objects produced by the project team. During this study project reviews appeared to be the appropriate instrument to evaluate the quality of the team production as well as team members' relationships and team cohesiveness.

Finally, a project team could use the CDF for concurrent monitoring of the collaboration effectiveness and efficiency among team members and to introduce time-to-time new collaboration methods, techniques and tools in order to make valuable observations on their capacity to contribute to overcoming collaboration barriers that are induced by distance factors.

6.5 Lessons Learned and Recommendations

A Living Lab user-centred research and innovation approach was introduced in order to provide student participants with a user experience of collaborative distance and Shared Workspace platforms and to evaluate the corresponding impact on collaboration performance. While a large amount of data was collected through the SW platform log data and focus group interviews, it is too early to come to a conclusion on the use of the Living Lab approach regarding the ideas brought by users (the students) for improving the SW technology. However, it was clear that there is a need for specific ICT based research instruments to support dynamic user profiling and modelling, multi-modal collection of data and multi-source data analysis in order to speed up the overall analysis process. This is especially true because collecting more data with finer granularity enhances the overall quality, but also requires more time spent on analysis and interpretation. In addition to the traditional features found in a collaborative platform, the results of this empirical study confirm that intuitive user interface (e.g. drag and drop), and social and personalisation features are crucial ingredients for user adoption. Good examples of expected features include the display of real-time information about what colleagues are doing, including project logo and photos in the webpage background. These, along with members' profiles with photos, all contribute to providing a human touch, not only 'humanising' collaborative platforms, but also improving the way people can perceive online collaboration.

Another interesting aspect is that right from the beginning, most of the participants thought that collaborative platforms are useful if and only if project team members are in a distributed situation. However, during the focus group interviews they became progressively more conscious of types of collaborative distance other than the famous geographical one, and of the fact that such a collaborative platform has also been experienced to be useful in a physically collocated mode.

The next stage would be the involvement of a more diverse group of users, engaging participants from different countries and regions. This would bring onboard more institutional, configurational, cognitive, cultural and lingual distance factors than those already observed in this empirical study.

6.6 Limitations and Future Research

While this empirical study was intentionally designed for student projects with real customers and external experts within a mixed mode of physical and virtual collocation, one limitation is the inherent natural open organisation mode of the university compared to the closer organisation mode of business. Hence project structuration and operation were not ruled by strict business organisation norms and policies (hierarchical directives). This situation could rightly be considered as a limitation because in the real working world, every project would have its own collaboration techniques, methods and tools. A worst possible scenario would consist of all partners in the same project using their own collaboration environment.

However, it would have been impossible to identify 14 projects with a similar topic of innovation in industry that would accept the use of common collaboration techniques, methods and tools for the sake of an empirical study. This empirical study was prepared with several invariants, such as the topic of the project cases, collaboration techniques, methods and tools, the size of the teams and the mixed mode of collocation. Other invariants included the incentive for students to gain an experience of a real innovation project with a real customer, to apply the various techniques, methods and tools they had studied in the classroom, and to check their performance. Finally, the project debriefing and ranking during the final review, which was translated into a collective mark, constituted another common incentive. The variables were the different backgrounds, cultures, disciplines, skills, behaviours and motivations of project participants, as well as social abilities, such as empathy (caring about others). Team composition, in terms of disciplines, was imposed according to the four Master's classes in Innovation (Strategic Information, European Venture, Agro-biology, and Virtual Reality). Collaboration attitude, cultural usages and norms did not differ greatly among project participants. The types of projects were quite similar (collaborative innovation). However, the project contents differed because they were related to customers' specific needs. The summary variables were the level of interaction among project participants and the level of contribution effort and coordination by team members. Indeed, all students were properly instructed in advance about potential collaboration barriers raised by various distance factors and distance types that could be partially or fully bridged or compressed by collaboration techniques, methods and tools. They were given a document on collaborative distance including the full list of distance types and their descriptions, and the list of distance factors.

This study has several other limitations. Notwithstanding the impressive number of papers selected for the literature review, it might still be possible to identify other distance types and related factors that would need to be included in this CDF. The different collaboration styles, from teamwork to mass collaboration, were properly identified, but owing to a lack of time they were not examined in-depth to compare the impact of various factors between structured and unstructured collaboration. An attempt was made to disambiguate concepts used to represent various distance types and related factors, and to reduce the number of concepts by identifying synonymous labels. Nonetheless, disambiguating and disentangling completely all distance types and related factors is still a challenge that would merit the setting-up of a specific research community dedicated to collaborative distance. Deciphering the relationships among all distance types and related factors within the four dimensions proposed in this study requires contributions from a dedicated researcher community that could take place in the newly initiated collaborative distance wiki pages.

Furthermore, this empirical study needs to be replicated in other project types besides collaborative innovation, with heterogeneous disciplines involved in this kind of virtual teamwork, to determine whether the outcome remains valid. The same model of guided students' projects with the same social mechanisms of interaction (extended Johari Window model) can be applied in other discipline areas in order to validate the holistic CD model.

However, it should be noted that a mass collaboration scenario (e.g. Wikipedia) was not considered in any of the comparative cases. In this specific case, the notion of team does not really exist, because contributors operate within a stigmergy or emergence approach. It would be valuable in the near future to design the domain landscape of eCollaboration in order to better locate mass collaboration and collaborative distance with other related research areas, as mentioned in section 2.1 (see Figure 2.1). The size of the different areas would depend on the respective volume of published papers.

In terms of future work, there is a need to enrich and complement the CDF by contributing results from other empirical studies that involve distance factors and collaboration barriers, in order to better correlate the findings. It would also be worthwhile to investigate the collateral impact of distance factors within the various dimensions and the role of new ICT in compressing or bridging the various distance types. The correlation among distance factors, collaboration barriers and ICT support is viewed as an important step towards the design of more effective and efficient collaborative working environments.

The medium to long term goal is to achieve a collaborative distance phenomenology, relating different empirical observations of distance phenomena to one another. In reality, one distance factor might also affect other distance factors, such as interpersonal relationships impacting trust and vice-versa. Therefore, networking distance factors among themselves and with observed phenomena would greatly increase the level of understanding and lead to a more effective and consolidated body of knowledge in this area.

This proposed CDF could be used for further empirical studies that would select an integrative approach, as offered with the four dimensions, instead of looking at certain factors in isolation. It could also be used by practitioners and ICT managers as a Collaboration Capability Assessment Framework to evaluate the collaboration capabilities or readiness of distributed project teams, online collaborative environments, collaborative infrastructures and collaboration tools. Developers could also use it to evaluate new collaboration artefacts and tools for compressing or bridging one or several distance types, in terms of features to be developed.

The survey results on the structural dimension confirm previous conclusions on the paramount importance of leadership and trust in both face-to-face and distributed collaboration. As a first conclusion, it would make sense to investigate how CWE can better support leadership, in terms of the shared purpose, vision, goals and objectives that are essential elements of distributed project management. However, the level of trust depends on the ability and amount of shared knowledge and strategic information (e.g. purpose, vision, goals and objectives) among distributed team members. Hence, it would also be worthwhile to investigate the potential connection between leadership and trust, in a CWE in which were embedded appropriate trust models for supporting eCollaboration.

Future work could address virtual or online proximity, which allow a wide spectrum of cultural and organisational diversity, together with the necessary supporting technologies and where and when to apply them in order to quickly reach the most appropriate level of mutual understanding while ensuring a high level of creativity and innovation. It is also intended that the proposed CDF will raise awareness of emerging concepts and artefacts that will, sooner or later, lead to the development of socially enabled technologies, allowing groups of users to create or personalise their own eCollaboration environment according to their specific needs.

Concerning the legal and ethical dimension of the CDF, there is currently a clear lack of ICT support, revealing numerous opportunities to create innovative tools. One example of this is the tracking of idea ownership, which would make project stakeholders more confident in sharing knowledge. As for the technical dimension, the two factors rated as the most significant are shared knowledge and shared meanings. Both contribute to reaching a mutual understanding, described by Roschelle & Teasley (1995) as the essence of collaboration. Meanwhile, Van den Bossche et al. (2010) state that shared mental models mediate the relationship between team learning behaviours and team effectiveness. In their recent empirical study they conclude that a shared mental model of task environment among team members leads to improved performance. This conclusion correlates with the comparison of collaboration performance among the 14 project cases obtained in this study, especially in terms of effectiveness. Now, it becomes obvious that the use of collaborative modelling techniques, methods and tools enabled team members to build shared mental models of their project tasks and process, which led to a mutual understanding and hence to an increased collaboration performance. Further research on experiencing different generic collaboration process and collaboration mechanics alternatives, including indicators for measuring the impact of distance factors on collaboration performance, would help to reach a deeper level of understanding on the embedded mechanics (instant learning among team members and across project teams, construction of shared mental models, shared cognition and cognitive mapping).

Some years ago, new technologies such as wiki and blogging opened the door to mass participation and collaboration. Such technologies allow individuals freely to create content and to share their views and concerns on the Web, and can potentially lead to some sort of collective intelligence and participative democracy. Furthermore, wiki has enabled mass collaboration, where thousands of individuals together create valuable content for the society at large (e.g. Wikipedia). Last but not least, online social networking has unleashed the power of individuals' social curiosity in such a way that millions of people spend time every day on people networking. Today, the challenge is to create new ICT artefacts, enabling a wide diversity of individuals to quickly build a minimum level of mutual understanding to support broader social interactions and hence deeper knowledge creation, leading to successful innovation, which is the desired outcome of any collaboration project.

References

Adams, B.N. (1967) Interaction Theory and the Social Network. *Sociometry*, 30(1): 64-78.

Ahuja, G. (2000) Collaboration networks, structural holes and innovation: a longitudinal study. *Administrative Science Quarterly*, 45: 425-455.

Alexander, S. (2000) Virtual Teams Going Global. *InfoWorld*, 22(46): 55-56.

Allen, T.J. (1977) *Managing the Flow of Technology*. Cambridge, MA: MIT Press.

Al-Rawas, A. and Easterbrook, S.M. (1996) A Field Study into the Communications Problems in Requirements Engineering. *Proceedings, Conference on Professional Awareness in Software Engineering (PACE-96)*, London, February 1996.

Ancona, D.G. and Caldwell, D.F. (1992) Bridging the boundary: External activity and performance in organizational teams. *Administrative Science Quarterly*, 37(4): 634-665.

Antoniac, P. and Pulli, P. (2000) The Trust Factor in the Virtual Enterprise. A Mobile Broadband Service Approach. In: *Proceedings of the 6th International Conference on Concurrent Enterprising (ICE 2000)* F. Weber and K. Pawar (eds), Toulouse, France, (University of Nottingham, Nottingham), pp. 287-294.

Antoniac, P., Pallot, M. and Pulli, P. (2006) Virtual and augmented reality supporting people consciousness within collaborative working environments. In: *Proceedings of the 12th International Conference on Concurrent Enterprising ICE 2006*, K.D. Thoben, K. S. Pawar, M. Taisch and S. Terzi (eds), 26-28 June 2006, Milan, Italy, University of Nottingham, Nottingham. (ISBN 0 85358 228 9). pp. 213-220.

Appelt, W., Pajo, S. and Prinz, W. (2007) Supporting trust building in distributed groups by appropriate security technology. In: *Proceedings of the 2007 International ACM Conference on Supporting Group Work* (Sanibel Island, Florida, USA, November 04 - 07, 2007). GROUP '07. ACM, New York, pp. 391-398.

Arias, E.G., Eden, H., Fischer, G., Gorman, A. and Scharff, E. (2000) Transcending the Individual Human Mind—Creating Shared Understanding through Collaborative Design. *ACM Transactions on Computer Human-Interaction*, 7(1): 84-113.

Armstrong, D. and Cole, P. (2002) Managing distances and differences in geographically distributed work groups. In: P. Hinds and S Kiesler (eds), *Distributed Work*. The MIT Press, Cambridge, MA, pp. 167-186.

Baird, F., Moore, C.J. and Jagodzinski, A.P. (2000) An ethnographic study of engineering design teams at Rolls-Royce Aerospace. *Design Studies*, 21(4): 333-355.

Baker, D.F. (2001) The Development of Collective Efficacy in Small Task Groups. *Small Group Research*, 32(4):451-474.

Bal, J. and Foster, P. (2000) Managing the Virtual Team and Controlling Effectiveness. *International Journal of Production Research*, 38: 40-54.

Barkema, H.G., Shenkar, O., Vermeulen, F. and Bell, J.H.J. (1997) Working abroad, working with others: How firms learn to operate international joint ventures. *Academy of Management Journal* 40: 426-442.

Basili, V.R. (1996) The Role of Experimentation in Software Engineering: Past, Current, and Future. In: *Proceedings of the 18th International Conference on Software Engineering*. Berlin, Germany, March 25-30, 1996), pp. 442-449.

Batagelj, V. and Mrvar, A. (2000) Some analyses of Erdős collaboration graph. *Social Networks*, 22 (2): 173-186.

Biggs, J. (1996) Western misperceptions of the Confucian-heritage learning culture. In: D.A. Walkins and J.B. Biggs (eds), *The Chinese Learner: Cultural Psychological and Contextual Influences*. Hong Kong: University of Hong Kong, Comparative Education Research Center, pp. 45-68.

Birnholtz, J.P. (2005) When do Researchers Collaborate? Towards a Model of Collaboration Propensity in Science and Engineering Research. PHD Thesis, The University of Michigan.

Bodker, K. and Pedersen, J. (1991) Workplace Cultures: Looking at Artifacts, Symbols and Practices, in J. Greenbaum and M. Kyng (eds.), Design at Work: Cooperative Design of Computer Systems, Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 121-136.

