European Journal of Information Systems (2005) 14, 37–48

www.palgrave-journals.com/ejis

Social ties, knowledge sharing and successful collaboration in globally distributed system development projects

Julia Kotlarsky[1] and
Ilan Oshri[2]

[1]Warwick Business School, The University of Warwick, Coventry, U.K.; [2]Rotterdam School of Management, Erasmus University, Rotterdam, The Netherlands.

Correspondence:
Julia Kotlarsky,
Warwick Business School, The University of Warwick, Coventry CV4 7AL, U.K.
Tel: +44 24 7652 4692;
Fax: +44 24 7652 4539;
E-mail: julia.kotlarsky@wbs.ac.uk

Abstract
Traditionally, the main focus of the information system (IS) literature has been on technical aspects related to system development projects. Furthermore, research in the IS field has mainly focused on co-located project teams. In this respect, social aspects involved in IS projects were neglected or scarcely reported. To fill this gap, this paper studies the contribution of social ties and knowledge sharing to successful collaboration in distributed IS development teams. Data were drawn from two successful globally distributed system development projects at SAP and LeCroy. Data collected were codified using Atlas.ti software. The results suggest that human-related issues, such as rapport and transactive memory, were important for collaborative work in the teams studied. The paper concludes by discussing the implications for theory and suggesting a practical guide to enhance collaborative work in globally distributed teams.
European Journal of Information Systems (2005) **14,** 37–48.
doi:10.1057/palgrave.ejis.3000520

Keywords: social aspects; knowledge sharing; collaborative work; dispersed teams

The biggest problem is a people problem: if people from different sites don't have the respect and trust for each other, they don't work well together
(Anthony, Chief Software Architect, LeCroy)

Introduction

Recent years have witnessed the globalization of many industries. Consequently, globally distributed collaborations and virtual teams have become increasingly common in many areas, for example new product development (Malhotra *et al*., 2001) and information systems (IS) development (Carmel & Agarwal, 2002; Herbsleb & Mockus, 2003; Sarker & Sahay, 2004).

Managing dispersed development projects is far more challenging than co-located projects. However, ongoing innovations in information and communication technologies (ICT) make it possible to cooperate in a distributed mode. Indeed, recent research in the IS field has focused on ICT in the context of globally distributed IS development teams (Carmel, 1999; Herbsleb *et al*., 2002; Mockus & Herbsleb, 2002). However, little is known about the social aspects associated with the management of globally distributed IS development projects and, in some studies, social aspects are perceived to be constraints on globally distributed collaboration (Jarvenpaa & Leidner, 1999; Evaristo, 2003; Sarker & Sahay, 2004). While

Received: 5 April 2004
Revised: 29 September 2004
2nd Revision: 1 December 2004
Accepted: 8 February 2005

other disciplines, such as organizational behaviour, have acknowledged the importance of social aspects, such as trust (Storck, 2000; Child, 2001), in global collaborations, evidence about the role that human and social aspects play in global collaborative work is still missing. To fill this gap, this paper attempts to address the following questions: *do social ties and knowledge sharing contribute to successful collaboration in globally distributed IS development teams and, if so, through what mechanisms are social ties established and facilitated?*

Following the Introduction, the paper will discuss the literature on globally distributed IS development projects. A review of past studies related to social ties, knowledge sharing and successful collaboration in various contexts, such as co-located sites and global alliances, will be provided. Following this, the motivation for this research, and an identification of the gap in the literature will be outlined. Following an outline of the research methods applied, data drawn from SAP and LeCroy, two companies that have engaged in globally distributed IS development projects, will be presented. A qualitative presentation of the findings will be followed by a quantification of the research data, providing evidence for the importance of social ties and knowledge sharing to collaborative work in globally distributed IS development teams. Evidence regarding the mechanisms supporting the build-up of social ties observed in the companies studied will also be outlined. Finally, the implications for theory and practice are discussed.

Background

Globally distributed IS development projects are projects that consist of two or more teams working together to accomplish project goals from different geographical locations. In addition to geographical dispersion, globally distributed teams face time zone and cultural differences that may include, but are not limited to, different languages, national traditions, values and norms of behaviour (Carmel, 1999).

Traditionally, the main focus of the IS literature on globally distributed teams has been on technical aspects related to system development projects. Past research in the IS field suggests that the proper application of technical and operational mechanisms such as collaborative technologies, IS development tools and coordination mechanisms is the key to successful system development projects (Carmel, 1999; Majchrzak *et al*., 2000; Herbsleb *et al*., 2002). It has been claimed, for example, that a powerful ICT infrastructure is required to ensure connectivity and data transfer at high speed between remote sites (Carmel, 1999). Additionally, generic collaborative technologies (e.g. Groupware) are needed to enable remote colleagues to connect and communicate. The most commonly suggested collaborative technologies are e-mail, chat (e.g. Instant Messaging), phone/teleconferencing, video-conferencing, intranet, group calendar, discussion lists and electronic meeting systems (Smith & Blanck, 2002; Herbsleb & Mockus, 2003). Finally, in addition to generic collaborative technologies, a number of specific tools for software development have been suggested to support globally distributed teams. These include configuration and version management tools, document management systems, replicated databases and CASE tools (Ebert & De Neve, 2001; Carmel & Agarwal, 2002; Smith & Blanck, 2002). Recent studies have focused on integrating software development tools (e.g. Integrated Development Environment) with collaborative tools (e.g. email, Instant Messaging) in order to offer solutions that deal with breakdowns in communication and coordination among developers in dispersed development teams (Cheng *et al*., 2004).

A related stream of studies has focused on issues pertaining to the geographical dispersion of work. Naturally, because of several constraints associated with globally distributed work, such as distance, time zone and cultural differences, traditional coordination and control mechanisms tend to be less effective in global development projects (Herbsleb & Mockus, 2003). Distance, for example, reduces the intensity of communications, in particular when people experience problems with media that cannot substitute face-to-face communications (Smith & Blanck, 2002). Cultural differences, expressed in different languages, values, working and communication habits and implicit assumptions, are believed to be embedded in the collective knowledge of a specific culture (Baumard, 1999) and thus may cause misunderstanding and conflicts. Time zone differences reduce opportunities for real-time collaboration, as response time increases considerably when working hours at remote locations do not overlap (Sarker & Sahay, 2004). Such challenges raise the question whether globally distributed work can benefit from other factors, human in nature, involved in dispersed projects. The following sections provide a review of the literature on the human and social aspects involved in collaborative work. We draw on studies from several disciplines in order to assess the extent to which human and social aspects have been considered as enablers for collaborative work in globally distributed projects.

