A dimensional analysis of geographically distributed project teams: a case study

J. Roberto Evaristo\textsuperscript{a,1}, Richard Scudder\textsuperscript{b}, Kevin C. Desouza\textsuperscript{a,*}, Osam Sato\textsuperscript{c}

\textsuperscript{a} Department of Information and Decision Sciences, University of Illinois at Chicago, 601 South Morgan Street, M/C 294, Chicago, IL 60607, USA
\textsuperscript{b} ITSC Department, University of Denver, USA
\textsuperscript{c} Tokyo Keizai University, 1-7 Minamichou, Kokubunjishi, Tokyo 185-8502, Japan

Abstract

In this paper, the authors describe a research project involving qualitative data collection from large organizations in the US, Japan and Europe. Its main objective is to understand what “distributed” means when discussing the management of distributed projects, an issue largely glossed over by the relevant literature. The discussion presented here suggests dimensions to the concept of “distributedness” through a theory-based model. An understanding of the distributedness dimensions simplifies the practical application of how to manage such systems.

© 2004 Elsevier B.V. All rights reserved.

Keywords: Project management; Distributed work; Information technology; Cross-cultural research; Knowledge management

1. Introduction

In the Winter of 1995, a few cross-country skiers got lost in a snowstorm in the back-country close to Aspen, Colorado. After quite a long ordeal, they were rescued - scared but virtually unscathed - at a high cost in both time and money.

An undergraduate student finished college and moved out of state. His roommate found that he could not keep the same phone number, unless the account continued in his ex-roommate’s name.

\textsuperscript{*} Corresponding author. Tel.: +1 312 829 8447; fax: +1 312 413 0385.
E-mail addresses: evaristo@uic.edu (J.R. Evaristo), rscudder@du.edu (R. Scudder), kdesou1@uic.edu (K.C. Desouza), osamsato@tku.ac.jp (O. Sato).

\textsuperscript{1} Tel.: +1 312 996 8415; fax: +1 208 475 9728.
What do these situations have in common? An obvious relation is that they all address telecommunication problems or opportunities. If the backcountry skiers had carried with them a satellite phone, they would have been able to call for help and describe their position. The student who had to give up his home phone number did not know that he was a victim of the inflexibility of a system which had been planned originally to ensure people’s privacy: a phone number cannot have the name of the subscriber simply changed. The traditional approach was that an account was cancelled, and that number was “frozen” for up to a year before being placed in a pool of available numbers and eventually made available to another customer. Chances of misdials declined tremendously after that time. This student also talked to customer service representatives who were using a new and sophisticated multimedia training method employing computer instruction.

These situations have something else in common. The systems that support or will support these applications were or are being developed by virtual teams. In all these cases, there were more than two teams in different locations working concurrently on the same product.

In fact, enabled by rapid advances and widespread deployment of telecommunications and transportation technologies, and as a consequence of intense globalization, increasingly businesses and multi- and international organizations are assembling teams of experts who work together and participate in projects while remaining physically dispersed in geographically distributed locations. From developing policies and strategies, to basic and applied research, to product design and implementation, such teams are operating in highly diverse industries as computer software and hardware, telecommunications, construction, electronics and semi-conductors, bio-technologies, and in multinational agencies and organizations such as the European Union, NATO, and the United Nations.

While there exists some knowledge about how project teams work at a single location, knowledge about how geographically dispersed project teams function and are managed is currently at an early stage and remains fragmented in a number of academic and professional disciplines. It is our belief that the synergy created by bringing together ideas from a variety of disciplines with a carefully designed empirical support effort will not only contribute to a more complete understanding of this phenomenon but would also help in developing multi-faceted solutions toward the design and management of such teams.

The current research project discusses a multi-site field study involving corporations from the United States, Europe and Japan. The objective of this project is multifold. First, we want to examine what the term “distributed” really means, a consistently overlooked issue in the literature. This theory building effort based on mini-case studies is the main focus of this manuscript. With this objective, a model is developed and presented. Although striving to be as complete as possible, the discussion of all its proposed dimensions is limited by the nature of the space allowed. A complete treatment of all proposed dimensions would require a book-length presentation. Second, we aim to improve understanding of how distributed teams are managed and what the best practices are. The improved understanding of ways in which a project can be “distributed” will leave a lasting legacy. This effort is akin to problem identification in the systems development literature, therefore enabling
the development of new project management techniques that deal appropriately with this issue.