Boix Miralles, R. (2001) Study of Company Networks. Master Thesis, School of Engineering, Jönköping University, Sweden/ Universitat Politècnica de Catalunya, Barcelona, Spain.

Boland, R.J. and Tenkasi, R.V. (1995) Perspective making and perspective taking in communities of knowing. *Organization Science*, 6: 350-372.

Bonifacio, M. and Molani, A. (2003) The Richness of Diversity in Knowledge Creation: An Interdisciplinary Overview. *Proceedings of IKNOW' 03*, Graz, Austria, pp. 379-388.

Borghoff, U.M. and Schlichter, J.H. (2000) *Computer-Supported Cooperative Work*. Springer.

Boschma. R.A. (2005) Proximity and innovation: a critical assessment, *Regional Studies*, 39(1): 61-74.

Bowers, J. (1993) Understanding Organization Performatively. In: L. Bannon and K. Schmidt (eds), *Issues of Supporting Organizational Context in CSCW Systems*, COMIC, Esprit Basic Research Project 6225, Computing Department, Lancaster University, Lancaster, UK, pp. 49-72.

Bowker, G.C. and Star, S. L. (2000) *Sorting Things Out — Classification and Its Consequences*. MIT Press, Cambridge, MA.

Bradner, E. and Mark, G. (2002) Why Distance Matters: Effects on Cooperation, Persuasion and Deception. In: *Proceedings of Computer Supported Cooperative Work CSCW 2002*, New Orleans, Louisiana, USA.

Bradshaw, M. (2001) Multiple proximities: Culture and geography in the transport logistics of newsprint manufactured in Australia. *Environment and Planning A*, 33 (10): 1717-1739.

Broom, M. (2002) From effective groups to powerful teams. *Incentive*, 176 (11): 65-7.

Brouthers, K.D. and Brouthers, L.E. (2001) Explaining the National Cultural Distance Paradox. *Journal of International Business Studies* 32 (1): 177-189.

Brown, J.S. and Duguid, P. (1991) Organizational Learning and Communities-of-Practice: Toward a Unified View of Working, Learning, and Innovation. *Organization Science*, 2(1): 40-57.

Brown, J.S. and Duguid, P. (2000) *The Social Life of Information*. Harvard Business School Press, Boston, MA.

Brown, J.S., Duguid, P. and Haviland, S. (1994) Toward Informed Participation: Six Scenarios in Search of Democracy in the Information Age. *The Aspen Institute Quarterly*, 6(4): 49-73.

Bryman, A. and Burgess, R. (1999) Introduction. In: *Qualitative Research Methodology: A Review*. London: Sage.

Bucciarelli, L.L. (1994) *Designing Engineers.* MIT Press, Cambridge MA.

Büchel, B. and Denison, D.R. (2003) *Knowledge Density and Success of New Product Development Teams*. IMD – International Institute for Management Development.

Byron, D. K. and Stoia, L. (2003) *An Analysis of Proximity Markers in Collaborative Dialogs*. The Ohio State University, Computer Science and Engineering.

Cairncross, F. (1997) *The Death of Distance: How the Communications Revolution Will Change Our Lives*. Harvard Business School Press: Cambridge, MA.

Cannon-Bowers, J.E., Salas, E. and Converse, S. (1993) Shared Mental Models in Expert Team Decision-Making. In: J. Castellan (ed.), *Individual and Group Decision-Making: Current Issues*. Mahwah, NJ: Lawrence Earlbaum and Associates, Inc.,1993, p. 221-246.

Carley, K.M. (1997) Extracting team mental models through textual analysis. *Journal of Organizational Behavior*, 18: 533–558..

Carroll, J.M., Rosson, M.B. and Zhou, J., (2005) Collective efficacy as a measure of community. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, April 02-07, Portland, Oregon, USA.

Chakrabarti, S., Srivastava, S., Subramanyam, M. and Tiwari, M. (2000) Memex: A Browsing Assistant for Collaborative Archiving and Mining of Surf Trails. In: *Proceedings of the 26th international Conference on Very Large Data Bases*. Morgan Kaufmann Publishers, San Francisco, CA, pp. 603-606.

Chatzkel, J.L. (2003) *Knowledge Capital*. New York, NY: Oxford University Press.

Cherniss, C. (2001) Emotional intelligence and organizational effectiveness. In: C. Cherniss and D. Goleman (eds), *The Emotionally Intelligent Workplace*. San Francisco: Jossey-Bass.

Chesbrough, H.W. (2003) *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, Harvard Business School Press.

Child, J., Ng, S.H. and Wong, C. (2002) Psychic distance and internationalization: A critical examination. *International Studies of Management and Organization*, 32: 36–56.

Citera, M., McNeese, M.D., Brown, C.E., Selvaraj, J.A., Zaff, B.S. and Whitaker, R.D. (1995) Fitting Information Systems to Collaborating Design Teams. *Journal of the American Society for Information Science*, 46(7): 551-559.

Clark, H. (1996) Using Language. Cambridge: Cambridge University Press.

Clark, H.H. and Brennan, S.E. (1991) Grounding in Communication. In: L.B. Resnick, J.M. Levine and S.D. Teasley (eds), *Perspectives on Socially Shared Cognition.* American Psychological Association, pp. 127-149.

Clark, K.B. and Fujimoto, T. (1991) *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Boston: Harvard Business School Press.

Coenen, L., Moodysson. J. and Asheim. B.T. (2004) Nodes, networks and proximities: on the knowledge dynamics of the Medicon Valley biotech cluster. *European Planning Studies*, 12(7): 1003-1018.

Cohen, W.M. and Levinthal, D.A. (1990) Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly*, 35 (1): 128-152.

Cohendet, P. (2005) On Knowing Communities. Proceedings of the Conference Advancing Knowledge and the Knowledge Economy, 10-11 January 2005, National Academies, Washington, DC.

Coleman, D. (ed.) (1997) *Groupware: Collaborative Strategies for Corporate LANs and Intranets*. Prentice Hall.

Constant, D., Kiesler, S., and Sproull, L. (1994) What's mine is ours, or is it? A study of attitudes about information sharing. *Information Systems Research*, 5(4): 400-421.

Constant, D., Sproull, L., & Kiesler, S. (1996) Kindness of strangers: The usefulness of electronic weak ties for technical advice. Organization Science, 7(2), 119-135.

Cooper, R.G. and Kleinschmidt, E.J (1995) Benchmarking the Firm's Critical Success Factors In New Product Development. *Journal of Product Innovation Management*, 12(5), November 1995: 374-391.

Coutu, D.L. (1998) Trust in virtual teams. *Harvard Business Review*, May-June, 76(3): 20-22.

Coviello, N. and McAuley, A. (1999) Internationalisation and the small firm: a review of contemporary empirical research. *Management International Review*, 39 (3): 223–256.

Cramton, C.D. (2001) The Mutual Knowledge Problem and Its Consequences for Dispersed Collaboration. *Organization Science*, 12(3): 346-371.

Créplet, F., Dupouët, O. and Vaast, E. (2003) Communities, communication, teaching and technology. *Humanist Discussion Group*, Vol. 17, No. 191, 2003.

Croft, W.B. and Turtle, H.A. (1989) Retrieval Model Incorporating Hypertext Links. *Proceedings of Hypertext '89*. ACM Press.

Csikszentmihalyi, M. (1996) *Creativity - Flow and the Psychology of Discovery and Invention*. HarperCollins Publishers, New York, NY.

Cummings, J.N. and Kiesler, S.B. (2003) Coordination and Success in Multidisciplinary Scientific Collaborations. *ICIS*, pp. 296-303.

Cunningham, J.B. (1997) Case study principles for different types of cases. *Quality and Quantity*, 31: 401-423.

Daft, R.L. and Lengel, R.H. (1984) Information Richness: A New Approach to Managerial Behavior and Organizational Design. In: *Research in Organizational Behavior*, L.L. Cummings and B.M. Staw (eds), JAI Press, Homewood, IL, pp. 191-233.

Daft, R.L. and Lengel, R.H. (1986) Organizational information requirements, media richness and structural design. *Management Science* 32(5): 554-571.

Daft, R.L., Lengel, R.H. and Trevino, L.K. (1987) Message Equivocality, Media Selection, and Manager Performance: Implications for Information Systems. *MIS Quarterly* 11(3):355-366.

Damian, D. (2002) *An empirical study of requirements engineering in distributed software projects: is distance negotiation more effective?* Faculty of Information Technology, University of Technology, Sydney, Australia.

Dana, L.P., Etemad, H. and Wright, R.W. (2001) Toward a paradigm of symbiotic entrepreneurship. *International Journal of Entrepreneurship and Small Business*, 5 (2): 109–126.

Das, T.H. (1983) Qualitative research in organizational behaviour. *The Journal of Management Studies*, 20 (3): 301-314.

Davenport, T.H. (2005) *Thinking for a Living: How to Get Better Performances and Results from Knowledge Workers*. Boston: Harvard Business School Press.

Demetriadis, S.N., Papadopoulos, P. and Tsoukalas, I. (2005) Bridging the contextual distance: The e-CASE learning environment for supporting students' context awareness. *Pan-Hellenic Conference on Informatics No10*, Volos, GRECE, vol. 3746, pp. 523-533.

DeSanctis, G., Wright, M. and Jiang, L. (2001). Building a global learning community. *Communications of the ACM*, 44(12): 80-82.

Dey, A., Salber, D. and Abowd, G. (2001) A conceptual framework and a toolkit for supporting the rapid prototyping of context-aware applications. *Human-Computer Interactions*, 16(2-4): 97-166.

Dong, A. (2005) The latent semantic approach to studying design team communication. *Design Studies*, 26(5): 445-461.

Donnellan, B. and Fitzgerald, B. (2003) Developing Systems to Support Organisational Learning in Product Development Organisations. *Electronic Journal of Knowledge Management*, paper 4 issue 2, Academic Conferences International Limited.

Dorigo, M. and Stützle, T. (2004) *Ant Colony Optimization*. MIT Press, 2004. ISBN 0-262-04219-3.

Druskat, V.U. and Wolff, S.B. (2001) Group emotional competence and its influence on group effectiveness. In: C. Cherniss and D. Goleman (eds), *The Emotionally Intelligent Workplace*. San Francisco: Jossey-Bass, pp. 132-155.

Eccles, D.W. and Tenenbaum, G. (2004) Why an expert team is more than a team of experts: A social-cognitive conceptualization of team coordination and communication in sport. *Journal of Sport and Exercise Psychology* , 26: 542-560.

Efimova, L. (2004). Discovering the iceberg of knowledge work: A weblog case. In *Proceedings of The Fifth European Conference on Organisational Knowledge, Learning and Capabilities (OKLC 2004)*, April 2-3, 2004.

Egea, K. (2006) Relationship building in virtual teams: An academic case study. In: *Proceedings for Informing Science and Information Technology Education Joint Conference (InSite'02)*, pp.25-28.

Elliott, M. (2006) Stigmergic Collaboration: The Evolution of Group Work. *M/C Journal*, 9(2). Retrieved Jun. 2008 from http://journal.media-culture.org.au/0605/03-elliott.php

Ellis, C.A., Gibbs, S.J. and Rein, G.L. (1991) Groupware: Some Issues and Experiences. *Communications of the ACM, 1991*, 34(1): 38-58.

Erickson, T. (2008) 'Social' systems: designing digital systems that support social intelligence. *AI Soc*. 23 (2): 147-166.

Erickson T. and Kellogg W.A. (2000) Social Translucence: An Approach to Designing Systems that Mesh with Social Processes. *Transactions on Computer-Human Interaction* 7(1):59-83.

Erickson, T., Huang, W., Danis, C. and Kellogg, W.A. (2004) A Social Proxy for Distributed Tasks: Design and Evaluation of a Working Prototype. *The Proceedings of CHI 2004*, 559-566.

Erickson, T., Kellogg, W.A., Laff, M., Sussman, J., Wolf, T.V., Halverson, C.A. and Edwards, D.A. (2006) A Persistent Chat Space for Work Groups: The Design, Evaluation and Deployment of Loops. *The Proceedings of DIS 2006*, 331-340.

Espinosa, J. A., Cummings, J. N., Wilson, J. M. and Pearce, B. M. (2003) Team Boundary Issues Across Multiple Global Firms. *Journal of Management Information Systems*, 19(4): 157–190.

Espinosa, J. A., Kraut, R. E., Slaughter, S. A., Lerch, F. J, Herbsleb, J. D. and Mockus, A. (2002) Shared Mental Models, Familiarity, and Coordination: A Multi-Method Study of Distributed Software Teams. In Proceedings of the International Conference in Information Systems, Barcelona, Spain, December 2002.

Filippi, M. and Torre, A. (2003) Local organisations and institutions. How can geographical proximity be activated by collective projects? *International Journal of Technology Management*, 26(2-4): 386-400.

Finholt, T.A., Sproull, L. and Kiesler, S. (2001) Outsiders on the inside: Sharing know-how across space and time. In: P. Hinds and S. Kiesler, *Distributed Work*, Cambridge, MA: MIT Press.

Finke, R.A., Ward, T.B. and Smith, S.M. (1992) *Creative Cognition: Theory, Research, and Applications*. Cambridge, MA: Bradford-MIT Press.

Fischer, G. (2001) Communities of Interest: Learning through the Interaction of Multiple Knowledge Systems. In Proceedings of the 24th Annual Information Systems Research Seminar in Scandinavia (IRIS'24), Ulvik, Norway, pp. 1-14.

Fischer, G. (2004) Social Creativity: Turning Barriers into Opportunities for Collaborative Design. In: F. deCindio and D. Schuler (eds), *Proceedings of the Participatory Design Conference (PDC'04)*, CPSR, P.O. Box 717, Palo Alto, CA 94302, University of Toronto, Canada, July, pp. 152-161.