Social aspects in globally distributed teams

A large number of factors that may contribute to collaborative work have been given consideration in earlier studies. Among the many socially related factors contributing to collaboration, past studies have considered formal and informal communications (Storck, 2000; Child, 2001; Dyer, 2001), trust (Arino *et al*., 2001; Child, 2001), motivation (Child, 2001) and social ties (Granovetter, 1973; Storck, 2000; Child, 2001). The literature on IS development projects is far more limited in addressing the impact that human-related factors may have on IS projects in general and successful collaboration in particular. It has been argued, for example, that informal communications play a critical role in coordination activities leading to successful collaboration in co-located IS development

(Kraut & Streeler, 1995). As the size and complexity of IS development increase, the need to support informal communications also increases (Herbsleb & Moitra, 2001). Consequently, one of the central problems in distributed development projects is induced by time, cultural and geographical distances that greatly reduce the amount of such communication. Nonetheless, past studies related to IS in the context of globally distributed teams have mainly raised concerns about managers' ability to overcome geographical, time zone and cultural differences. According to Smith & Blanck (2002, p. 294), for example, 'an effective team depends on open, effective communication, which in turn depends on trust among members. Thus, trust is the foundation, but it is also the very quality that is most difficult to build at a distance'. *Trust* was defined by Child (2001, p. 275) as 'the willingness of one person or group to relate to another in the belief that the other's action will be beneficial rather than detrimental, even though this cannot be guaranteed'. Trust is more likely to be built if personal contact, frequent interactions and socializing between teams and individuals are facilitated (Arino *et al*., 2001; Child, 2001).

Additional challenges to globally distributed work have been raised by Herbsleb & Mockus (2003). They claim that (i) distributed social networks are much smaller than same-site social networks, (ii) there is far less frequent communication in distributed social networks compared to same-site social networks, (iii) people find it much more difficult to identify distant colleagues with necessary expertise and to communicate effectively with them, and (iv) people at different sites are less likely to perceive themselves as part of the same team than people who are at the same site. Studies that have sought solutions to overcome the above challenges, often induced by the lack of personal interactions between remote teams, have suggested a division of labour and task between remote sites (e.g. Grinter *et al*., 1999; Battin *et al*., 2001). While it seems that the main challenge is to create rapport between members of the dispersed teams, the solutions proposed have been mainly in the field of technical and project procedures. *Rapport* is defined as 'the quality of the relation or connection between interactants, marked by harmony, conformity, accord, and affinity' (Bernieri *et al*., 1994, p. 113). Past research has indeed confirmed that rapport is the key to collaboration between project teams and individuals, however in the context of co-located project sites (Gremler & Gwinner, 2000). Little is known about creating rapport between globally distributed teams.

To summarize, while past studies in the various disciplines have acknowledged the importance of social aspects in collaborative work, the studies that have focused on the IS field have tended to see such social aspects (e.g. trust and rapport) as very difficult to encourage or foster in the context of globally distributed projects.

Knowledge sharing in globally distributed teams

The importance of knowledge sharing for collaborative work has already been established in past studies (e.g. Hendriks, 1999; Goodman & Darr, 1998). Storck (2000), for example, claims that sharing knowledge is important to building trust and improving the effectiveness of group work. Herbsleb & Moitra (2001) reiterated such an observation, claiming that without an effective sharing of information, projects might suffer from coordination problems leading to unsuccessful collaborations. Nonetheless, achieving an effective knowledge sharing process may encounter certain challenges, in particular when teams are faced with cultural, geographical and time zone differences (Kobitzsch *et al*., 2001; Herbsleb & Mockus 2003). Herbsleb *et al*. (2000, p. 3) described how one global IS development project was facing major challenges in trying to identify who knows what: 'difficulties of knowing who to contact about what, of initiating contact, and of communicating effectively across sites, led to a number of serious coordination problems'. There seemed to be a need to know whom to contact about what in this particular organization, something that is far more challenging in globally distributed teams. This organizational aspect, knowing who knows what, has been acknowledged as the key to knowledge sharing activities by several studies (Orlikowski, 2002; Herbsleb & Mockus, 2003). Faraj & Sproull (2000), for example, suggested that instead of sharing specialized knowledge, individuals should focus on knowing where expertise is located and needed. Such an approach towards knowledge sharing is also known as transactive memory. *Transactive memory* is defined as the set of knowledge possessed by group members coupled with an awareness of who knows what (Wegner, 1987). It has been claimed that the transactive memory may positively affect group performance and collaboration by quickly bringing the needed expertise to knowledge seekers (Faraj & Sproull, 2000; Storck, 2000).

Another socially constructed concept that was proposed as a connecting mechanism between individuals and teams is collective knowledge. Grant (1996) claims that collective knowledge comprises elements of knowledge that are common to all members of an organization. In the case of globally distributed system development projects, the 'organization' involves all people participating in the project in remote locations. *Collective knowledge* is defined as 'a knowledge of the unspoken, of the invisible structure of a situation, a certain wisdom' (Baumard, 1999, p. 66). Such a concept may entail the profound knowledge of an environment, of established rules, laws and regulations. It may include language, other forms of symbolic communication and shared meaning (Grant, 1996). Building a sense of collective knowledge in co-located organizations would mean the development of a collective mind (Weick & Roberts, 1993; Weick *et al*., 1999) through participation in tasks and social rituals (Orr, 1990; Baumard, 1999; Orlikowski, 2002).

To conclude, while globally distributed teams have employed a range of communication tools (e.g. Groupware applications comprising chat, e-mail, discussion list and application sharing capabilities) that support the sharing of knowledge across remote sites, evidence from recent research suggests that the challenges involved in sharing knowledge across globally distributed teams are still widespread, and that breakdowns in sharing knowledge do occur. Indeed, technical solutions are important, but are not sufficient. This calls for further investigation of socially constructive elements involved in developing collective knowledge and transactive memory as complementary mechanisms to existing technical solutions.