2. Theoretical background

In geographically dispersed projects, coordination and communication among the players is paramount for an efficient and effective outcome. Project management, the body of knowledge that deals with these issues, is considered a key factor in delivering products or systems that satisfy user requirements on time and within budget. The discipline and literature in project management per se started in earnest in the late 50s with the Rand Corporation. The introduction of tools such as PERT and CPM, as well as the clear focus on goals, objectives and scope management brought by project management has had major impacts. Yet, project management is still, in many ways, an inexact science. Techniques used to manage project risk, control resource consumption and coordinate the project depend heavily on the experience of managers in charge.

One of the resulting needs is an improved understanding of the characteristics of distributed projects. This is particularly true at the conceptual level, where there is a dearth of work. This research project proposes a conceptualization of the issues surrounding distributed project management, and supports that initiative with empirical data collection. The research will deal with many of the distributed issues affecting project management, such as geographic dispersion, distance and cultural barriers.

Much of the work done in the area of project management does not address the concurrency problems existing when the developers and/or the users are located in geographically dispersed places. For instance, Turner and Speiser (1992), Ferns (1991) and Van Der Merwe (1997) address the problem of multiple project management, or program management. However, they do not discuss the problems that are likely to occur when the same project involves more than one location, therefore assuming that each project is separate and independent from the others.

Exceptions are works like Lea et al. (1993), who describe an information technology environment that supports the creation of code by programmers that may be in different places. Related bodies of literature include the work on Computer Supported Cooperative Work, such as Kyng (1991) who described how systems analysts could work remotely and concurrently on the same design piece.

The need for distributed projects has generated new forms of organizations which, enabled by advanced ICT, are labeled “virtual organizations” (Fulk and DeSanctis, 1995; Ciborra, 1996). The central focus here is on projects that increasingly occur within or between these types of organization. These “virtual projects” may involve people cooperating from internationally distributed sites and even different organizations (Adams and Adams, 1997). Teams are formed across physical, organizational and cultural barriers engaging in projects with a global focus (Geber, 1995; Townsend et al., 1996). These virtual projects involve new challenges compared with common project management practice (Solomon, 1995; Odenwald, 1996).

Part of the problem is that when the term “distributed” is used it can have many different meanings. It could be in reference to the distance among the actual projects, the team
members, or coordinators. However, in an age of advanced information technologies, what is the definition of “distance”? In other situations, the term “distributed” could be used in reference to different complexity levels or need for synchronous communication among the team members (who may belong to different distributed cultures). This argument suggests that “distributedness” is not a single variable concept, and may in fact be multidimensional. In the balance of this paper, we will discuss a tentative model of distributed projects, and the variables that may have an influence in the performance of such projects.

3. Model development/methodology

It is clear that “distributedness” of projects can be categorized along many dimensions. Such categorization is an important step in the understanding of this phenomenon. The theoretical model is presented in Fig. 1.

In the next section, we will present a more detailed description of the dimensions suggested in Fig. 1. Several theoretical streams are relevant to this work. Theories that apply to only one variable are discussed locally in the context of that particular variable. There are two theories, however, that are proposed to mediate the effects of distributed project

Perceived Distance
Level of dispersion
Synchronicity
Types of Stakeholders
Complexity
Culture
Type of Project
Systems Methodology
Existence of Policies/Standards

Trust

Distributed Project Management Performance

Fig. 1. Distributedness dimensions.
dimensions in the outcomes of distributed project management: transaction cost theory and agency theory.

Transaction cost theory proposes that the choice between producing an asset internally (inside a hierarchy) or in a market is a matter of minimizing the sum of production and transaction costs. Moreover, under the assumption of uncertainty in the exchange process, and bounded rationality and opportunism on the part of economic actors, this choice is also dependent on the level of asset specificity - or the extent to which this exchange is supported by transaction specific investments. Agency theory is based on the assumption that agents are work averse, opportunistic, and maximize their own self interests, many times conflicting with the principal’s interest.

Therefore, the decision of whether to create a distributed structure to manage a project is to a tremendous extent dependent on the transaction costs of doing so; analogously, the cognitive agency costs are also key in making that decision. Can the principal assume that the distributed agents are indeed aligned with his or her interests? The answers to these questions are an integral part of what determines this type of governance structure.

4. Distributed project dimensions

The following are proposed to be some of the dimensions of “distributedness”.