Fischer, G. (2005a) From Reflective Practitioners to Reflective Communities. *Proceedings of the HCI International Conference (HCII)*, Las Vegas, July 2005.

Fischer, G. (2005b) Social Creativity: Turning Barriers into Opportunities for Collaborative Design. *Proceedings of the Eighth Conference on Participatory Design*, ISBN 1581138512, pp. 152-161.

Fischer, G. (2005c) Distances and diversity: sources for social creativity. *Proceedings of the 5th Conference on Creativity and Cognition*, New York: ACM Press, pp.128-136.

Foroohar R. and Roll, A.S. (2005) Newsweek special issue - Issues 2006: The Knowledge Revolution.

Fuchs-Kittowski, F. and Köhler, A. (2005) Wiki Communities in the Context of Work Processes. In proceedings of WiKiSym'05, October 16-18, San Diego, CA, U.S.A.

Fuller, M., Hardin, A. and Davison, R. (2006) Efficacy in Technology-Mediated Distributed Teams, *Journal of Management Information Systems*, 23(3): 209-235.

Furst, S., Blackburn, R. and Rosen, B. (1999) Virtual Team Effectiveness: A Proposed Research Agenda. *Information Systems Journal*, 9: 249-270.

Fussell, S. R., Kiesler, S. , Setlock, L. D. , Scupelli, P. (2004) Effects of instant messaging on the management of multiple project trajectories. In Proceedings of the SIGCHI conference on Human factors in computing systems, p.191-198, April 24-29, 2004, Vienna, Austria .

Gartner and MIT (2001) The Agile Workplace: Supporting People and their Work. A Research Partnership between Gartner, MIT and 22 Industry Sponsors: Stamford, CT, December 2001.

Gasson, S. (2004) The Management of Distributed Organizational Knowledge. In Proceedings of the 37th Hawaii International Conference on System Sciences, Hawaii, USA.

Gaudes, A., Hamilton-Bogart, B., Marsh, S. and Robinson, H. (2007). A Framework for Constructing Effective Virtual Teams. *The Journal of E-working* 1(2): 83-97.

Gentner D. (1983) Structure-mapping: A theoretical framework for analogy. In Cognitive Science, 7 (2), pp. 155-170.

Gertler M.S. (1995) Being there - proximity, organization, and culture in the development and adoption of advanced manufacturing technologies. *Economic Geography*, 71(1): 1-26.

Ghemawat, P. (2001) Distance still matters: the hard reality of global expansion. *Harvard Business Review*, 79 (9): 137–147.

Gibson, C.B. (1999) Do they do what they believe they can? Group efficacy and group effectiveness across tasks and cultures. *Academy of Management Journal*, 42 (2): 138-152.

Gibson, C.B., Randel, A.E. and Earley, P.C. (2000) Understanding group efficacy: An empirical test of multiple assessment methods. *Group & Organization Management*, 25(1): 67-97.

Gill, J. and Butler, R.J. (2003) Managing instability in cross-cultural alliances. *Long Range Planning*, 36(6), December 2003: 543-563.

Glaser, B. and Strauss, A. (1967) *The Discovery of Grounded Theory*. Chicago: Aidine.

Glover, K. (2000) Proximal and distal deixis in negotiation talk. *Journal of Pragmatics*, 32: 915-926.

Goleman, D. (1998) *Working with Emotional Intelligence*. N.Y.: Bantam.

Goleman, D. (2006) *Social Intelligence: The New Science of Social Relationships*. Bantam Books. ISBN 978-0553803525.

González, M.G., Burke, M.J., Santuzzi, A.M. and Bradley, J.C. (2003) The impact of group process variables on the effectiveness of distance collaboration groups. *Computers in Human Behavior*, 19 (5): 629-648.

Goodall, K. and Roberts, J. (2003) Repairing Managerial Knowledge-Ability over Distance. *Organization Studies* 24 (7): 1153-1175.

Grabher, G. (2004) Learning in Projects, Remembering in Networks? Communality, Sociality and Connectivity in Project Ecologies. *European Urban and Regional Studies*, 11(2): 103-123.

Greunz, L. (2003) Geographically and technologically mediated knowledge spillovers between European regions. *Annals of Regional Science*, 37 (4): pp. 657-680.

Griffin, A. (1996) PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices. *The Journal of Product Innovation Management*, 14(6): 429-458.

Griffin, R. and Kacmar, K. M. (1991) Laboratory research in management: Misconceptions and missed opportunities. *Journal of Organizational Behavior*, 12: 301–311.

Grinter, R.E., Herbsleb, J.D. and Perry, D.E. (1999) The Geography of Coordination: Dealing with Distance in R&D Work, *Proceedings of the GROUP 99 Conference of the ACM*, Phoenix, AZ, 306-315.

Gross, T. and Prinz, W. (2003) Awareness in context: a light-weight approach. In: *Proceedings of the Eighth Conference on European Conference on Computer Supported Cooperative Work* (Helsinki, Finland, September 14 - 18, 2003), K. Kuutti, E. H. Karsten, G. Fitzpatrick, P. Dourish and K. Schmidt (eds), ECSCW. Kluwer Academic Publishers, Norwell, MA, 295-314.

Gross, T., Wirsam, W. and Gräther, W. (2003) AwarenessMaps: visualizing awareness in shared workspaces. In Proceedings of CHI03 Extended Abstracts, pp.784-785.

Grossman, S. J. and Hart, O. D. (1986) The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy*, University of Chicago Press, 94(4): 691-719, August.

Gully, S.M., Incalcaterra, K.A., Joshi, A. and Beaubien, J.M. (2002) A meta-analysis of team-efficacy, potency, and performance: Interdependence and level of analysis as moderators of observed relationships. *Journal of Applied Psychology*, 87(5): 819-832.

Gundel, J., Hedberg, N. and Zacharski, R. (1993) Cognitive Status and the Form of Referring Expressions in Discourse. *Language* 69(2): 274-307.

Gupta, R. and Landry, J. (2000). Profiting from Open Source. Harvard Business Review. doi:10.1225/F00503.

Gutwin, C. and Greenberg, S. (1999) A Framework of Awareness for Small Groups in Shared-Workspace Groupware. Technical Report 99-1, Department of Computer Science, University of Saskatchewan, Canada.

Gutwin, C. and Greenberg, S. (2000) The Mechanics of Collaboration: Developing Low Cost Usability Evaluation Methods for Shared Workspaces. In: *Proceedings of the 9th IEEE international Workshops on Enabling Technologies: Infrastructure for Collaborative Enterprises* (June, 2000), WETICE. IEEE Computer Society, Washington, DC, pp. 98-103.

Gutwin, C., Greenberg, S. (2002) A Descriptive Framework of Workspace Awareness for Real-Time Groupware, Computer Supported Cooperative Work, 11(3): 411-446.

Hackman, J.R. and Morris, C.G. (1975) Group tasks, group interaction process, and group performance effectiveness: A review and proposed integration. In: L. Berkowitz (ed.), *Advances in Experimental Social Psychology* (Vol. 8). New York: Academic Press.

Hall, Edward T. (1966) *The Hidden Dimension*. Anchor Books. ISBN 0-385-08476-5.

Halliday, M. and Hasan, R. (1976) *Cohesion in English*. Longman.

Harary, F. (1979) *Topics in Graph Theory*. New York Academy of Sciences, 1979. ISBN:0897660285.

Hardin, A. M., Fuller, M. A. and Davison, R. M. (2007) I Know I Can, but Can We? Culture and Efficacy Beliefs in Global Virtual Teams. *Small Group Research*, 38 (1): 1-25.

Hardin, A.M., Fuller, M.A. and Valacich, J. (2006) Group Efficacy in Virtual Teams: New Questions in an Old Debate. *Small Group Research*, 37(1): 65-85.

Hart, O. and Moore, J. (1990) *A Theory of Corporate Financial Structure Based on the Seniority of Claims*. STICERD - Theoretical Economics Paper Series 217, Suntory and Toyota International Centres for Economics and Related Disciplines, LSE.

Hill, A., Song, S., Dong, A. and Agogino, A. M. (2001) Identifying Shared Understanding in Design Teams Using Document Analysis. *Proceedings of the 13th International Conference on Design Theory and Methodology*, DETC2001/DTM-21713, Pittsburgh, PA, USA.

Hofstadter D.R. and Mitchell M. (1995) The copycat project: A model of mental fluidity and analogy-making. In: D. Hofstadter and the Fluid Analogies Research Group, *Fluid Concepts and Creative Analogies.* Basic Books, Chapter 5, pp. 205-267.

Hofstede, G. (1980) *Culture's Consequences: International Differences in Work-related Values.* Sage, Beverly Hills, CA.

Hofstede, G. (1994) Cultural constraints in management theories. *International Review of Strategic Management*, Vol. 5, 27-49.

Hoinville, G. and Jowell, R. (1978) *Survey Research Practice*. Heinemann, London, UK.

Hollan, J., Hutchins, E. and Kirsch, D. (2001) Distributed Cognition: Toward a New Foundation for Human-Computer Interaction Research. In: J. M. Carroll (ed.), *Human-Computer Interaction in the New Millennium*. ACM Press, New York, pp. 75-94.

Hoschka, P. (1998) CSCW Research at GMD-FIT: From Basic Groupware to the Social Web. In Newsletter ACM SIGGROUP Bulletin Volume 19 Issue 2, Aug. 1, 1998

Howells, J.R.L. (2002) Tacit knowledge, innovation and economic geography. *Urban Studies*, 39(5-6): 871-884.

Hurley, R.F. and Hult, T.M. (1998) Innovation, market orientation, and organizational learning: an integration and empirical examination. *Journal of Marketing*, 62(3): 42-54.

Hutchins, E. (1990) The Technology of Team Navigation. In J. Galegher, R. Kraut and C. Egido (eds.): Intellectual Teamwork: Social and Technological Foundations of Cooperative Work. Hillsdale, NJ: Lawrence Erlbaum, pp. 191–220.

Hymes, C. M. and Olson, G. M. (1992) Unblocking Brainstorming through the Use of a Simple Group Editor. In: *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW'92)*, pp. 99-106.

Hyypiä, M. and Kautonen, M. (2005) Dimensions of Proximity in Relationships between Knowledge Intensive Business Service Firms and Their Clients. In: *Regional Studies Association International Conference on Regional Growth Agendas* Aalborg, Denmark, May 28 – 31.

Introna, L. (2005) Strangers and hospitality: on the social and ethical conditions of virtual communities. In: *Ethics of New Information Technologies. Proceedings of the 6th Computer Ethics: Philosophical Enquiries Conference.* University of Twente, The Netherlands, pp. 229-240.

Jarvenpaa, S. L. and Leidner, D. E. (1999) Communication and Trust in Global Virtual Teams. *Organization Science*, 10(6): 791-815.

Johanson, J. and Wiedersheim-Paul, F. (1975) The Internationalisation of the Firm-Four Swedish Cases. *Journal of Management Studies*, 12(3): 305-322.

Jones, P., Pawar, K.S., Riedel, J. and Pallot, M. (1999) Electronic Commerce for Programme management Information sharing in the Concurrent Enterprise (EPICE): Opening up the black box. *Proceedings of the 5th International Conference on Concurrent Enterprising, ICE'99 The Concurrent Enterprise in Operation*. The Hague, the Netherlands.

Jung, D.I. and Sosik, J.J. (2003) Group potency and collective efficacy: Examining their predictive validity, level of analysis, and effects of performance feedback on future group performance. *Group & Organization Management*, 28(3): 366-391.

Kapor, M. (2005) Content Creation by Massively Distributed Collaboration. Distinguished lecture at UC Berkeley. Retrieved from: http://www.sims.berkeley.edu/about/events/dls11092005

Katz-Navon, T.Y. and Erez, M. (2005) When Collective- and Self-Efficacy Affect Team Performance: The Role of Task Interdependence. *Small Group Research*, 36(4): 437-465.

Kayworth, T. R. and Leidner, D. E. (2002) Leadership Effectiveness in Global Virtual Teams. *Journal of Management Information Systems*, 18, 7-41.

Ketchen, D.J. Jr., Combs, J.G., Russell, C.J. and Shook, C. (1997) Organizational configurations and performance: A meta-analysis. *Academy of Management Journal*, 40(1): 223-240.

Kiesler, S. and Cummings, J.N. (2002) What Do We Know about Proximity and Distance in Work Groups? A Legacy of Research. In: P. Hinds and S. Kiesler (eds), *Distributed Work*. Cambridge: MA: MIT Press.

Kilker, J. (1999) Conflict on Collaborative Design Teams. *IEEE Technology and Society Magazine*, Fall, 12-21.

Kirat, T. and Lung, Y. (1999) Innovation and proximity - Territories as loci of collective learning processes. *European Urban and Regional Studies*, 6 (1): 27-38

Kleinsmann, M. (2006) *Understanding Collaborative Design*. Delft University of Technology, Delft.

Kleinsmann, M. and Dong, A. (2007) Investigating the Affective Force on Creating Shared Understanding. *ASME 2007 Int'l Design Engineering Technical Conferences and Computers and Information in Engineering Conference*, IDETC/CIE 2007, Las Vegas, Nevada, USA.

Kleinsmann, M. and Valkenburg, R. (2005). Learning from collaborative new product development projects. Journal of Workplace Learning, 17(3), 146-156.

Kleinsmann, M., Valkenburg, R. and Buijs, J. (2007) Why do actors in collaborative design understand each other? An empirical study towards a better understanding of collaborative design. *CoDesign*, 5(1): 1-15.