Successful collaboration in information system projects

The word collaboration comes from the Latin words *com* (prefix *together*) and *laborare* (verb *to work*). It means that two or more individuals work jointly on an intellectual endeavour (Webster, 1992). *Collaboration* is a complex, multi-dimensional process characterized by constructs such as coordination (Faraj & Sproull, 2000), communication (Weick & Roberts, 1993), meaning (Bechky, 2003), relationships (Gabarro, 1990), trust (Meyerson *et al*., 1996) and structure (Adler & Borys, 1996).

The IS literature has discussed at length some factors that support successful collaboration. *Successful collaboration* is the process through which a specific outcome, such as a product or desired performance, is achieved through group effort. In this sense, successful collaboration is represented in this paper as either product success or a desired performance of a distributed team. Product success can be represented by various indicators, such as growth in sales, product delivery on time and within the budget (Nellore & Balachandra, 2001; Andres, 2002) or short time-to-market (Datar *et al*., 1997). In line with these indicators, *product success* is thus defined as the achievement of project objectives (Gallivan, 2001). This criterion for product success can either be objective, that is, based on market or company data, or subjective, that is, based on project participants' perception of product success.

A desired result of a distributed team can also be a people-related outcome (Hoegl & Gemuenden, 2001), which entails meeting the psychological needs of the members (Gallivan, 2001). Hoegl & Gemuenden (2001) and Gallivan (2001), for example, suggest that, in addition to performance objectives, teams must also work in a way that increases members' motivation to engage in future teamwork. There should be some level of personal satisfaction that motivates individuals and teams to continue their engagement in collaborative work despite geographical, time and cultural differences. We perceive *personal satisfaction* as the outcome of a positive social experience. Such positive social experience can, for example, be in the form of stress-free communication rituals between remote counterparts and collegial relationships between remote teams. Some factors that may foster people-related outcomes and thus may improve personal satisfaction are open and multiple informal communication channels (Hoegl & Gemuenden, 2001), the encouragement of interactions between parties involved in the development process (Nelson & Cooprider, 1996), and the cohesion of a team (Gallivan, 2001; Hoegl & Gemuenden, 2001). Naturally, geographical, cultural and time-zone differences pose additional challenges to globally distributed teams to achieve successful collaboration, whether seen either as a people-related outcome or as a product outcome.

The motivation for the research: the gap

Thus far, the solutions proposed to support globally distributed teams have been technical in nature, paying little attention to the human and social aspects involved in globally distributed work (Al-Mushayt *et al*., 2001). Furthermore, in the few studies that focused on social aspects in globally distributed projects, these aspects were presented as concepts that added challenges to the coordinating of collaborative work because of cultural, geographical and time-zone differences. Jarvenpaa & Leidner (1999), for example, indicated that lack of trust is likely to develop between globally distributed teams, while Carmel (1999) raised a concern about possible breakdowns in communications that may cause coordination problems because of language barriers, cultural differences, asymmetry in distribution of information among sites and lack of team spirit.

While we accept the observation that insufficient trust and poor social relationships may act as barriers to successful collaboration in globally distributed teams, and sufficient trust and well-established social relationships may act as enablers to collaborative work, we also argue that there is a need to understand whether, and how, social aspects actually contribute to successful collaboration. The importance, and the contribution, of social aspects to collaborative work in globally distributed projects is neglected in the IS literature, and the little that is known about this area is mainly based on co-located project teams. To fill this gap, three concepts – social ties, knowledge sharing and successful collaboration – will be studied in an attempt to address the following questions: *do social ties and knowledge sharing contribute to successful collaboration in globally distributed IS development teams and, if so, through what mechanisms are social ties established and facilitated?*

Figure 1 illustrates the three main concepts, social ties, knowledge sharing and successful collaboration; and their categories, trust and rapport, transactive memory and collective knowledge, and product success and personal satisfaction, respectively. In addition, the importance of collaborative tools will be studied in order to assess their impact on successful collaboration in comparison to the contribution that social ties and knowledge sharing have made to successful collaborative work. Lastly, the mechanisms that support social ties will be explored in an attempt to explain how companies may

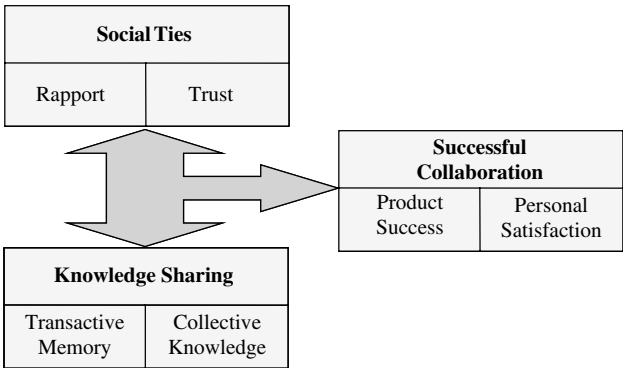

Figure 1 Main concepts and their categories.

create social ties between globally distributed team members.

Research method and approach

An in-depth ethnographic study of globally distributed software development projects is provided in this paper. A qualitative, interpretive approach is adopted. In line with much past IS research (e.g. Palvia *et al.*, 2003), a case study method was selected for this research.

Applying a case study method as a research strategy involves the use of an all-inclusive method and offers several approaches to data collection and analysis (Yin, 1994). Typically, a study based on a case study methodology from an interpretive perspective starts with a discussion of the existing literature followed by data collection and analysis procedures (Yin, 1994). In this study, evidence was gathered from a variety of sources such as documentation, archival records and interviews (Eisenhardt, 1989; Yin, 1994). Data were also triangulated through interviews with team counterparts in different locations and in cases where the interpretation of subjective evidence was questionable, such as in the case of successful collaboration. In addition, data analysis methods involved both the presentation of qualitative data in the form of statements made by interviewees as well as a quantification of data in the form of statement frequencies.

To correspond with the main interests of the research, only project teams at SAP and LeCroy that were globally distributed across at least two locations were considered for this study (see Company background in Appendix A). Interviews were conducted at two remote sites per company: in India and Germany for SAP, and Switzerland and USA for LeCroy. Interviewees were chosen to include (1) counterparts working closely at remote locations, and (2) diverse roles such as managers and developers. In total, 10 interviews (five at each company) were conducted (see Interviewees' details in Appendix B). Interviews lasted 1 h and 30 min on average; they were recorded and fully transcribed. A semi-structured interview protocol was applied, to allow the researchers to clarify specific issues and follow up with questions (see Interview protocol in Appendix C).