4.1. Type of project

The type of project (manufacturing versus design project; hardware versus software; mixed) affects the way it should be managed. For instance, Fujitsu, a large Japanese company, is involved both in distributed software development and physical plant building in several locations. The different divisions in charge of these objectives have very different approaches to managing their respective distributed projects. Their physical plant engineering division was engaged in shortening the life cycle of plant building, or improving the management of the project without quality loss. It has been able to reduce the time between starting of design to the first assembled component rolling out of the production line to only thirteen months. And this was done notwithstanding the many changes in layout and purpose of the plant, which had been started as a general hardware manufacturing plant and ended up as a hard disk manufacturing plant only.

Additionally, there were problems because the project design team was headquartered in Tokyo, whereas the plant was built in Malaysia - and there were project managers in charge on both locations. Moreover, many of the subcontractors were neither Japanese nor Malaysian, with their respective headquarters in other countries. This life cycle shortening is similar to Nissan’s reduction in new car development and production cycle to only 19 months - but Nissan’s whole team was collocated. Such successes are achieved by overlapping different phases of the project, and in particular design and implementation. The difficulties, of course, are in managing any changes in later design stages which affect production decisions already made based on earlier design specifications.

Fujitsu is also one of the largest software developers in Japan. They are responsible for outsourcing/consulting development for other organizations; their software development
strategy involves a hands-on approach, with small teams being deployed into the client’s facilities and keeping in touch with headquarters only for a limited amount of know-how and general directions. The crucial difference in this case was the amount of coordination needed: in the case of plant construction, there were many parties involved in different areas, and this created additional difficulties. In the case of software development, the small team deployed in a client’s location was almost self-sufficient. Naturally, it could be that different software projects could generate different needs (as we will see later). However, in general terms, self sufficiency in software development is more likely than in engineering projects that involve, by their own nature, many subcontractors and parties to make it come to fruition.

Transaction cost theory suggests that there will be more space for opportunistic behavior from a variety of stakeholders in non-software projects due to the inherently larger number of parties involved. Additionally, a construction project is more likely to look for partners or subcontractors in the open market due to the diversity of asset specific resources needed when compared to small teams for software development. Therefore, the project management technique should allow not only for multiple sites but also for the large number of stakeholders. The situation could change when the software development is very complex (see under complexity dimension below) or outsourcing is being contemplated. In this situation, Fujitsu was already the corporation in charge of outsourcing the software development.

4.2. Structure

The level of structure present in the project tasks is relevant to the way the project is managed. Some projects may be complex to implement, but their high level of structure implies decreased ambiguity and therefore increased simplicity in management. For instance, the Titus Project is a joint venture of US West, Time Warner, Toshiba and another Japanese partner with the objective of wiring several main Japanese cities with optical fiber for high bandwidth data, voice and image transmission. In the beginning, problems abounded when trying to implement the cabling:

“The design expertise to design these networks is resident in the US - Time Warner has a design center in Denver. We also use design teams from Pennsylvania and Washington State. They can do the basic design, but it has to come back here to Japan before all of the additional information is added - besides, it has to be translated to Japanese. Constantly flipping back and forth. You work on a piece, then it is flipped back to the other side, given back. Design will come from work here, and the physical map does not fit. Given the time difference, you cannot pick up the phone and discuss it - they e-mail back and forth maps and comments. There are many people involved, at least two different design teams in the US, and many more sub-contractors. The same holds true for the manufacturing side - most in US, some in Japan”.

The Denver office would send plans on where to install the cables, repeaters, and other hardware. Sometimes the maps were flawed, and the field personnel would object to installing a piece of hardware on a pole where no more space was left. The corrected map was sent back to the US. However, after the different teams involved became experienced with the repetitive procedure of exchanging corrected plans between the Tokyo office and
Denver, most of the communication boiled down to electronic file transfers. Even the language difference became less of an issue since the US designers learned the set of fifty or so different Japanese characters that applied to the maps and plans. But all this did not come without a price:

“There has been face to face contact with people in Denver - we made it a point that they know each other. Time Warner people here in Japan knew people in Denver originally, but they still also invited them to come to Japan to meet Japanese staff. We sent Japanese staff to Denver or Pennsylvania so they could meet each other and see each other’s shop just to get a better feeling for what they do. They feel that is very important, because if there is a problem, it gets solved a lot faster if there is a relationship there, and to know what the other can physically handle. E-mails took a while because everyone had different types of communications software, and we had to get that consistent throughout”.