Knoben J. and Oerlemans L.A.G. (2006) Proximity and Inter-Organizational Collaboration: A Literature Review. *International Journal of Management Reviews*, 8(2):71-89.

Kock, N. (2005). Media Richness or Media Naturalness? The Evolution of our Biological Communication Apparatus and its Influence on our Behavior Toward E-Communication Tools. *IEEE Transactions on Professional Communication*, 48(2): 117-130.

Kock, N. and D'Arcy, J. (2002) Resolving the e-collaboration paradox: The competing influences of media naturalness and compensatory adaptation. *Information Management and Consulting*, 17(4): 72-78.

Koch, M. and Gross, T. (2006) Computer-Supported Cooperative Work – Concepts and Trends. *Proceedings of the Conference of the Association Information and Management (AIM).*

Kock, N. and Nosek, J. (2005) Expanding the Boundaries of E-Collaboration. *IEEE Transactions on Professional Communication*, 48(1), March 2005.

Koen, P., Ajamian, G., Burkart, R., Clamen, A., Davidson, J., D'Amore, R., Elkins, C., Herald, K., Incorvia, M., Johnson, A., Karol, R., Seibert, R., Slavejkov, A. and Wagner, K. (2001) Providing Clarity and a Common Language to the Fuzzy Front End. *Research-Technology Management.* Industrial Research Institute, Inc., 44(2): 46-55.

Kraut R., Fussell, S., Brennan, S. and Siegel, J. (2002) Understanding Effects of Proximity on Collaboration: Implications for Technologies to Support Remote Collaborative Work. In: P. Hinds and S. Kiesler (eds), *Distributed Work*. Cambridge: MA: MIT Press, pp. 137-162.

Kriplean, T., Beschastnikh, I., McDonald, D.W. and Golder, S.A. (2007) Community, consensus, coercion, control: cs*w or how policy mediates mass participation. In: *Proceedings of the 2007*

International ACM Conference on Supporting Group Work. GROUP '07. ACM, New York, NY, pp. 167-176.

Kristensen K. (2003) Physual Designing – A Supportive Framework for Dispersed Engineering Design. Doctoral dissertation, Department of Machine Design and Materials Technology, NTNU, Trondheim, Norway, 2003.

Kristensen K., Røyrvik J. (2005) Applications of the Physual Designing Network in Extended Teams. *Proceedings of the 11th International Conference on Concurrent Enterprising*, Munich, Germany, 2005.

Kristensen, K., Hildre, H.P., Sivertsen, O.I.. and Røyrvik, J. (2004) Physual Designing Network - Addressing Inter-layer Collaboration in Dispersed Teams. *Proceedings of the 10th International Conference on Concurrent Enterprising*. Seville, Spain, pp. 19-26.

Langdridge, D. (2004) *Introduction to Research Methods and Data Analysis in Psychology*. Pearson/Prentice Hall.

Latané, B., Liu, J. H., Nowak, A., Bonevento, M. and Zheng, L. (1995) Distance Matters: Physical Space and Social Impact. *Personality and Social Psychology Bulletin*, 21(8): 795-805.

Lave, J. and Wenger, E. (1991) *Situated Learning: Legitimate Peripheral Participation*. Cambridge University Press, New York.

Levesque, L.L., Wilson, J.M. and Wholey, D.R. (2001) Cognitive Divergence and Shared Mental Models in Software Development Project Teams. *Journal of Organizational Behavior*, (22), March 2001, 135-144.

Levina, N. and Vaast, E. (2005) Turning Collaboration into Transaction: A Case of Intranet Use in Boundary-Spanning Practices. *Proceedings of the 38th Hawaii International Conference on System Sciences – 2005.*

Lindkvist, L. (2005) Knowledge communities and knowledge collectivities: A typology of knowledge work in groups. *Journal of Management Studies*, 42: 1189-1210.

Lipnack, J. and Stamps, J. (1997) *Virtual Teams. Reaching Across Space, Time and Organizations with Technology*. Canada: John Wiley & Sons.

Liu, H. and Singh, P. (2004) ConceptNet - a practical commonsense reasoning tool-kit. *BT Technology Journal*, 22(4): 211-226.

Lloyd, P. (2000) Storytelling and the development of discourse in the engineering design process. *Design Studies*, 21: 357-373.

Lu, M., House, C.H., Watson-Manheim, M.B. and Matzkevich, T. (2005) Does Distance Matter? - Bridging the Discontinuities in Distributed Organizations. In: *Proceedings of the 38th Annual Hawaii International Conference on System Sciences (Hicss'05)* - Track 1 - Volume 01 HICSS. IEEE Computer Society, Washington, DC.

Luft, J. and Ingham, H. (1955) The Johari window, a graphic model of interpersonal awareness. *Proceedings of the Western Training Laboratory in Group Development*. Los Angeles: UCLA.

Malhotra, A., Majchrzak, A., Carman, R. and Lott, V. (2001) Radical innovation without collocation: A case study at Boeing-Rocketdyne. *MIS Quarterly*, 25: 229.

Malone, T.W., Yates, J. and Benjamin, R.I. (1987) Electronic Markets and Electronic Hierarchies. *Communications of the ACM*, 30: 484-497.

Marks, M.A., Mathieu, J.E. and Zaccaro, S.J. (2001) A temporally based framework and taxonomy of team processes. *Academy of Management Review*, 26: 356–376.

Mårtensson, P. (2001) *Management Processes: An Information Perspective on Managerial Work*. Stockholm, Sweden: The Economics Research Institute.

Martins, L.L., Gilson, L.L. and Maynard, M.T. (2004) Virtual teams: What do we know and where do we go from here? *Journal of Management*, 30(6): 805-835.

Mathieu, J., Goodwin, G.F., Heffner, T.S., Salas, E. and Cannon-Bowers, J.A. (2000)The Influence of Shared Mental Models on Team Process and Performance. *Journal of Applied Psychology*, 85(2):273-283.

Maxim, P. (1999) *Quantitative Research Methods in the Social Sciences*. Oxford University Press.

Mayben R., Nichols S. and Wright V.H. (2003) Distance Technologies in Collaborative Research: Analyzing the Successes and Barriers. *The Journal of Interactive Online Learning*, 2(2).

Mayer, J.D., Salovey, P. and Caruso, D. R. (2000) Models of emotional intelligence. In: R.J. Sternberg (ed.), *Handbook of Human Intelligence* (2nd ed., 396-420). N.Y.: Cambridge University Press.

Maznevski, M.L. and Chudoba, K.M. (2000) Bridging space over time: Global virtual team dynamics and effectiveness. *Organization Science*, 11(5): 473-492.

McDonough, III, E.F., Kahn, K.B. and Barczak, G. (2000) An investigation of the use of global, virtual, and collocated new product development teams. *The Journal of Product Innovation Management*, 18(2): 110-120.

McGrath, J.E. (1964) *Social Psychology: A Brief Introduction*. New York: Holt.

Meisters, C. and Werker, C. (2004) Physical and organizational proximity in territorial innovation systems: introduction to the special issue. *Journal of Economic Geography* 4(1): 1-2.

Meyer, A.D., Tsui, A.S. and Hinings, C.R. (1993) Configurational approaches to organizational analysis. *Academy of Management Journal*, 36(6): 1175-1195.

Miller, D. (1987) The Genesis of Configuration. *Academy of Management Review*, 12(4): 686-701.

Moon, Y. (1999) The Effects of Physical Distance and Response Latency on Persuasion in Computer-Mediated Communication and Human-Computer Communication. *Journal of Experimental Psychology: Applied*, 5(4): 379-392.

Moon, Y. and Sproull, L. (2002) Essence of distributed work: The case of the Linux kernel. In: P.J. Hinds and S. Kiesler (eds.), *Distributed Work*, MIT Press, Cambridge, MA, pp. 381-404.

Moran, T.P. and Carroll, J.M. (eds.) (1996) *Design Rationale: Concepts, Techniques, and Use*, Lawrence Erlbaum Associates, Inc., Hillsdale, NJ.

Morello, D. and Burton, B. (2006) *Future Worker 2015: Extreme Individualization*. Gartner Research Report, Gartner Research.

Morosini P., Shane, S. and Singh, H. (1998) National cultural distance and cross-border acquisition performance. *Journal of International Business Studies*, 29(1): 137-158.

Morris, M. (2005) How do users feel about technology? *Forrester Research,* April 2005. Massachusetts: Forrester Research, Inc,

Mulder, I. (2002) A didactic model for learning and working together in global virtual teams. In: Purdue, D. and Stewart, M. (eds), *Understanding Collaboration*. Bristol, England: University of the West of England, Faculty of the Built Environment, pp. 159-162.

Murray, B. (1999) Schools unready for technology boom. *APA Monitor on Psychology*, 30(9): 22.

Nachum L. and Zaheer S. (2005) The persistence of distance? The impact of technology on MNE motivations for foreign investments. *Strategic Management Journal*, 26: 747-767.

Nardi, B. and Whittaker, S. (2002) The Role of Face-to-Face Communication in Distributed Work. In: P. Hinds and S. Kiesler (eds), *Distributed Work: New Research on Working across Distance Using Technology*, MIT Press, Cambridge, MA, pp. 83-112.

Neck, C.P. and Manz, C.C. (1994) From groupthink to teamthink: Toward the creation of constructive thought patterns in self-managing work teams, *Human Relations*, 47(8): 929-952

Neumann, A., Badke-Schaub, P. and Lauche, K. (2006) Measuring the development of shared mental models in product design teams. In: *16th World Congress of Ergonomics*, Maastricht. Netherlands, July 10-14

Noble, D. and Letsky, M. (2003) *Cognitive-based Metrics to Evaluate Collaboration Effectiveness*. Retrieved from: http://www.au.af.mil/au/awc/awcgate/navy/onr_metrics_on_collab.pdf

Nonaka, I. (1994) A Dynamic Theory of Organizational Knowledge Creation. *Organization Science*, 5(1): 14-38.

Nonaka, I. and Konno, N. (1998) The Concept of 'Ba': Building a Foundation for Knowledge Creation. *California Management Review*, 40: 40-54.

Nonaka, I. and Takeuchi, H. (1995) *The Knowledge-Creating Company: How the Japanese Companies Create the Dynamic of Innovation*. Oxford University Press.

Nooteboom, B. (1992) Towards a dynamic theory of transactions. *Journal of Evolutionary Economics*, 2: 281-99.

Nooteboom, B. (1999) *Inter-Firm Alliances: Analysis and Design*. London: Routledge

Nooteboom, B. (2000) Learning by interaction: Absorptive capacity, cognitive distance and governance. *Journal of Management and Governance*, 4: 69-92.

Nordstrom, K.A. and Vahlne, J.E. (1992) Is the globe shrinking? Psychic distance and the establishment of Swedish sales subsidiaries during the last 100 years. Paper presented at the International Trade and Finance Association's Annual Conference, April 22-25, Laredo, Texas.

Norman, D. (1993) Things That Make Us Smart. Reading, MA: Addison-Wesley.

Norman, D.A. and Hutchins, E.L. (1988) Computation via Direct Manipulation. Technical Report N00014-85-C-0133, Institute for Cognitive Science, University of California, San Diego, La Jolla, California, 1 August 1988.

North, D. C. (1997) The American Economic Review, Vol. 87(2), Papers and Proceedings of the Hundred and Fourth Annual Meeting of the American Economic Association (May, 1997), pp. 412-414

Nova, N. (2003) Socio-cognitive functions of space in collaborative settings: a literature review about Space, Cognition and Collaboration. Retrieved from: http://tecfa.unige.ch/perso/staf/nova/CRAFT_report1.pdf .

Novak, J. and Wurst, M. (2005) Collaborative Knowledge Visualization for Cross-Community Learning. In: Tergan, Sigmar-Olaf and Keller, Tanja (eds), *Knowledge and Information Visualization*, Springer LNCS, 2005, pp.95-116.

Odda, T. (1979) On properties of a well-known graph or what is your Ramsey number? Topics in graph theory. *Annals of the New York Academy of Sciences*, 328: 166–172.

O'Donnell, F.J. and Duffy, A.H. (2001a) Design Activity Modeling: A Performance Viewpoint. International Conference on Engineering Design. Glasgow.

O'Donnell, F.J. and Duffy, A.H. (2001b) Performance Management at Design Activity Level. In Proceedings of the International Conference on Engineering Design. Glasgow.

Oerlemans, L.A.G., Meeus, M.T.H. and Boekema. F.W.M. (2000) On the spatial embeddedness of innovation networks: an exploration of the proximity effect. Paper presented at the 40th European Congress of the European Regional Science Association, Barcelona, 2000. *Regional Studies*, 39(1): 89-104.

O'Kelly, P. and Gotta, M. (2006) Microsoft Versus IBM Lotus: Comparative Analysis. In Proceedings of the Collaborative technologies conference, Burton Group.

O'Leary, M.B. and Cummings, J.N. (2002) The spatial, temporal and configurational characteristics of geographic dispersion in work teams. Working paper #148, MIT E-Business Center, Cambridge, MA.

Oldham, G. R., Cummings, A. and Zhou, J. (1995) The Spatial Configuration of Organizations: A Review of the Literature and Some New Research Directions. *Research in Personnel and Human Resource Management*, 13: 1-37.

Olson, G. M. and Olson, J. S. (2001) Distance Matters. In: J. M. Carroll (ed.), *Human-Computer Interaction in the New Millennium*, ACM Press, New York, pp. 397-417.

Orlikowski, W.J. (2002) Knowing in practice: Enacting a collective capability in distributed organizing. *Organization Science*, 13(3): 249–273.

Ortiz de Guinea, A., Webster, J. and Staples, S. (2005) A meta-analysis of the virtual teams literature. Presented October 12, 2005 at the Symposium on High Performance Professional Teams, Queen's University, Kingston, ON, Canada.