Data analysis followed several steps. It relied on iterative coding of the data using the open-coding technique (Strauss & Corbin, 1998), sorting and refining themes emerging from the data based on the definitions of the categories with some level of diversity (Miles & Huberman, 1994; Strauss & Corbin, 1998), and linking these to categories and concepts (see Appendix D).

Coding was done in Atlas.ti – packaged Qualitative Data Analysis (QDA) software. The QDA software facilitated the analysis process. In particular, it was used for coding, linking codes and text segments, documenting diversity in codes, creating memos, searching, editing and re-organizing, and visual representation of data and findings (Miles & Huberman, 1994; Weitzman, 2000).

Data were analysed by the researchers independently. The interpretation of selective codes (those that seemed to have dual meaning), the consolidation of codes into categories and the examination of empirical findings against the literature were done by both researchers together. In addition, feedback sessions with key informants in the case companies were organized and their comments were incorporated into the research findings. Such a data analysis approach is believed to enhance confidence in the findings (Eisenhardt, 1989).

Empirical results and analysis

In this section, the results of two case studies carried out at SAP and LeCroy will be presented. Based on the empirical evidence presented below, we argue that social ties and knowledge sharing contributed to successful collaboration in the companies studied. In principle, we claim, based on the data analyzed, that in globally distributed IS development teams, social ties and knowledge sharing improved collaboration. Furthermore, several organizational mechanisms supporting the build-up of social ties between remote sites were reported. In order to support the above claim, three levels of evidence will be outlined in the following section. The first level is an outline of statements made by interviewees associated with the concepts under investigation (i.e. social ties, knowledge sharing and successful collaboration). The second level is the frequency of these statements. The third level will present the number of instances in which social ties, knowledge sharing and collaborative tools were linked to successful collaboration.

Social ties in globally distributed teams: evidence

Statements made by interviewees about rapport and trust are presented below. These statements were analysed and associated with rapport and trust based on the definitions provided above.

Rapport

LeCroy *Most of the guys know each other very well – we try to make sure they interact, we increase the possibility that they really get to know each*

other (Anthony: see Interviewees' details in Appendix B).

SAP *I need to have good relationships with the people I am working with […] the better you know the people the easier it gets. I know Sudhir and Thomas, both of them I think by now quite well* (Christoph).

Trust

LeCroy *It makes a big difference, when the guys know each other but more importantly when the guys trust each other* (Anthony).

SAP *The team-building exercise was a way to show that we care about remote locations. The end result of that exercise was that the entire team* [globally distributed] *feels more comfortable to work together. Now they know each other and trust each other better* (Stefan).

Knowledge sharing in globally distributed teams: evidence

Statements made by interviewees about transactive memory and collective knowledge are presented below. These statements were analysed and associated with rapport and trust based on the definitions provided above.

Transactive memory

LeCroy *When a problem occurs it is important for the team, instead of finding the bug, to find quickly who knows best about the failing component* (Gilles).

SAP *What I did in the past was – this was in the very early phase of the project, I sent requests only to Sudhir and he would distribute the issues between people. But by now, after 6 months, I know quite well what everybody is doing. So after a time, you just know who's doing what* (Christoph).

Collective knowledge

LeCroy *How do you pick all the guys that we had – pure embedded programmers – and teach them all about Windows and a new Microsoft COM technology at the same time. Well, we all got together in the mountains of France. It was a real fun week with two purposes: one was to teach us all about this new technology. The other which was fairly equally important if not more important in some way – was to really try to build relationships between people* (Larry).

SAP *It [*team-building*] was a pretty good experience for myself: learning the culture and also how the team internally works. So my understanding of what you can expect from the team, and what you cannot expect, is very important for us* (Stefan).

Successful collaboration in globally distributed teams: evidence

Successful collaboration can be defined by various indicators. The perception of interviewees that a project team was collaborative is one indication of successful collaboration. However, there may also be external indicators of successful collaboration, such as project and product success. These indicators can be either subjective or objective. Subjective evidence may include statements made by interviewees about their perception of product success, while objective evidence presents evidence in the form of sales, growth, and industry recognition associated with the product. While objective evidence should not be biased, one has to acknowledge that some indicators may have been manipulated prior to presentation by the company (e.g. sales figures). The perception of interviewees with regard to product success and personal satisfaction, representing successful collaboration, is presented below. These statements were analysed and associated with product success and personal satisfaction based on the definitions provided above.

Product success

LeCroy Engineers described the Maui project as the first project to adopt a component-based architecture, claiming that this new approach serves as a basis for future products because '*we can take the bunch of different components and create different instruments* […] *within a few months rather than in a few years*' (Larry).

SAP *We just went through a merger, so setting up a global project was not an easy task. Despite all the difficulties we managed to have a successful second software release in 8 months* (Stefan).

Personal satisfaction

LeCroy *The job here is very demanding and challenging. I think that those who stay onboard are the engineers who share the same goal: to work on complex problems in cutting edge technologies. I think that the fact that we share this goal helps us to work well together* (Gilles).

SAP *The team building exercise from our side* [Bangalore team] *was more of a building of awareness about the whole team of Stefan, because he heads now all our team, so he needed to have a good picture of how the team composition is, what each individual is like or what different people are like* (Sudhir).

In addition, objective evidence, presented below, supports the perception of product success that was reported by interviewees.

Product and project success (objective evidence)

LeCroy

- LeCroy's WaveMaster 8600, the first release of the Maui Project, was announced as the Best Product of Year 2002 by EDN, a leading magazine for design engineers.

- While revenues in 2003 were down to $107.8M from $111.5M in 2002 because of the difficult economic environment, the WaveMaster had a positive impact on the financial results of year 2003: *Our high-end oscilloscope product orders grew by 7% in the first quarter of fiscal 2003 over a comparable period in fiscal 2002. This success is due to the new WaveMaster product line, including the introduction of the world's highest performance oscilloscope during the quarter, the WaveMaster 8600A* (Tom Reslewic, CEO, LeCroy, news release, 16 October 2002).

SAP

- According to JupiterResearch, a leading research and consulting company in emerging technologies, SAP Enterprise Portal is the third largest software solution, with 17% of the USA market in 2002. The studied Collaboration Project developed Collaborative tools as one of the three main features of the SAP Enterprise Portal.
- The 2003 revenues for SAP Enterprise Portal were up by 5% representing 13% of SAP software sales (SAP's 2003 annual report).