At Bell Corp, which was developing the billing system for US West, a very similar finding about the level of a priori knowledge between the stakeholders involved in conference calls:

“Do they know each other beforehand? Not when they first start off, but after a year and a half into the project, you get to know the personalities, who cannot talk to who. Also, although expensive, we flew persons to the client site to see what happened when users work with the software - they could feel the emotion and dissatisfaction - it was clearly uncomfortable for developers”.

On the other hand, other projects lacked structure. For instance, Baxter Healthcare Japan was involved in selling many different medical products in the very complex Japanese market. The procedures involved are very involved, and the unstructured strategic nature of the decisions typically dictated much more communication back and forth between the Japanese office and the headquarters. All top personnel involved were Americans.

“...In 1988 we decided to change from country management to global management. Rather than each country doing its own thing, we decided to integrate what’s happening within a business in a country to a business globally. Rather than just build it for a US doctor, why not incorporate the requirements of France, Germany, Japan, etc. before we build this thing. So that has been very successful, but added incredible complexities to the communication process. The ability to communicate and share across different cultures is now becoming the critical skill set in the company. . . . We still do a tremendous amount of international travel, but we have phone mail, email, televideoconferencing. We have TVs and ISDN lines in our homes”.

An interesting observation was that employees whose first language was not English would prefer answering a message left in voice mail with an e-mail. This made the concurrent use of different media extremely important.

4.3. Perceived distance

There is continuum of possibilities between the ability to meet face to face frequently (very close) and never being able to do so (very far). This measure applies to all project participants regardless of role - please notice the dimension called level of dispersion where
member role or function becomes relevant. Media richness (Daft and Lengel, 1986) - or Critical Social Theory - (Ngwenyama and Lee, 1997) and new media alternatives (Rice, 1992) may be some of the theories that could help explain the positioning of a given project in the continuum. Different media tools may be used to facilitate the lessening of the distance effect on a project. For instance, in the case study at Baxter Healthcare described above, although the different subsidiaries are scattered across the world, the organizational culture is such that meetings occur consistently every week over videoconferencing. The assignment of who has to wake up in the middle of the night is rotated across locations.

But clearly perceived distance affects the communication media choice. At Bell Corp., for instance,

“To produce a requirements document, we need to get through internally first - this can be very rapid - through a series of meetings, maybe even all-day sessions if needed. Then the document will come out and they need to get the customer’s buy in. If issues are small enough, we use conference call. For complicated issues, writing it down is a very good idea. Once problem is well defined and well understood it is just a matter of disagreement. E-mailing or writing back and forth does not get it. In the case of complicated issues, you really have to talk”.

Perceived distance affects coordination activities, such as described in the US West billing system case:

“Coordinating work activities - something that they are doing in one place depends on what they are doing in another place. In order to test systems, we want to use real live data - data extracted from here in Denver. So we will make a request to extract data from this system and send it to us so we can test our system. It is further complicated by the fact that the people needed to get data from are not in the project. I will go to my client contacts, and they will have to go to an outside organization to make the request and it is not always a priority. A further complication - the requirements document - have to have someone else pull it off the server, print it out, and overnight it to four different people in US West who need the document, whereas if I were in the building, I would print it out, and I did put it into inter-office mail, or I did walk it to them, and they did have it in 10 min. I do exchange a lot of documents by e-mail, and a lot of times there is translation problems”.

Perceived distance may also be felt between manufacturing plants, users and designer teams. At Baxter Healthcare Japan,

“We manufacture in different parts of the world, and those products, which we supply from different suppliers around the world, are then transferred to Japan . . . . So the coordination that goes on seems to be multi-site, improvements to the departments, customer requirements for Japan that are fed back into the manufacturing plant, actually in the marketing department in the US, into the manufacturing plant, with provisions being done such that products meet specific requirements here as opposed to the Ministry of Health in Brazil. That is probably the most common event or example I can think of in my business, speaks to people at multiple sites working at the project”.

Monitoring of an agent’s adherence to the principal’s objectives is very critical. When knowledge - or trust - goes up, monitoring can decrease considerably. Monitoring requires
higher bandwidth or effort from all stakeholders involved. This higher effort also increases the transaction costs, therefore changing the interaction dynamics - to the point where the group may price itself out of the market. In other words, when a group does not trust each other and does not know each other, they may engage in so much monitoring that it overwhelms actual productive work to an extent that no productive work happens. This can also happen in the relationship between a project manager (PM) and the team members. For example, if a PM does not fully trust an agent, he or she may require more information from the agent. The PM may require a multitude of regular formal reports from the agent detailing accomplishments, how time was spent and progress on objectives. But the PM may also require that the information content of the reports be extended as well.