Pallot, M. (2007) Why Webergence and Webergic Collaboration? A blog entry of the Webergence blog. Retrieved from: http://www.cwe-projects.eu/pub/bscw.cgi/737753?id=715404_737753

Pallot, M. and Bergmann, U. (2010) Collaborative Virtual Environments and Immersion in Distributed Engineering Contexts. In: H. Kühnle (ed.), *Distributed Manufacturing: Paradigm, Concepts, Solutions and Examples*. Springer. ISBN: 978-1-84882-706-6.

Pallot, M., Bergmann, U., Kühnle, H., Pawar, K. S., Riedel, J. CKH (2010), Collaborative Working Environments: Distance Factors Affecting Collaboration. In: Proceedings of the 16th International Conference on Concurrent Enterprising, ICE'2010 "Collaborative Environments for Sustainable Innovation", Lugano, Switzerland, 21-23 June 2010, Centre for Concurrent Enterprise, University of Nottingham, Nottingham. ISBN 9780853582 700. www.ice-proceedings.org.

Pallot M. and Hof, K. (1999) FREE - Fast Reactive Extended Enterprise, The Results. In: K-D Thoben, PM Wognum, KS Pawar, (Eds) *Proceedings of the 5th International Conference on Concurrent Enterprising, ICE'99 The Concurrent Enterprise in Operation*. 14-17 March 1999, The Hague, The Netherlands. University of Nottingham, Nottingham.

Pallot, M. and Sandoval, V. (1998) *Concurrent Enterprising: Toward the Concurrent Enterprise in the era of the Internet and Electronic Commerce*. Kluwer Academic Publishers, USA. ISBN: 0-7923-8172-6.

Pallot, M., Maigret, J.P., Boswell, J. and de Jong, E. (2000) EPICE: Realising the Virtual Project Office. *Proceedings of the e-Business for Industry Conference, Flagship Conference of UK Council for Electronic Business*. Kensington, London, United Kingdom.

Pallot, M., Pawar, K., Salminen, V. and Pillai, B. (2004) Business Semantics: The Magic Instrument Enabling Plug and Play Collaboration? In: Thoben, K-D; Pawar, K.S. & Weber, F. (Eds) *Proceedings of the 10th International Conference on Concurrent Enterprising - "Adaptive Engineering for Sustainable Value Creation"*, 16-18 June 2003, Sevilla, Spain. www.ice-conference.org, University of Nottingham, Nottingham. (ISBN: 0 85358 128 2).

Pallot M., Prinz, W. and Schaffers, H. (2005) Future Workplaces, Towards the Collaborative Web. *Proceedings of the AMI@Work Communities Forum Day*, Munich, June 2005.

Pallot, M., Prinz, W. and Pawar, K.S. (2006) Stimulating Creativity and Innovation through People - Concepts Connectivity within On-line Collaborative Workspaces. *IRMA 2006 Conference Proceedings*. Washington May 2006.

Pallot, M., Ruland, R., Traykov, S. and Kristensen K. (2006) Integrating Shared Workspace, Wiki and Blog. In: Thoben, K-D; Pawar, KS; Taisch, M; & Terzi, S. *Proceedings of the 12th International Conference on Concurrent Enterprising: Innovative products and services through collaborative networks*, 26-28 June 2006, Milan, Italy, University of Nottingham, Nottingham. (ISBN 0 85358 228 9).

Pallot, M., Richir, S. and Samier, H. (2008) Shared Workspace and Group Blogging Experimentation through a Living Lab Approach. In: Thoben, K-D; Pawar, KS & Goncalves, R. (2008) Proceedings of the 14th International Conference on Concurrent Enterprising, ICE'2008 "A new wave of innovation in Collaborative Networks", Lisbon, Portugal, 23-25 June 2008, Centre for Concurrent Enterprise, University of Nottingham, ISBN 978 0 85358 244 1.

Pankoke-Babatz, U., Prinz, W. and Schäfer, L. (2004) Stories about Asynchronous Awareness. In: F. Darses, R. Dieng, C. Simone and M. Zacklad, IOS Press (eds.) et al. (eds.) *Cooperative Systems Design - Scenario-Based Design of Collaborative Systems*. IOS Press, pp. 23-38.

Parker, L.E. (1994) Working together: Perceived self- and collective-efficacy at the workplace. *Journal of Applied Social Psychology*, 24(1): 43-59.

Patton, M.Q. (1990) *Qualitative Evaluation and Research Methods*. (2nd ed.). London: Sage.

Pauleen, D. and Yoong, P. (2001) Facilitating virtual team relationships via Internet and conventional communication channels. *Internet Research: Electronic Networking Applications and Policies*, 11(3): 190-202.

Pawar, K. and Sharifi, S. (1997) Physical or Virtual Team Collocation: Does It Matter? *International Journal of Production Economics*, 52(3), December: 283-290.

Pawar, K. and Sharifi, S. (2000) Physical or Virtual Team Co-location: Speed versus Co-ordination. *International Journal of Agile Management Systems*, 2(2): 104-113.

Pawar, K., Haque, B. and Barson, R.J. (1999) Establishing Concordance within Concurrent Engineering Teams. *Concurrent Engineering Research and Applications*, 7 (3): pp. 215-229.

Pawar, K., Menon, U. and Riedel, J. (1994) Time to Market. *Integrated Manufacturing Systems*, 5 (1): 14-23.

Perttula, M.K. and Sääskilahti, M.T. (2004) Product Concept Development as a Conscious Resource. NordDesign 2004 – Product Design in Changing Environment, 18-20 August 2004, Tampere, Finland.

Pescosolido, A.T. (2001) Informal leaders and the development of group efficacy. *Small Group Research*, 32(1): 74-93.

Phillips, D.C. (1987) *Philosophy, Science, and Social Inquiry*. Oxford: Pergamon Press.

Piccoli, G., Powell, A. and Ives, B. (2004) Virtual teams: team control structure, work processes, and team effectiveness. *Information Technology and People*, 17(4): 359–379.

Piwek, P.L.A., Bean, R.J. and Cremers, A.H.M. (1995) Deictic use of Dutch Demonstratives. In: *IPO Annual Progress Report 30*, Eindhoven University of Technology.

Powell, A., Piccoli, G. and Ives, B. (2004) Virtual teams: a review of current literature and directions for future research. *SIGMIS Database*, 35(1): 6-36.

Prante, T., Magerkurth, C. and Streitz, N. (2002) Developing CSCW tools for Idea Finding - Empirical Results and Implications for Design. In: *Proceedings of the ACM Conference on Computer Supported Cooperative Work (CSCW 2002)*, New Orleans, Louisiana, USA, ACM Press, November 16–20, pp. 106-115.

Prasad B. (1998) Decentralized co-operation: a distributed approach to team design in a concurrent engineering organization. *Team Performance Management: An International Journal,* 4(4): 138-167.

Prinz, W. (1999) NESSIE: An Awareness Environment for Cooperative Settings. In: S. Bødker, M. Kyng, and K. Schmidt (eds), *ECSCW'99: Sixth Conference on Computer Supported Cooperative Work.* Copenhagen: Kluwer Academic Publishers, pp. 391-410.

Prinz, W., Pankoke-Babatz, U., Gräther, W., Gross, T., Kolvenbach, S. and Schäfer, L. (2004) Presenting activity information in an inhabited information space. In: E. Churchill, D. Snowdon, and F. Frecon (eds), *Inhabited Information Spaces: Living with your Data*. Springer Verlag, UK, pp. 181-208.

Prinz, W., Loh, H., Pallot, M., Schaffers, H., Skarmeta, A. and Decker, S. (2006) ECOSPACE Towards an Integrated Collaboration Space for eProfessionals. In Proceedings of CollaborateCom 2006 "Collaborative Computing: Networking, Applications and Worksharing". 17-20 Nov. 2006, pp. 1 - 7

Prussia, G.E. and Kinicki, A.J. (1996) A Motivational Investigation of Group Effectiveness Using Social-Cognitive Theory. *Journal of Applied Psychology*, 81(2): 187-198.

Pulli, P., Pyssysalo, T., Metsävainio, J.P. and Komulainen, O. (1998) CyPhone – Experimenting Mobile Real-Time Telepresence. *Proceedings of the 10th Euromicro Workshop on Real-Time Systems*, Berlin, Germany, pp. 10-17.

Putnam, R. D. (2000) *Bowling Alone. The Collapse and Revival of American Community*. New York: Simon and Schuster. http://www.infed.org/biblio/social_capital.htm

Puybaraud M. (2004) *The Flexible Working Survey*. Johnson Controls, University of the West of England and Facilities Innovation Programme, Bristol, UK.

Puybaraud, M. (2005) Work Loneliness: The Impact of Flexible Working. *MOSAIC Newsletter*, issue 3, January 2005.

Rafii F. (1995) How important is physical co-location to product development success? *Business Horizons*, Jan-Feb, 78-84.

Raymond, E.S. and Young, B. (2001) *The Cathedral and the Bazaar: Musings on Linux and Open Source by an Accidental Revolutionary*. O'Reilly & Associates, Sebastopol, CA.

Reagans, R. and McEvily, B. (2003) Network Structure and Knowledge Transfer: The Transfer Problem Revisited. Working paper, Columbia University, New York.

Reed, D. (1999) That Sneaky Exponential - Beyond Metcalfe's Law to the Power of Community Building. *Context*, Spring 1999, retrieved from http://www.reed.com/gfn/docs/reedslaw.html

Resnick, L.B., Levine, J. and Teasley, S.D. (1991) *Perspectives on Socially Shared Cognition*. American Psychological Association, Washington, DC.

Rice, R.E. and Aydin, C. (1991) Attitudes toward new organizational technology: network proximity as a mechanism for social information-processing. *Administrative Science Quarterly*, 16(2): 219-244.

Richardson, M. and Domingos, P. (2003) Building large knowledge bases by mass collaboration. In: *Proceedings of the 2nd International Conference on Knowledge Capture* (Sanibel Island, FL, USA, October 23 - 25, 2003), K-CAP '03. ACM, New York, NY, pp. 129-137.

Ristau Baca, M. (2006) *Barriers To Innovation: Intellectual Property Transaction Costs In Scientific Collaboration*, Harvard Law School.

Robinson, M. and Bannon, L. (1991) Questioning Representations. In: L. Bannon, M. Robinson and K. Schmidt (eds), *Proceedings of ECSCW'91: 2nd European Conference on Computer-Supported Collaborative Work*. Kluwer, Amsterdam Sept 25-27, pp. 219-233.

Roschelle, J. (1992) Learning by collaborating: Convergent conceptual change. *Journal of the Learning Sciences*, 2(3): 235-276.

Roschelle, J. and Teasley, S.D. (1995) The construction of shared knowledge in collaborative problem solving. In: C.E. O'Malley (ed.), *Computer Supported Collaborative Learning*. Berlin: Springer-Verlag, pp. 69-97.

Ross, D.T. (1985) Applications and Extensions of SADT. *IEEE Computer*, 18(4): 25-34.

Ross, D.T. (1989) The NATO Conferences form the Perspective of an Active Software Engineer. *ICSE 1989*: 101-102.

Ross, D.T. and Schoman Jr., K.E. (1976) Structured Analysis for Requirements Definition. *ICSE 1976*: 1.

Sackmann, S. (1992) *Cultural Knowledge in Organizations*. Sage, Newbury Park.

Sakiroglu, M, Riedel, J.C.K.H. and Pawar, K. (2002) Computer Based Human Readiness Assessment Tool for Virtual Organizations. In: B. Stanford-Smith, E. Chiozza and M. Edin (eds) *Challenges and Achievements in eBusiness and eWork*, Conference Proceedings, 16-18th October 2002, Prague, Czech Republic, www.ebew.net, IOS Press, Amsterdam, pp. 940-947.

Saunders, C.S. (2000) Virtual Teams: Piecing Together the Puzzle. In: R.W. Zmud (ed.) *Framing the Domain of IT Management: Projecting the Future through the Past*. Cincinnati, OH: Pinnaflex.

Sawhney, N (2002) The Sociological Nature of Intellectual Property Rights Emerging from Open Collaborative Design in University Settings. Preliminary Analysis of Student Projects in MIT Design Studios. retrieved from http://web.media.mit.edu/~nitin/thesis/nitin-ipr-study.pdf

Schäfer, L., Valle, C. and Prinz, W. (2004) Group storytelling for team awareness and entertainment. In: *Proceedings of the Third Nordic Conference on Human-Computer Interaction* (Tampere, Finland, October 23 - 27, 2004). NordiCHI '04, vol. 82. ACM, New York, NY, pp. 441-444.

Schaffers, H., Brodt, T., Pallot, M. and Prinz, W. (eds) (2006) *The Future Workspace: Perspectives on Mobile and Collaborative Working*. Telematica Instituut, The Netherlands, ISBN 10: 90-75176-00-7, ISBN 13: 978-90-75176-00-1.

Schamp, E.W., Rentmeister, B. and Lo. V. (2004) Dimensions of proximity in knowledge-based networks: the cases of investment banking and auto-mobile design. *European Planning Studies*, 12(5): 607-624.

Scharff, E. (2002) Open Source Software, a Conceptual Framework for Collaborative Artefact and Knowledge Construction. Ph.D. Dissertation, University of Colorado at Boulder.

Schein, E.H. (1985) *Organizational Culture and Leadership*. Jossey-Bass, San Francisco.

Schmidt, K. (1994) *Social Mechanisms of Interaction*. The COMIC project, Esprit Basic Research Action 6225, ISBN 0 901800 55 4, Lancaster University.

Schön, D. A. (1983) *The Reflective Practitioner: How Professionals Think in Action*. Basic Books, New York.