Concept frequencies for social ties, knowledge sharing, collaborative tools and successful collaboration

The above section presented a sample of statements made by interviewees from SAP and LeCroy with regard to social ties, knowledge sharing and successful collaboration. This section presents a calculation of all statements made by interviewees at SAP and LeCroy in the context of social ties, knowledge sharing, collaborative tools and successful collaboration. We refer to this calculation as concept frequencies. In all, 51 statements were made by interviewees from SAP, for example, with regard to knowledge sharing in globally distributed teams. In addition, 'diversity in codes' was calculated. 'diversity in codes' represents the number of different codes grouped within one category (as illustrated in Appendix D). Under the category 'trust', for example, three different codes were identified. In other words, 'diversity in codes' represents the number of instances that a statement was found to be somehow different from another statement in the context of a particular category (Table 1).

Our calculations show that 81 statements were made with regard to social ties, 72 statements concerning knowledge sharing and 102 statements about collaborative tools. Within the concepts, a large number of statements were associated with rapport (71). These findings may suggest that interviewees have considered developing rapport with counterparts from remote sites to be an important element in collaborative work. The importance of social ties and knowledge sharing in successful collaboration will be further discussed in the following section.

The relationships between social ties, knowledge sharing, collaborative tools and successful collaboration

To assess the importance of social ties and knowledge sharing for successful collaboration, a calculation was made of statements that represented explicit relationships between social ties, knowledge sharing, collaborative tools and successful collaboration (see an example in Appendix D). These calculations are presented in Table 2 under the column 'Relationships with successful collaboration'.

Two conclusions can be drawn from the calculations presented in Table 2. Firstly, Table 2 suggests that social ties and knowledge sharing were positively associated with successful collaboration in 30% and 43% of the statements made, respectively. Collaborative tools were positively associated with successful collaboration in 37% of statements made about this concept. Secondly, social ties (30%) and knowledge sharing (43%) were associated with successful collaboration, almost to the same extent or even further than collaborative tools (37%). The significance of these findings can be further underlined by the observation that interviewees were asked a similar number of questions about human-related issues and about collaborative tools (see Interview protocol in Appendix C).

Based on the evidence above, we argue that our findings suggest that, in addition to technical solutions,

Table 1 Concept frequencies for SAP and LeCroy based on number of statements

Concept	*Categories in concept*	*Diversity in codes*	*Concept frequencies (Number of statements per concept)*		
			SAP	*LeCroy*	*SUM*
Social ties	Rapport	17	50	21	81
	Trust	3	3	7	
Knowledge sharing	Transactive memory	15	28	14	72
	Collective knowledge	15	23	7	
Collaborative tools	None	8	54	48	102
Successful collaboration	Product success	14	23	24	120
	Personal satisfaction	19	45	28	

Table 2 Calculated values of relationships between concepts based on number of associated codes

Concepts	*Concept frequencies (count from Table 1)*	*Relationships with successful collaboration (statements/percent)*
Social ties	81	24 (30%)
Knowledge sharing	72	31 (43%)
Collaborative tools	102	38 (37%)

Table 3 Organizational mechanisms and activities supporting social ties in globally distributed teams

Mechanisms	*Mechanism frequencies*	
	SAP	*LeCroy*
Before Face-to-Face (F2F)	**88**	**30**
• Promote initial (non-F2F) introduction (e.g. virtual F2F, ***short visit to location***, set up virtual mini teams, advocate shared cyber spaces)	61	26
• Reduce communication barriers (e.g. English courses, ***set up contact person***, distribute news letters and communication protocol)	27	4
After F2F	**35**	**34**
• Routinize communications (e.g. regular reflection sessions, around the table discussions, project meetings, ***visit to remote locations***)	14	9
• Open communication channels (e.g. ***direct communication channel***, centralized source of shared information)	18	15
• Ensure message quality (e.g. detailed email, use phone, ensure understanding messaged received, ***use graphical representation***)	3	10
Tools	**62**	**58**
• Various collaborative tools (e.g. ***phone, email, Groupware tools***, Knowledge repositories, teleconference, videoconference, on-line chat)	54	48
• Practices (flexible working hours, standardized software packages)	8	10

human-related issues in the form of social ties and knowledge sharing were considered as the key to successful collaboration.

Organizational mechanisms supporting social ties in globally distributed teams

The analysis of the evidence collected at SAP and LeCroy suggests that there were two phases of activities that supported the build-up of social ties: (i) before Face-to-Face (F2F) and (ii) after F2F. In addition, the analysis of the empirical evidence suggests that there were some particular tools that the projects studied have applied. Table 3 outlines the activities associated with the two phases of building up social ties and outlines the set of tools applied by the projects studied. In addition, a calculation of the number of statements made with regard to a particular activity or tool is provided per company. The highest frequency calculated is in bold.

Table 3 suggests that interviewees from SAP considered activities prior to an F2F meeting important for building social ties, that is, rapport and trust, between members of the globally distributed team. In particular, a short visit to a remote location was mentioned as an important mechanism prior to a formal introduction of the team. Interviewees from LeCroy considered activities before F2F and after F2F as equally important for the build-up of social ties. Nonetheless, managers from LeCroy also considered an initial introduction activity before F2F as important for instituting social relationships. In terms of post-F2F activities, interviewees from both companies indicated the importance of open communication channels. A non-hierarchical communication approach was another mechanism contributing to social relationships. Lastly, the tools through which social relationships were created across different sites were mainly phone, email and groupware applications. Nonetheless, interviewees also indicated that the quality of messages, meaning, the assurance that messages communicate the issue successfully and are understood and interpreted properly, is important for establishing social relationships between team members.

So far, evidence about the importance of social aspects in globally distributed teams and the means through which social ties can be established, has been presented. The following section will discuss the implications for research and practice.

Implications

Human and organizational aspects involved in system development projects are the centre of this study. The cases of SAP and LeCroy demonstrated the importance of some human aspects, e.g. social ties and knowledge sharing activities, and organizational aspects, for example, tools and project procedures, in globally dispersed

collaborative work. The implications for human and organizational aspects are both theoretical and practical.