Schrage, M. (1990) *Shared Minds: The New Technologies of Collaboration*. NY: Random House.

Schunn, C., Crowley, K. and Okada, T. (2002) What makes collaborations across a distance succeed? The case of the cognitive science community. In: P. Hinds and S. Kiesler (eds), *Distributed Work*, pp. 407-430.

Segal, L. (1995) Designing Team Workstations: The Choreography of Teamwork. In P. Hancock, J. Flach, J. Caird and K. Vicente (eds.): Local Applications of the Ecological Approach to Human-Machine Systems. Hillsdale, NJ: Lawrence Erlbaum, pp. 392–415.

Shane, S. (1994) Championing change in the global corporation. *Research-Technology Management*, 29–35.

Sharifi, S. and Pawar, K. S. (2001) Product Development Strategies for Agility. In: Gunasekaran, A. (ed.), *Agile Manufacturing: The 21st Century Competitive Strategy*, Elsevier, 2001.

Sharifi, S. and Pawar, K.S. (2002) Virtually Co-located Product Design Teams: Sharing teaming experiences after the event? *International Journal of Operations and Production Management*, 22(6): 656 - 679.

Shenkar O. (2001) Cultural distance revisited: Towards a more rigorous conceptualization and measurement of cultural differences. *Journal of International Business Studies*, 32 (2): 519-35.

Shipman, F. (1993) Supporting Knowledge-Base Evolution with Incremental Formalization. Ph.D. Dissertation, University of Colorado at Boulder.

Siebdrat, F., Hoegl, M. and Ernst, H. (2009) How to Manage Virtual Teams. *MIT SLOAN Management Review*, 50(4): 63-68.

Silverman, D. (1997) *The Logics of Qualitative Research*. London: Sage.

Silverston, R. (2004) Proper distance: Toward an ethics for cyberspace. In: G. Liestøl, A. Morrison and T. Rasmussen (eds), *Digital Media Revisited*, MIT Press, Cambridge, Mass, pp. 469-490.

Slagter, R., Vicente D., Buitrago, G., Klöckner, K., Prinz, W., Schaffers, H., Villa, M. and Wang, Y. (2006) State of the Art of Collaboration Infrastructure. *ECOSPACE Report D1.2*.

Smircich, L. (1983) Organization as shared meaning. In: L.R. Pondy, P.J. Frost, G. Morgan and T.C. Dandridge (eds.), *Organizational Symbolism.* JAI Press, Greenwich Conn., pp. 55-65.

Smith-Jentsch, K.A., Mathieu, J. and Kraiger, K. (2005) Investigating linear and interactive effects of shared mental models on safety and efficiency in a field setting. *Journal of Applied Psychology*, 90(3): 523-535.

Sommer, R. (1969) *Personal Space*. Englewood Cliffs, NJ: Prentice Hall.

Staples, D.S., Hulland, J.S. and Higgins, C.A. (1999) A Self-Efficacy Theory Explanation for the Management of Remote Workers in Virtual Organizations. *Organization Science*, 10(6): 758-776.

Star, S.L. and Griesemer, J.R. (1989) Institutional ecology, 'translations' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, 19(3): 387-420.

Sternberg, R.J. (ed.) (1988) *The Nature of Creativity*. Cambridge University Press, Cambridge.

Stewart, D.W. and Shamdasani, P.N. (1990) *Focus Groups: Theory and Practice*. London: Sage.

Suchman, L.A. (1987) *Plans and Situated Actions. The Problem of Human - Machine Communication.* Cambridge University Press, Cambridge.

Swan, J., Scarbrough, H. and Robertson, M. (2002) The construction of 'communities of practice' in the management of innovation. *Management Learning*, 33(4): 479-496.

Tang, J. (1991) Findings from Observational Studies of Collaborative Work. International Journal of Man-Machine Studies, 34(2): 143–160.

Terveen, L. G. Selfridge, P. G. and Long, M. D. (1995) Living design memory: framework, implementation, lessons learned. In *Human.-Computer Interaction.* 10(1): 1-37.

Thimbleby, H., Anderson, S. and Witten, I.H. (1990) Reflexive CSCW: Supporting Long-Term Personal Work. *Interacting with Computers*, 2(3): 330-336.

Thompson, S. (1992) *Sampling*. London: Wiley.

Tihanyi L., Griffith D.A. and Russell C.J. (2005) The effect of cultural distance on entry mode choice, international diversification, and MNE performance: a meta-analysis. *Journal of International Business Studies*, 36 (3): 270-283.

Torre, A. and Gilly, J.P. (2000) On the analytical dimension of proximity dynamics. *Regional Studies*, 34(2): 169-180.

Torre, A. and Rallet, A. (2005) Proximity and localization. *Regional Studies*, 39(1): 47-59.

Toye, G., Cutkosky, M.R., Leifer, L.J. and Glicksman, J. (1993) SHARE: A Methodology and Environment for Collaborative Product Development. *Proceedings of IEEE Infrastructure for Collaborative Enterprises Revue d'Economic Region-tile et Urhaine* (5): 835-852.

Tsai, W. (2001) Knowledge Transfer in Intraorganizational Networks: Effects of Network Position and Absorptive Capacity on Business Unit Innovation and Performance. *Academy of Management Journal*, 5: 996-1004.

Vahlne, J.E. and Wiedersheim-Paul, F. (1977) Psychic distance – an inhibiting factor in international trade, Working Paper, Center for International Business Studies, Department of Business Administration, University of Uppsala, Sweden, pp.1-19.

Vaidyanathan, G. (2006) Networked Knowledge Management Dimensions in Distributed Projects. *International Journal of eCollaboration*, 2 (4): 19-36.

Valkenburg, R.C. (1998) Shared understanding as a condition for team design. *Automation in Construction*, 7(2-3): 111-121.

Valkenburg, R.C. (2000) *The Reflective Practice in Product Design Teams*. Delft University of Technology, Delft.

Van den Bossche, P., Gijselaers, W., Segers, M., Woltjer, G. and Kirschner, P. (2010) Team learning: building shared mental models. *Instructional Science*, 2010-03-16. Springer, Netherlands, 0020-4277,.

Vendramin, P., Valenduc, G. (1998), "Telework in the scenarios of the future of work", Proceedings of the Fifth European Assembly on Telework and New Ways of Working, DG XIII, Brussels and APTD, Lisbon.

Walther, J.B. (2002) Time Effects in Computer-Mediated Communication: Past, Present, and Future. In: P. Hinds and S. Kiesler (eds), *Distributed Work*. Cambridge, MA: MIT Press, pp. 235-258.

Wasserman, S. and Galaskiewicz, J. (1994) *Advances in Social Network Analysis: Research in the Social and Behavioral Sciences*. Sage Publications, Thousand Oaks, CA.

Watson-Manheim, M.B., Chudoba, K.M. and Crowston, K. (2005) The Paradox of Discontinuities and Continuities: Toward a More Comprehensive View of Virtuality. Retrieved from http://crowston.syr.edu/system/files/paradox2004.pdf.

Watson-Manheim, M.B., Chudoba, K.M. and Crowston, K. (2002) Discontinuities and continuities: a new way to understand virtual work. *Information Technology and People*, 15(3): 191-209.

Webster, J. and Staples, S. (2006) Comparing virtual teams to traditional teams: An identification of new research opportunities. *Research in Personnel and Human Resource Management*, 25: 183-218.

Weick, K.E. (1979) *The Social Psychology of Organising*. Reading, MA: Addison-Wesley.

Weick, K.E. (1995) *Sensemaking in organisations*. Thousands Oaks CA: Sage.

Wenger, E. (1998) *Communities of Practice - Learning, Meaning, and Identity*. Cambridge University Press, Cambridge, UK.

Wertsch, J. (1991) *Voices of the Mind, A Sociocultural Approach to Mediated Action*. Harvard University Press, Cambridge, MA., pp. 47-92.

West J. and Graham L. (2004) A linguistic-based measure of cultural distance and its relationship to managerial values. *Management International Review* 44 (3): 239-260.

Whiteoak, J.W., Chalip, L. and Hort, L.K. (2004) Assessing group efficacy: Comparing three methods of measurement. *Small Group Research*, 35(2): 158-173.

Wilkof, M.V., Brown, D.W. and Selsky, J.VV. (1995) When the stories are different: the influence of corporate culture mismatches on interorganizational relations. *The Journal of Applied Behavioral Science*, 31: 373-388.

Wilson, J. (2001) The development of trust in distributed groups. Unpublished doctoral dissertation, Carnegie Mellon University.

Wilson, J. M., Boyer O'Leary, M., Metiu, A. and Jett, Q. (2005) *Subjective Distance in Teams*. Working papers series, INSEAD.

Winroth, M. and Danilovic, M. (2002) Manufacturing Networks: Critical factors to successful collaboration. The 35th CIRP-Insternational Seminar on Manufacturing Systems, 12-15 May 2002, Seoul, Korea.

Wong, L.F. and Trinidad, S.G. (2004) Using Web-based distance learning to reduce cultural distance. *The Journal of Interactive Online Learning*, 3 (1), retrieved from http://www.ncolr.org/jiol/issues/pdf/3.1.2.pdf.

Zellars, K.L., Hochwarter, W.A., Perrewe, P.L., Miles, A.K. and Kiewitz, C. (2001) Beyond self-efficacy: Interactive effects of role conflict and perceived collective efficacy. *Journal of Managerial Issues*, 13(4): 483-499.

Zeller, C. (2004) North Atlantic innovative relations of Swiss pharmaceuticals and the proximities with regional biotech arenas. *Journal of Economic Geography*, 80(1): 83–111.

Zhang, J., Scardamalia, M., Reeve, R. and Messina, R. (2006) Collective cognitive responsibility in knowledge building communities. In: *American Educational Research Association Annual Meeting*, 2006, San Francisco, CA.

Zheng M., Pawar K. and Riedel J. (2006) Evaluation of communication patterns during NPD within European and Chinese context. In: Thoben, K-D; Pawar, KS; Taisch, M; & Terzi, S. *Proceedings of the 12th International Conference on Concurrent Enterprising: Innovative products and services through collaborative networks*, 26-28 June 2006, Milan, Italy, University of Nottingham, Nottingham. (ISBN 0 85358 228 9). pp449-458.