Theoretical implications

From a theoretical perspective, this study suggests that more attention is needed to understand the relationships between social ties, knowledge sharing and successful collaboration in globally distributed teams. As it stands, the IS literature tends to overemphasize the contribution of technical solutions and collaborative tools to the flow and sharing of information (e.g. Battin *et al.*, 2001; Ebert & De Neve, 2001), and in some cases to downplay the role of social aspects, such as rapport, in globally distributed collaborative work. We claim that collaborative work can also be understood from a social construction viewpoint in which the quality of the relation or connection between interactants in globally distributed teams can be enhanced through story telling (Orr, 1991) and participation in social rituals (Lave & Wenger, 1991). In this respect, the social practice is the primary activity and collaboration is one of its characteristics. The learning involved in the manner in which people successfully collaborate is located within the social world. As part of the participation involved in a collaborative practice, members of a globally distributed project change locations and perspectives to create and sustain learning trajectories (Lave & Wenger, 1991, p. 36). We argue that collaboration is actually about renewing the set of relations between globally distributed project members through continuous participation and engagement. In this sense, collaborative tools are one mediator through which collaboration as a learned social practice is developed.

Practical implications

From a practical viewpoint, we argue that in order to achieve successful collaboration in globally distributed teams, companies need to introduce organizational mechanisms that create social spaces between team members. There is substantial support in research and practice, as for example in this study, for F2F meetings, suggesting that such meetings are important for teamwork and performance (Jarvenpaa *et al.*, 1998; Govindarajan & Gupta, 2001).

We argue that some activities should be planned both before and after F2F meetings, to ensure the participation and engagement of project members in collaborative work. We suggest, for example, that managers should facilitate social interaction prior to a F2F meeting, such as short visits to a remote location of key project members, the introduction of a contact person to the dispersed team, support for language courses and the dissemination of clear communication procedures. These activities, often ignored prior to a F2F meeting in globally distributed teams, have been reported as the key to establishing social and human contact and supporting the build-up of rapport between counterparts from remote sites. Regular meetings, either virtual or in terms of short visits, after F2F meetings, will ensure participation of project members over time. We also suggest that a variety of communication tools be utilized to assist the maintenance of a high level of participation of project members and to enrich the quality of messaging involved in collaborative work, such as phone, videoconference media and email.

Lastly, from a strategic viewpoint, management should demonstrate strong commitment to addressing human-related issues in globally distributed system development projects and should dedicate resources that ensure the renewal of social relationships, as was done at SAP and LeCroy.

Concluding remarks

In this paper, the contribution of social ties and knowledge sharing to successful collaboration in distributed IS development teams has been explored. We conclude that in addition to technical solutions, human-related issues in the form of social ties and knowledge sharing were reported as keys to successful collaboration. In particular, the importance of rapport and transactive memory was evident in the studied projects. Furthermore, organizational mechanisms that create and maintain social ties between dispersed team members were reported in detail.

The conclusions offered in this paper are based on an in-depth study of two companies, by applying a qualitative, interpretive methodological lens. Additional methodological approaches may contribute to further understand the relationships between social ties, knowledge sharing and successful collaboration in globally distributed teams. We propose that future studies should conduct a survey across the IS industry in which the causal relationships between these three main concepts will be further investigated.

Acknowledgements

Data collection in India was sponsored by a grant from the Netherlands Foundation for the Advancement of Tropical Research (WOTRO).

About the authors

Julia Kotlarsky is lecturer in Information Systems, Operations Research and Information Systems Group, Warwick Business School, U.K. She is completing her Ph.D. in management and information systems at Rotterdam School of Management, The Netherlands. Her main research interests revolve around social, technical and design aspects in globally distributed teams. Julia has written on this subject and her work

was presented in various conferences and was published in *International Journal of Production Research*.

Ilan Oshri is Assistant Professor in the Department of Strategy and Business Environment, Rotterdam School of Management, The Netherlands. He holds a Ph.D. in strategic management and technological innovation from Warwick Business School, England. His main research interest lies in the area of innovation and the organization of the firm for innovation. Ilan has written extensively on this subject and his work was published in several books and journals including *Management Learning* and *Knowledge Management Research and Practice*.

References

ADLER PS and BORYS B (1996) Two types of bureaucracies: enabling and coercive. *Administrative Science Quarterly* **41**, 61–89.

AL-MUSHAYT O, DOHERTY NF and KING M (2001) An investigation into the relative success of alternative approaches to the treatment of organizational issues in system development projects. *Organization Development Journal* **19(1)**, 31–48.

ANDRES HP (2002) A comparison of face-to-face and virtual software development teams. *Team Performance Management* **8(1/2)**, 39–48.

ARINO A, DE LA TORRE J and RING PS (2001) Relational quality: managing trust in corporate alliances. *California Management Review* **44(1)**, 109–131.

BATTIN RD, CROCKER R and KREIDLER J (2001) Leveraging resources in global software development. *IEEE Software* **(March/April)**, 70–77.

BAUMARD P (1999) *Tacit Knowledge in Organizations*. Sage, London.

BECHKY BA (2003) Sharing meaning across occupational communities: the transformation of understanding on a production floor. *Organization Science* **14(3)**, 312–330.

BERNIERI FJ, DAVIS JM, ROSENTHAL R and KNEE CR (1994) Interactional synchrony and rapport: measuring synchrony in displays devoid of sound and facial affect. *Personality and Social Psychology Bulletin* **20**, 303–311.

CARMEL E (1999) *Global Software Teams: Collaborating across Borders and Time Zones*. Prentice-Hall, Upper Saddle River, NJ.

CARMEL E and AGARWAL R (2002) The maturation of offshore sourcing of information technology work. *MIS Quarterly Executive* **1(2)**, 65–77.

CHENG L, DE SOUZA CRB, HUPFER S, PATTERSON J and ROSS S (2004) Building collaboration into ides. *Queue* **1(9)**, 40–50.

CHILD J (2001) Trust – the fundamental bond in global collaboration. *Organizational Dynamics* **29(4)**, 274–288.

DATAR S, JORDAN C, KEKRE S and SRINIVASAN K (1997) New product development structures and time-to-market. *Management Science* **43(4)**, 452–464.

DYER JH (2001) How to make strategic alliances work. *MIT Sloan Management Review* **42(4)**, 37–43.

EBERT C and DE NEVE P (2001) Surviving global software development. *IEEE Software* **(March/April)**, 62–69.

EISENHARDT KM (1989) Building theories from case study research. *Academy of Management Review* **14(4)**, 532–550.

EVARISTO R (2003) The management of distributed projects across cultures. *Journal of Global Information Management* **11(4)**, 58–70.

FARAJ S and SPROULL L (2000) Coordinating expertise in software development teams. *Management Science* **46(12)**, 1554–1568.

GABARRO JJ (1990) The development of working relationships. In *Intellectual Teamwork: Social and Technological Foundations of Cooperative Work* (GALEGHER J, KRAUT RE and EGIDO C, Eds), pp 79–110, Lawrence Erlbaum Associates, New Jersey.

GALLIVAN MJ (2001) Striking a balance between trust and control in a virtual organization: a content analysis of open source software case studies. *Information Systems Journal* **11(4)**, 227–304.

GOODMAN PS and DARR ED (1998) Computer-aided systems and communities: mechanisms for organizational learning in distributed environments. *MIS Quarterly* **22(4)**, 417–440.

GOVINDARAJAN V and GUPTA AK (2001) Building an effective global business team. *MIT Sloan Management Review* **42(4)**, 63–71.

GRANOVETTER MS (1973) The strength of weak ties. *American Journal of Sociology* **78(6)**, 1360–1380.

GRANT RM (1996) Toward a knowledge-based theory of the firm. *Strategic Management Journal* **17(Winter)**, 109–122.

GREMLER DD and GWINNER KP (2000) Customer–employee rapport in service relationships. *Journal of Service Research* **3(1)**, 82–104.

GRINTER RE, HERBSLEB JD and PERRY DE (1999) The geography of coordination: dealing with distance in R&D work. In *Proceedings of the International ACM SIGGROUP Conference on Supporting Group Work (Group 99)*. ACM Press, Phoenix, Arizona.

HENDRIKS P (1999) Why share knowledge? The influence of Ict on the motivation for knowledge sharing. *Knowledge and Process Management* **6(2)**, 91–100.

HERBSLEB JD, ATKINS DL, BOYER DG, HANDEL M and FINHOLT TA (2002) Introducing instant messaging and chat into the workplace. In *Proceedings of the Conference on Computer–Human Interaction* pp 171–178, Minneapolis, Minnesota.

HERBSLEB JD, MOCKUS A, FINHOLT TA and GRINTER RE (2000) *Distance, Dependencies, and Delay in Global Collaboration Conference on Computer Supported Cooperative Work*. Philadelphia, PA, USA.

HERBSLEB JD and MOCKUS A (2003) An empirical study of speed and communication in globally-distributed software development. *IEEE Transactions on Software Engineering* **29(6)**, 1–14.

HERBSLEB JD and MOITRA D (2001) Global software development. *IEEE Software* **(March–April)**, 16–20.

HOEGL M and GEMUENDEN HG (2001) Teamwork quality and the success of innovative projects: a theoretical concept and empirical evidence. *Organization Science* **12(4)**, 435–449.

JARVENPAA SL, KNOLL K and LEIDNER DE (1998) Is anybody out there? Antecedents of trust in global virtual teams. *Journal of Management Information Systems* **14(4)**, 29–64.

JARVENPAA SL and LEIDNER DE (1999) Communication and trust in global virtual teams. *Organization Science* **10(6)**, 791–815.

KOBITZSCH W, ROMBACH D and FELDMANN RL (2001) Outsourcing in India. *IEEE Software* **(March/April)**, 78–86.

KRAUT RE and STREELER LA (1995) Coordination in software development. *Communications of the ACM* **38(3)**, 69–81.

LAVE J and WENGER E (1991) *Situated Learning Legitimate Peripheral Participation*. Cambridge University Press, Cambridge.

MAJCHRZAK A, RICE RE, KING N, MALHOTRA A and BA S (2000) Computer-mediated inter-organizational knowledge-sharing: insights from a virtual team innovating using a collaborative tool. *Information Resources Management Journal* **13(1)**, 44–54.

MALHOTRA A, MAJCHRZAK A, CARMAN R and LOTT V (2001) Radical innovation without collocation: a case study at Boeing-Rocketdyne. *MIS Quarterly* **25(2)**, 229–249.

MEYERSON D, WEICK KE and KRAMER RM (1996) Swift trust and temporary groups. In *Trust in Organizations: Frontiers of Theory and Research* (KRAMER RM and TYLER TR, Eds). Sage, Thousand Oaks, CA.

MILES MB and HUBERMAN AM (1994) *Qualitative Data Analysis: An Expanded Sourcebook* (2nd edn). Sage, Thousand Oaks, CA.

MOCKUS A and HERBSLEB JD (2002) Expertise browser: a quantitative approach to identifying expertise. In *Proceedings of the International Conference on Software Engineering* pp 503–512, Orlando, FL.

NELLORE R and BALACHANDRA R (2001) Factors influencing success in integrated product development projects. *IEEE Transactions on Engineering Management* **48(2)**, 164–174.

NELSON KM and COOPRIDER JG (1996) The contribution of shared knowledge to IS group performance. *MIS Quarterly* **20(4)**, 409–432.

ORLIKOWSKI WJ (2002) Knowing in practice: enacting a collective capability in distributed organizing. *Organization Science* **13(3)**, 249–273.

ORR J (1991) Sharing knowledge celebrating identity: community memory in a service culture. In *Collective Remembering* (MIDDLETON D and EDWARDS D, Eds). Sage, London.
PALVIA P, MAO E, SALAM AF and SOLIMAN KS (2003) Management information system research: what's there in a methodology? *Communications of the Association for Information Systems* **11,** 289–309.
SARKER S and SAHAY S (2004) Implications of space and time for distributed work: an interpretive study of US-Norwegian system development teams. *European Journal of Information Systems* **13(1),** 3–20.
SMITH PG and BLANCK EL (2002) From experience: leading dispersed teams. *The Journal of Product Innovation Management* **19(4),** 294–304.
STORCK J (2000) Knowledge diffusion through 'strategic communities'. *Sloan Management Review* **41(2),** 63–74.
STRAUSS AL and CORBIN JM (1998) *Basics of Qualitative Research* (2nd edn). Sage, Thousand Oaks, CA.
WEBSTER (1992) *Webster's Dictionary*. Oxford University Press, Oxford.
WEGNER DM (1987) Transactive memory: a contemporary analysis of the group mind. In *Theories of Group Behaviour* (MULLEN G and GOETHALS G, Eds), Springer-Verlag, New York.
WEICK KE and ROBERTS KH (1993) Collective mind in organisations: heedful interrelating on flight desks. *Administrative Science Quarterly* **38(3),** 357–382.
WEICK KE, SUTCLIFFE KM and OBSTFELD D (1999) Organizing for high reliability: processes of collective mindfulness. In *Research in Organizational Behaviour* (STAW B and CUMINGS LL, Eds), vol. 21, pp 81–123, JAI Press, Greenwich, Connecticut.
WEITZMAN EA (2000) Software and qualitative research. In *Handbook of Qualitative Research* (2nd edn) (DENZIN NK and LINCOLN YS, Eds), pp 803–820, Sage, Thousand Oaks, CA.
YIN RK (1994) *Case Study Research: Design and Methods*. Sage, Newbury Park, CA.