Appendix A

Collaborative Distance: Detailed Table

Imagination is more important than knowledge. – Albert Einstein

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
St1	Configurational	Structural	Globalisation	Activities context and globalisation trend; dispersed teams; lack of leadership, incentive, cohesiveness and vision.	Online groups, communities and social networking; online project office.	Clustering of members at sites, Role Index and External Index, clear leadership, shared vision, collaboration incentive, balanced power and expertise in decision making	In this context, configuration is the arrangement of group members across sites, whatever the distances among them. Such configurations include: a 'fully dispersed' team with only one member at each of several sites, a team with multiple members at multiple sites, or a team split across only two sites. Sub-group configurations can lead to conflict and members who are isolated from the rest of the team tend to be left out of group communications and interactions.	Grinter et al., 1999; Oldham et al., 1995; Ancona & Caldwell, 1992; Armstrong & Cole, 2002; O'Leary & Cummings, 2002; Cramton, 2001; Ketchen et al., 1997; Meyer et al., 1993.
St2	Institutional		Globalisation	Globalisation; contextual factors such as investment rules, legal framework, political climate (instability), lack of interoperability (e.g. institutional incompatibility).	Migration tides; colonial heritage; institutional presence; modern transportation.	Internationalisation experience; local political stability; overseas education; professional management training; institutional convergence; globalisation set of business policies & regulations.	Institutional distance is generated by differences among individuals according to their historical, political, economical and cultural/social environments, which drive formal rules to be applied by those individuals. For example the EU is minimising the national regulation divergence amongst member states as a kind of uniformisation of the business competition rules.	Kirat & Lung, 1999; North, 1997; Zeller, 2004; Child et al., 2002; Orlikowski, 2002; Johanson & Wiedersheim-Paul, 1975; Nordstrom and Vahlne, 1992.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
St3	Organisational		Professional, Structural	Multiple communication channels; lack of interoperability; not belonging to a same group or community; no behavioural cohesion.	Virtual teams; virtual enterprises; online groups and communities.	Belonging to the same cluster (i.e. firms, technological, innovations, professionals); multidisciplinary communities (i.e. prof. community, community of practice, community of knowledge).	Organisational distance represents the degree to which explicit or implicit rules of interaction and routines of behaviour that make coordination more effective are different. Individuals belonging to the same structure and using common routines are in close organisational proximity. The reverse situation implies that individuals are organisationally distant from each other.	Meisters & Werker, 2004; Torre and Rallet, 2005; Schamp et al., 2004
St4	Spatial		Geographical, Local, Territorial, Physical, Proximity	Lack of collocation and face-to-face communication.	Fast transportation; virtual or online collocation.	Short duration physical collocation (i.e. kick-off meeting).	Spatial distance directly conditions the opportunity for collocation, either permanent or temporal, and physical face-to-face meetings. Close physical proximity is said to enable shared vision and understanding as well as knowledge sharing while remote working is considered as a barrier toward shared vision and understanding as well as knowledge sharing.	Fischer, 2005a; Olson & Olson, 2001; Brown & Duguid, 2000; Fischer, 2004; Raymond & Young, 2001; Scharff, 2002; Kock, 2005; Wilson et al., 2005; Knoben & Oerlemans, 2006; Nardi & Whittaker, 2002
St5	Temporal			Lack of collocation and face-to-face communication.	Collaboration tools supporting asynchronous interactions.	Asynchronous mode; incremental formalisation.	Time distortion (e.g. different time zones and different working shifts). Temporal (across time), requiring support for asynchronous, indirect, long-term communication.	Finholt, Sproull, & Kiesler, 2001; Fischer 2004; Thimbleby et al., 1990; Moran & Carroll, 1996; Shipman, 1993.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
So1	Relational	Social	Inter-personal, Social	Positional situation; status differences; wrong relationships and inter-personal relationships; lack of social interaction ties and trust.	Online groups, communities, networks, wiki, blog; online social networking; social translucence; social awareness.	Perceived similarity; role centrality; trusted relationships, groups and communities; personal or social networks; social capital.	Relational distance is directly linked to the individual's network and relationship levels with other individuals, which also means it is strongly related to human, intellectual and social capital. Relational distance conditions the level of mutual trust which enables knowledge sharing and knowledge creation. Social distance is a measure of the extent to which the individuals across organisations are familiar with each other's ways of thinking and working and are at ease with them. Social distance is about the simplicity of weak ties or the complexity of strong ties. It is also about reaching a large number of people, and traversing greater social distance (i.e., path length).	Lave & Wenger, 1991; Brown & Duguid, 1991; 1994; 2000; Wenger, 1998; Créplet, Dupouet, & Vaast, 2003; Lindkvist, 2005; Swan, Scarbrough, & Robertson, 2002; Nooteboom, 2000; Grabher, 2004; Putnam, 2000; Constant, Sproull, & Kiesler, 1996; Reagans & McEvily, 2003; Bradshaw 2001; Schamp et al., 2004; Coenen et al., 2004; Knoben & Oerlemans, 2006; Luft & Ingham, 1955.
So2	Cultural		Usage, Local, Heterogeneous group	Due to international diversification, local usage and norms influencing individual and group behaviour generate difficulties in reaching a mutual understanding.	Tools for boundary-spanning (boundary objects) connecting people across geographical and cultural distances (e.g. simulation game); on-line communities.	Internationalisation experience; overseas education; situational training; clusterisation (i.e. business sectors, innovation territories).	Cultural distance is the degree to which the norms and values of different organisations differ because of their place of origin. Cultural distance is the difference of local usage and norms influencing individuals' behaviour, thoughts and interpretation. Cultural differences may appear at different levels such as geographical areas, industrial sectors, business areas, enterprises, networks or communities.	Gill & Butler, 2003; Gertler, 1995; Levina & Vaast, 2005; Moon & Sproull, 2002; Gasson, 2004; Star & Griesemer, 1989; Malone, Yates, & Benjamin, 1987; Zheng Ma, Pawar & Riedel, 2006; Boland & Tenkasi, 1995; Morosini et al., 1998; Shenkar, 2001; West & Graham, 2004; Tihanyi et al., 2005; Brouthers & Brouthers, 2001; Gertler, 1995; Nooteboom, 2000; Bonifacio & Molani, 2003; Fischer, 2005b; Star and Griesemer, 1989.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
So3	Emotional		Affective	Demonstrative expressions (e.g. a distal or proximal expression); affective and emotional state and interpersonal awareness.	Tools for cognitive modelling; online multimedia meeting system; emotional avatars.	Past-time referent; JOHARI Window; cognitive training; mirror approach.	Emotional distance is related to the social climate; for example face-to-face interaction makes individuals less willing to voice opinions and suggestions and less objective, and creates feelings of sympathy or compassion for the co-located individuals. The social climate helps to create a less hostile and less inhibiting environment in which to talk to the other individuals. Spatial distance enables less personal and less emotional interaction. This spatial distance appears to help individuals maintain emotional distance and act more objectively in evaluating the alternatives proposed by the involved individuals.	Byron & Stoia, 2003; Halliday & Hassan, 1976; Glover, 2000; Fussell et al., 2004; Piwek et al., 1995; Damian, 2002; Glover, 2000; Al-Rawas & Easterbrook, 1996; Basili, 1996; Damian, 2002; Pallot et al., 2008; Nardi & Whittaker, 2002.
So4	Lingual			Local languages; different forms of writing leading to a lack of understanding.	Automatic translators; online encyclopaedia; online dictionary.	Translation; shared language.	Lingual distance determines the level of difficulty for a heterogeneous group of people to share meanings and understanding while at the same time it brings diversity as languages are very much based on history, culture and tradition and therefore play a key role in cultural and cognitive behaviours.	Wong and Trinidad, 2004; Biggs, 1996.
So5	Cognitive			Diversity (different domains, different disciplines, different practices); novelty against absorptive capacity.	Large amount of technological capital; instant learning.	Community of practice; norm of reciprocity; community-related and personal outcome expectations.	Cognition denotes a broad range of mental activity, including proprioception, perception, sense making, categorisation, inference, value judgments, emotions, and feelings, which all build on each other. People have developed along different life paths and in different environments; they interpret, understand and evaluate the world differently. This leads to the notion of cognitive distance between people. Different people have a greater or lesser 'cognitive distance' between them. The problem is that people may not understand each other and have to invest in understanding and largely depends on their absorptive capacity.	Nooteboom, 1992, 1999, 2000; Grabher, 2004; Cohendet, 2005.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
T1	Conceptual	Technical	Expertise	Expertise gaps (i.e. novice v. expert); same concept name and different meanings leading to interpretations.	Integrating diversity through online multidisciplinary groups and communities; building-up online folksonomy, tagsonomy, concept mapping and topic maps within use of wiki for shared meanings.	Integrating diversity through multidisciplinary groups and communities; making all voices heard; establishing a common ground and shared meanings.	Conceptual distance is the degree to which disciplines' views and concepts are compatible. Conceptual barriers are often mentioned as being expertise gaps. Gentner's structure-mapping theory of analogy emphasises formal, shared syntactic relations between concepts. In contrast, Hofstadter and Mitchell's 'slipnets' project emphasises semantic similarities and employs connectionist notions of conceptual distance and activation to make analogy more dynamic and cognitively plausible. Conceptual distance across different communities of practice requires support for common ground and shared understanding.	Gentner, 1983; Liu and Singh, 2004; Hofstadter and Mitchell, 1995; Fischer, 2001, 2004, 2005b; Resnick et al., 1991.
T2	Contextual			Local and situational arrangements; conditions and rules are leading to cognitive overload.	Online context awareness automatically deducted from shared events and meta-data.	Collecting information for building-up context awareness.	Contextual distance is the degree to which local and situational arrangements, availability conditions and rules differ from one to one another. A common feature of situations leading to creative results lies in the contextual distance to the problem-relevant domain.	Demetriadis et al., 2005; Gross & Prinz, 2003; Prante, Magerkurth, & Streitz, 2002; Hymes & Olson, 1992; Finke, Ward & Smith, 1992.
T3	Referential		Correlation	Unevaluated degree of relevance.	Computerised formulation of relevance.	Correlation; calculation.	The referential distance corresponds to the distance between the point of origin and the correlating document measured by the number of minimally necessary references. In this way it is possible to describe the potential relevance of a document compared to the origin of referencing. If the referential distance increases, the relevance can be expected to decrease.	Fuchs-Kittowski & Köhler, 2005; Chakrabarti, Srivastava, Subramanyam & Tiwari 2000; Croft & Turtle, 1989.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
T4	Semantic		Ontological		Semantic web.	Classification; taxonomy; ontology; semantic networks.	Semantic distance, as well as semantic relatedness and semantic similarity (inverse of distance, also known as semantic proximity), represents the level of relationship from one term to another. It could be expressed by a number ranging from -1 up to 1, or between 0 and 1, where 1 displays high relatedness and 0 for none.	Norman and Hutchins, 1988; Suchman, 1987; Bowers, 1993.
T5	Technological		Industrial	Incompatible technological skills	Online instant learning; wide technology knowledge and online tutorials and experimentation	Absorptive capacity; training; seminar; tutorial.	Technological distance is the result of the differences between the use of various technologies that could be either Information and Communication Technologies (ICT) or production technologies, or even a combination of other technology types (i.e. Biology). Differences in technological experience and knowledge (between persons and artefacts), require knowledge-based, domain-oriented systems.	Boix Miralles, 2001; Greunz, 2003; Zeller, 2004; Cohen and Levinthal, 1990; Clark and Fujimoto, 1991; Fischer, 2004; Terveen, 1995; Mayben et al., 2003; Mulder, 2002; Pauleen & Yoong, 2001; DeSanctis et al., 2001.

Ref	Distance types	Dimensions	Synonymous distance types	Distance-creating factors	Distance compressing factors	Distance bridging factors	Description	References
L1	Ownership	Legal & Ethical	Intellectual Property Rights (IPR)	Ownership divergence may lead to conflicting situation.	Online recording of individuals' contributions (i.e. wiki, group blog). Open source and creative commons strategies.	Tracking of individuals' contributions; common IPR policies.	Ownership distance is the degree to which partners, either individuals or organisations, have different IPR policies. Ownership distance is also induced by diverse local IPR regulations, views and opinions on innovation efficiency. It is argued that innovation efficiency is based upon either open innovation through the implementation of open source or creative commons licensing mode, or more close innovation through intensive protection in terms of IPR, patents and so forth.	Sawhney, 2002; Gupta & Landry, 2000; Ristau Baca, 2005, Pallot et al., 2006.
L2	Financial		Investment	Investment vulnerability; contextual factors such as investment policies and rules leading to unbalanced investment behaviour.		Shared risk and common value mechanism; financial agreement.	The basic premise is that the value of a business relation depends on the participation of, and investments made by, the parties to the relation. In terms of participation, some actors may be indispensable to an asset. For instance, the asset may not be productive at all if the agent does not participate in the venture. More generally, indispensable means that if the agent does not participate in the under-taking where the asset is used then the presence or absence of the asset does not affect the other agents' investment behaviour. Some investments are relation or asset specific meaning that their value outside the relation is very low.	Hart & Moore, 1990.
L3	Contractual		Security, Confidential, Ethical	Incomplete contracting setting; globalisation effect; legal framework; political climate (instability).	Proper level of online security, confidentiality and privacy	A formal contractual framework; internationalisation experience; local political stability; overseas education; professional management training.	Contractual distance originates in an incomplete contracting setting. Incomplete contracting and incentives for relation specific investments imply the following. If contracting is costless and information perfect then the allocation of ownership matters little for the organisation of economic activity. Any profitable venture requiring the participation of several parties can be realised by drafting a suitable contract specifying the participants' rights and obligations under every conceivable circumstance.	Hart and Moore, 1990; Grossman & Hart, 1986; Silverston, 2004; Appelt et al., 2007; Introna, 2005.

Appendix B

Focus Group Interviews: Synthesis Tables

The important thing is not to stop questioning. Curiosity has its own reason for existing. – Albert Einstein

Project Case P01

Ref	FG01 - Answers
Q1	It is of paramount importance that everyone should agree to share knowledge with others and reach a common understanding. It is most important to have a central repository constantly up-to-date. As important as teambuilding is the cohesiveness of the group. Leading to the building of a common culture whatever is the role of participants, their age, their home country. Using a common vocabulary and set of techniques. Mutual trust is the mandatory basis for collaboration while knowledge sharing contributes to progressively increase the level of trust and facilitates a mutual understanding.
Q2	Allow to access information from almost anywhere, hence from home where it is quieter for thinking work. Did not find the document versioning and therefore found painful to have to remove older versions. Did appreciate very much the reliable central storage, classification of documents and size as well as structuration of documents. At the beginning each team member was improvising a structure but soon it became so painful that they had a specific meeting for deciding on how to rationalise the structure. They would appreciate a more dedicated event notification than nightly email notification for all day events. In any case, the notification mechanism encourages everyone to have a look at what others accessed (curiosity?). They found that uploading documents was faster than on MSN.
Q3	Not fully used but did experiment with to be convinced about the usefulness in case of physical collocation. Did not get consciousness about the interest to have a project journal. Meeting minutes were uploaded into the shared workspace. Would be more useful in case of involvement of external users as they were not successful to get their customer as participants of their project shared workspace.
Q4	They are complementary as one is for sharing documents and the other is for communicating asynchronously about important events happening within the duration of the project.
Q5	Technologies contribute to overcome distance factors and this is interestingly true for compressing geographical and temporal distance especially when participants are geographically distributed.
Q6	Too much technology breaks team feeling, hence creates relational distance and brings technological distance depending on the technology skills of each team member. Furthermore, it created cultural and lingual distances as it was not available in French but only in English and German.
Q7	Brings in a good value for sharing documents but not really for communicating. Does not support the creativity process and brings risk of dispersion among team members that do not communicate enough.
Q8	Better to upload a doc into the shared workspace, especially for draft for some team members and for final version for some other team members. However, they sent email for notifying the others instead of using the project blog for example.
Q9	Having shorter URL. Generalise the drag and drop instead of copy/paste and cut/paste. Show the structure tree for selecting content.

Project Case P02

Ref	FG02 - Answers
Q1	Allows to progressively build up a common ground based on every team member expertise and contribution to the understanding of the project goal and objectives as well as related process.
Q2	Represents an online central storage of documents. Allows to get access to documents from anywhere at any time. Provides the ability for a team member who is not physically collocated to share with the team members.
Q3	Useless when team members are physically collocated. Useful when there are external members.
Q4	Yes, blog entries provide an opportunity to add specific information related to uploaded material and get comments about them.
Q5	Compress some distance factors such as organisational, geographical, temporal and technological distance types but the duration depends on the nature of the project.
Q6	Yes, creates relational distance. Leads to weak interpersonal relationships and lingual distance as both the tool and documentation were not available in French but only in English and German.
Q7	Useful for collecting all contributions.
Q8	Email is still important for communicating while a shared workspace is a central storage for sharing documents.
Q9	Include notification of events by SMS. Add an online editing or collaborative authoring like wiki.

Project Case P03

Ref	FG03
Q1	It is important to make sure everyone understands the same things otherwise there is a strong risk that misunderstandings lead to non coherent work.
Q2	Very useful when participants are not physically collocated. Allows saving document versions into an online central storage space and accessing them from almost everywhere at anytime.
Q3	Useful for developing a project culture.
Q4	Looks complementary to each other as one is for communicating and the other is for sharing documents.
Q5	It clearly allows overcoming geographical distance.
Q6	Does not stimulate social activities, hence creates cultural, relational and emotional distances. This kind of tool also creates lingual distances as it was not available in French but only in English and German.
Q7	Very useful for tracking document versions and be sure to use the latest version.
Q8	Sending too many emails is polluting email boxes as it makes too much noise where it is difficult to see which emails to reply to in priority.
Q9	Online editing or collaborative authoring like googledoc. Drag & drop to move objects from one folder to another.

Project Case P04

Ref	FG04 - Answers
Q1	Sharing documents also provides a good view about the project progress.
Q2	Not intuitive. Not having a pleasant look and feel. Event notification is providing useful information about what other team members have been doing. Useful structuration of folders. Downloading documents is quicker than uploading.
Q3	Useful for providing specific information about uploaded documents and for giving some level of awareness about the latest status. Allows providing document links to external participants.
Q4	Complementary in case of spatial distance among team members.
Q5	Partly help to overcome some distance factors such as spatial distance.
Q6	Lack of naturalness in the communication and lack of live interactions (i.e. chat) to support the building of interpersonal relationship. Creates technological distance.
Q7	Allows tracking the project progress through the production of documents. It provides a kind of democratic access to all documents and information.
Q8	Far better to upload documents than sending them by email attachment. Still need to notify by sending an email. It is important to understand that an email tool is a systematic tool for any user.
Q9	Synchronous and asynchronous chat. Web conferencing with shared application to support live interaction and discussion/argumentation. Voice message box.

Project Case P05

Ref	FG05 - Answers
Q1	Very useful for informing all team members and to avoid doing the same work twice
Q2	Useful for centralising all documents as a common place to access them and be sure to re-use the latest version.
Q3	Useful when there are external participants.
Q4	Allows linking shared documents with blog entries, hence to have an easy way to search for specific material.
Q5	Allow to overcome geographical distance and more generally all structural distance types that helped to solve conflicts as there is a democratic way of sharing information. No one retains information for himself as everyone gets access to the same amount of information.
Q6	Induce a lack of social activities, hence create relational distance.
Q7	Helps in centralising documents and to get access from almost everywhere at any time. Especially useful for working from home or Internet cafe
Q8	It depends on whether it is urgent to inform team members. In this case better to use emailing.
Q9	Online editing of shared documents like in googledoc. Individual structuration as a personalisation mechanism.

Project Case P06

Ref	FG06 - Answers
Q1	Experience has shown that mutual understanding is vital for an effective collaboration mode. However, due to the diversity of previous disciplines, it is not a piece of cake to understand the specific vocabulary used by everyone.
Q2	Useful for sharing documents with external participants (customer) and more specifically for deliverables with a continuous review approach instead of periodic reviews.
Q3	Customer was requesting more formal approach than the use of a blog.
Q4	Even if they did not use the group blogging so much they thought that it could complementary.
Q5	Allows overcoming mainly spatial distance as well as temporal distance. Though it also helps to overcome technological distance as all project participants have to use the same tool to get access to centralised documents.
Q6	This kind of tool creates technological distance as well as cultural and lingual distances as it was not available in French but only in English and German.
Q7	Allows enriching the mutual understanding in exposing information.
Q8	Equal use.
Q9	Shared applications, online editing of documents, web conference, collaboration dashboard, and event widgets.

Project Case P07

Ref	FG07 - Answers
Q1	Mutual understanding is the basis to make sure no-one is going to work in the wrong direction and important for avoiding embedded misunderstandings that often still happen in projects. Sharing permanently information also allows seeing what others are doing and how they progress which is useful to adapt our own contribution in the leanest way. The use of modelling techniques like activity functional modelling is also essential for creating a mutual understanding. It is especially true for discussing everyone's view with the use of a common language or graphic representation (IDEF0) which facilitates the communication and interaction among team members and for coming to a good compromise satisfying all team members.
Q2	Allows to be sure that all team members will get access to the same set of documents wherever they are and whenever they wish (though it requires having an Internet connection available). It is also a secure storage place which avoids the risk of lost documents. It provides a way to follow the project progress through the production of documents and to involve external participants.
Q3	It was quite difficult to evaluate as external participants did not use it.
Q4	Complementarity is quite obvious as each tool has a different purpose. Group or project blog is for people to express their concern or to point colleagues to specific information while shared workspace is for sharing documents.
Q5	Helps to mainly overcome structural distance types such as geographical, organisational and temporal distances.
Q6	Creates distance on social aspects such as cultural and relational distance types.
Q7	Very useful for centralising all documents to be shared but blogging is supplanted by face-to-face interactions.
Q8	Used partly email and partly shared workspace depending on whether there was a need to share a document or not.
Q9	Event notification should be like instant messaging and not as a report grouping all events once per night.

Project Case P08

Ref	FG08 - Answers
Q1	Creating a mutual understanding is of paramount importance otherwise it is difficult to collaborate if everyone uses his own vocabulary.
Q2	Not something culturally known and accepted. However, the versioning function of the shared workspace is very useful to avoid working on an old dated version.
Q3	Useful when there are people (like the project coach) monitoring the project progress.
Q4	Obviously complementary but do regret that there was no possibility to do online editing of shared documents which means one has to download a document, edit it and then upload it back into the shared workspace.
Q5	Overcame totally geographical and temporal distances and partially contributed to compress configurational and organisational distances.
Q6	Creates technological and relational distance as well as emotional distance. However, in the case of emotional distance it could help a person who is too shy for expressing problems.
Q7	Very useful for sharing documents and keeping a project history. Googledoc has a limited space size.
Q8	Turned from emailing to sharing with the use of the shared workspace tool.
Q9	Collaboration dashboard, web conference, instant messaging, zichio, presence

Project Case P09

Ref	FG09 - Answers
Q1	Sharing allows seeing what others are doing and provides a global view on the project progress.
Q2	Having a common place for the project contributed to the group cohesiveness. Sharing and centralising documents that are accessible from almost everywhere is very useful and all team members are up-to-date.
Q3	Found interesting to have a project journal where each participant could react in either creating his own entries or in commenting the ones from other participants. However, reacting by comment without directly talking to the other person might not necessarily be appreciated by the author of the commented entry (cultural problem).
Q4	Complementarity is obvious.
Q5	Helps to overcome partially spatial distance as there is no synchronous communication tool available with this platform. Nonetheless, it is ok for temporal distance as in this case the need is to have asynchronous communication.
Q6	Creates distance in social interaction as it encourages participants to have asynchronous communication with limited level of interaction but at the same time good for someone who is too shy to express his/her feeling.
Q7	At least useful as a central storage even for physically collocated group.
Q8	Emailing is still the most favourite tool especially when there is no attachment.
Q9	Should include online editing like googledoc or wiki style, instant messaging, visio-conference, and dashboard.

Project Case P10

Ref	FG10 - Answers
Q1	Mutual understanding is a key element of collaboration as demonstrated by the modelling of the project process to make sure all project team members have the same understanding of their process. Sharing knowledge allows reaching a mutual understanding when the vocabulary becomes common to every participant.
Q2	Sharing documents is a good point but having the opportunity to add comments directly online and give a rating to contribution would be more effective.
Q3	Did not have time to experiment the project blog.
Q4	Complementarity is obvious, though too much personal feeling entries might be disturbing to the cohesiveness of the group.
Q5	It has contributed to overcome most of the structural type of distances and more particularly distance related to the shared workspace structuration as a kind of standard for all participants was very much appreciated by the team especially for enhancing team cohesiveness. However, spatial distance type was not fully compressed due to the lack of synchronous communication such as web conferencing tool or VoIP (i.e. Skype).
Q6	Creates relational distance and technological distance (everyone does not have the same ICT skill) as well as cultural distance, though it might be, in some cases, creating a specific online culture among project participants hence contributes to overcome cultural distance. It has the same effect on overcoming technological distance due to the fact that all project participants are using the same central storage always accessible from whenever located participants are and whenever they wish. However, in this case the technological distance among participants could be due to the fact that the Internet is not available everywhere, hence not all participants necessarily have Internet access.
Q7	Useful for sharing documents and especially with external participants. Structuration with folders and sub-folders is also very helpful and appreciated as it looks like almost the same way as PC folders structure.
Q8	Partly use emailing and partly use shared workspace since they had the opportunity to experiment the use of a shared workspace.
Q9	Should include instant messaging, a more ergonomic and user friendly user interface. Google doc and adobe share are in comparison more intuitive. A collaboration dashboard providing events notification in real time would be very much appreciated as it would help to foresee what others are doing.

Project Case P11

Ref	FG11 – Answers
Q1	*Did not see the interest due to the physical collocation….though sharing among all projects would have been more attractive.*
Q2	Useful when team members are distributed and in case of full time project.
Q3	Useless when team members are physically collocated. Useful when there are external members.
Q4	Yes, combine project journal style and storage space for shared documents.
Q5	It was obvious that such technology contributes to overcome spatial and temporal distances but the condition was the availability of an Internet connection. Even sharing knowledge (documents) led to the progressive development of trust among the project participants (give and take), hence it helps overcoming various distance types such as configurational, organisational and relational.
Q6	This kind of technology creates cultural and emotional distances. However, emotional distance could be worthwhile to have especially in case of conflicts among participants that cannot agree with the decision process. In somehow it helps to feel more detached (not so closely embedded into the conflict) and be more pragmatic on decision making.
Q7	Ease of use with tree folders structuration.
Q8	Email notification of events is polluting the email box because there is an email generated and sent for each event.
Q9	Web conf.

Project Case P12

Ref	FG12 – Answers
Q1	*Did not see the meaning of the question….*
Q2	Useful as a saving place. Especially when a team member forgets to bring his USB memory stick.
Q3	Useful when team members are distributed or for informing external members. Chat is more efficient than blogging and more interactive (synchronous).
Q4	Good level of complementarity.
Q5	On the one hand, such technology is useful when team members are distributed and also for remote working like working from home which helped overcoming configurational, institutional, spatial and temporal distances. It helped bridging conceptual and contextual distances, especially with folders structuration.
Q6	Created social type of distances (more to the point, less time to broadly discuss). Furthermore, it also created distance with implicit knowledge as there wasn't any video conferencing tool (synchronous communication) such as Webex or Skype video for example. It implies technological distance but found it was the reverse situation when using the central storage.
Q7	Useful as a shared storage unit.
Q8	Shared workspace was more systematic than emailing.
Q9	Presence awareness to know who is there and who is available to ask a question or discuss issues. Web conferencing with video, White-Board and shared application. Adding a wiki style for online editing which is easier for managing document versions as there is only one latest version.

Project Case P13

Ref	FG13 – Answers
Q1	Experiences are showing that mutual or common understanding is fundamental ingredient of collaboration. The project process modelling exercise through the use of IDEF0 has revealed this fact as well as sharing the same model.
Q2	Allows all group members to access the same information and documents. Reduce time spent for finalising a document where several participants have to contribute.
Q3	Group blogging appears to be a less formal way of communicating spontaneously which provides to the other participants a good idea about the cognitive situation and feelings of the author. It also allows drawing the attention of the project team members to some external resources through the provision of a short article and links.
Q4	Complementarity is quite obvious. Shared workspace for sharing documents and group blogging for sharing information and feelings as well as drawing the attention to external resources.
Q5	Experience has shown that such technology contributed to overcome most of the structural type of distances. However, spatial distance was partly compressed due to the lack of synchronous communication. Referential distance was also bridged in inserting URL in the folders and in blog entries.
Q6	Creates emotional distance which is not necessarily a bad point. In case of problem faced in the shared workspace then it is pushing to set-up a physical meeting.
Q7	Usefulness is also quite obvious and not questionable…only question is what happens when all project members are not using the same shared workspace tool.
Q8	They prefer to use a shared workspace for exchanging documents when a group is already set-up but still intensively use emailing when the group is less formal.
Q9	Would be necessary to improve the socio-ergonomic aspect. Mandatory is to have online editing capability, on demand notification, and second life style for creating competences spaces.

Project Case P14

Ref	FG14 - Answers
Q1	Sharing documents is partly contributing to the sharing of knowledge as most of the sharing of information and knowledge is done via speech mode.
Q2	Useful for sharing with MRV group until tasks were complementary.
Q3	Useful for interaction with external participants.
Q4	Good complementarity between shared workspace and group blogging.
Q5	It was clear that this technology compressed temporal, organisational and spatial distance among team members. However, other distance types such as conceptual, referential and cultural were progressively less and less affecting the team effectiveness due to the use of a common vocabulary for structuring folders in the shared workspace and for URL as a kind of a new online culture of standardising concepts for avoiding cognitive load among team members.
Q6	As the duration was not so long, it is quite difficult for experimenting whether this technology really creates social type of distances (except for the emotional distance). In contrast, it was clear at the beginning of the project that depending on each participant's ICT skill then it was more or less easy to use, hence it was creating some kind of technological distance. This kind of distance was progressively not so present after using this tool for some time and even helped team cohesiveness through the emergence of a specific culture. There was also some concern with the customer regarding security issues with the use of a shared workspace as well as Intellectual Property Rights (IPR) that were related to ownership distance between the academic and industry approaches.
Q7	Useful for working with external participants. No creativity support.
Q8	Emailing is simpler to access though shared workspace allows seeing what others are producing.
Q9	Improve look and feel of the user interface. Provide a better feeling of team "family" like having a photo gallery.