Appendix A

Company background

Background of LeCroy and studied project Founded in 1964, LeCroy Research Systems is recognized as an innovator in instrumentation. LeCroy specializes in the design and production of oscilloscopes and other signal analyzer equipment. LeCroy employs more than 400 people worldwide and its 2003 sales amounted to $107.8 million. LeCroy's teams are located in New York (headquarters, manufacturing and software development) and Geneva (software development). The software development team, globally distributed between New York and Geneva, is described in this paper. There were about 10–15 people in Geneva and the same amount in New York. In particular, the Maui project ('Maui' stands for Massively Advanced User Interface) was investigated. The Maui project has developed software platform for new generations of oscilloscopes and oscilloscope-like instruments based on the Windows operating system.

Background of SAP and Studied Project Founded in 1972, SAP is a recognized leader in software solutions. SAP employs nearly 30,000 people in more than 50 countries with software sales of 2.148 EUR million in 2003. This case study focuses on the Knowledge Management (KM) Collaboration Unit/Group that is part of the Enterprise Portal Division. The KM Collaboration Group develops a collaborative platform to foster teamwork. This Group consisted of four teams: two teams in Walldorf, Germany (10 people in each team), one team in Bangalore, India (six people) and one team in Palo Alto, USA (five people). Each team worked on a different part of the Collaboration project. The Collaboration project started in September 2001.

Appendix B

Interviewees' details

LeCroy: interviewees' details Interviews were carried out between November 2001 and January 2003.

Name	*Role*	*Location*
Larry	Director of Software Engineering	NY
Anthony	Chief Software Architect	Geneva
Gilles	Software engineer	Geneva
Adrian	Web-master	NY
Corey	Vice President Information Systems	NY

SAP: interviewees' details Interviews were carried out between February and June 2002.

Name	*Role*	*Location*
Stefan	Director of KM Collaboration Group	Walldorf
Sudhir	Development Manager	Bangalore
Christoph	Development Architect, contact person for Bangalore team	Walldorf
Ahhilesh	Developer	Bangalore
Jyothi	Senior developer	Bangalore

Roles are correct for 2002. Interviewees were selected based on the criteria presented in the Research method and approach section. Interviewees were not selected based on gender; however, they all happened to be male because of the team composition.

Appendix C

Interview protocol

1. Please tell me about your role and involvement in the project.
2. Please describe the structure and division of work in your project across different sites
3. The use of media and collaborative tools:
   - (a) What tools do you use for collaboration:
     - (i) Which media and collaborative tools?
     - (ii) Which software development/technical tools?
   - (b) Why did you choose these particular tools?
   - (c) Did the use of these tools have any impact on the level of collaboration between remote sites? How and why?
   - (d) What problems did these tools have? How did you solve these problems?
4. Human- and socially-related issues:
   - (a) Please describe with whom you mainly collaborate within the project and across remote sites and explain why.
   - (b) Do human-related elements matter in collaborative work in these cases? Which ones and why?
   - (c) Did your project have socially-related activities to assist in collaboration across remote sites? What kind of activities? What was the impact?
   - (d) Were there any challenges related to human factors in this respect?
5. Methodologies:
   - (a) Did your project have any methodologies (project management, product development) for collaboration across remote sites? Were they helpful?
   - (b) Were there particular challenges that negatively affected collaboration between sites?
6. Coordination:
   - (a) What were the criteria for dividing work between the different sites in your project?
   - (b) How was the coordination of work carried out during the project?
   - (c) What organizational mechanisms were important for coordinating global work in your project?
   - (d) Were there particular problems in coordinating work across the different sites? What kind of problems and why?

Appendix D

Figure 2 presents the process through which codes, which are chunks of text that are partial or complete sentences or expressions describing specific activities (Strauss & Corbin, 1998), were associated with categories. A bottom-up, interpretive approach was used to associate codes with particular categories and concepts.

Interview transcripts were analysed using Atlas.ti software. Figure 3 illustrates how the data were analysed: in the statements analysed, codes were identified and grouped, and their association with categories (e.g. trust and rapport) as well as their corresponding concepts (e.g. social ties) were established.

Figure 3 also shows how relationships between concepts were established. The types of relationships examined were: 'lead to' (as shown in the Figure 3), 'therefore' and 'in order to'. Given that these relationships were based on our interpretation and interviewees' perception, a triangulation procedure was carried out by validating these relationships with counterparts from remote locations.

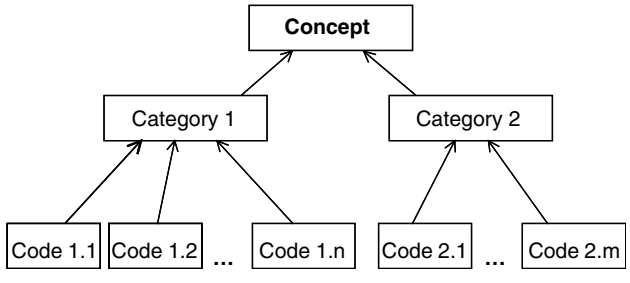

Figure 2 Data sorting and linking.

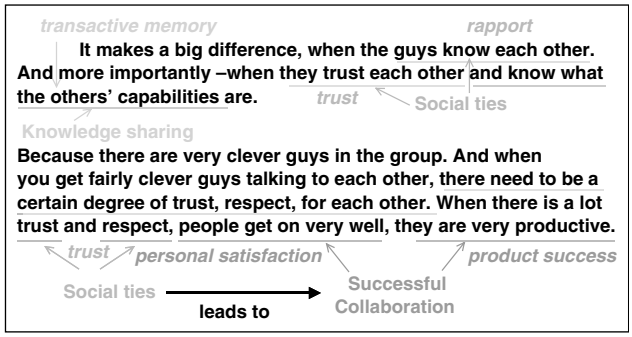

Figure 3 Example interview statements analysed according to codes and categories.