4.4. Synchronicity

Synchronicity is the extent to which people may be working on the same project concurrently. One of the conditions for total synchronicity occurs when all stakeholders are in the same time zone or are willing or need to work at the same time on a given project. Of course, this may occur for certain situations only, such as the need for people to engage in a teleconferencing session once a week. A related measure is how frequently people need to engage in synchronous situations. In the Titus project described above, because of the nature of the back and forth exchange of work between Tokyo, Denver and Stamford (CT), there was no need for synchronous work - most of the time. Therefore, the differences in time zone worked to their advantage: when workers came to work in the morning whichever question had been asked the night before was probably already answered. Management of synchronicity is perceived by managers as quite difficult.

A way to evaluate synchronicity is assessing checkpoint frequency. Continuous checkpoints are indicative of real-time interaction. One can think of an index of dispersion, or how far apart the different versions are allowed to diverge before the checkpoint process brings them together. Synchronization occurs both in quality and content.

In most cases, monitoring of synchronous work is more difficult than sequential work. It requires careful design of monitoring methods to assure that project tasks are updated to reflect all aspects of synchronous activity. It is often difficult for a project manager to individually monitor work progress, it becomes tangibly more difficult when work must also be monitored by other team members. A project manager must create carefully designed monitoring methods to manage the flow of information about project status. The monitoring methods must provide information not just to the project manager and sponsors, but also between synchronized units of the project.

4.5. Complexity

The complexity level of a project is also proposed to affect the performance of distributed projects. Sheer size may be one of the determining factors of complexity. Other issues of complexity revolve around the level of technology used in the project and the level of definition of project goals and scope. For instance, in the case of the orbiting satellites for telecommunications described earlier:
“Now we move down into a lower earth orbit so that we have better signal-to-noise ratio for hand-held telephones. Now, in order to close that gap, now we get satellites that have contact with ground stations that are on the order of 40–50 min. So they keep going over the hill on you. And you have to plan a handle, and that is why so many antennas at each ground station, you have to plan the handle.

Twelve satellites simultaneously going around all the ground stations, and hand them back and forth from station to station. The planning and scheduling is our component that figures out who is doing what, when, to whom. And plans all that handover. We then break into a second major configuration segment which is an off-line component. And that is calculating, figuring out all the orbits, and looking at the deployment of the spacecraft and what do I need to do to maintain my orbital spacing? What maneuvers do I need to do . . . detail about all the information about satellites, all the clusters on board the satellites. Be able to predict when to do maneuvers, and actually schedule those maneuvers, and calculate down to the fact. Cluster number six, point two pound thruster should be turned on at this exact time to the millisecond for 47 ms, then it should go off”.

4.6. Culture

Culture, in itself, is a multidimensional factor, all affecting the performance of distributed projects in different ways. In this article, we will glean broadly on the cultural characteristics of project teams and how they may affect their behavior.

A project culture may borrow national culture characteristics of its team members and of its different locations, such as uncertainty avoidance, power distance, masculinity versus femininity, individualism, and time horizon (Hofstede, 1991). These variables affect many of the behaviors exhibited by members of various cultures. Other approaches to research on culture include Trompenaars (1993) and Erez and Earley (1993). We will not re-visit here research on specific individual and national cultural characteristics.

Another set of dimensions might include the organizational culture and the project orientation of the organization. Management by projects is the central management strategy of project-oriented companies. By starting, directing, and closing down projects, a dynamic balance is achieved that is supposed to ensure the continuous development and survival of the company. The conscious and explicit application of management by projects requires adequate corporate structures and cultures. Again, the joint venture US-Japan described above had its share of initial problems, with critical finger pointing on initial mistakes from both sides.

Eventually it became clear that both sides made mistakes, partly caused by assumptions about each other’s backgrounds and cultures. For instance, in the Titus project, the first time that a mistake occurred in the US manufacturing organization that had not thoroughly tested all possibilities the Japanese partners were upset, claiming that such a problem would never had happened if they were in charge of manufacturing. A few weeks later, a problem happened whose responsibility was the Japanese partner’s. All in all, this created an environment conducive to understanding the fact that everybody was doing their best and on occasion either side could make mistakes - but just in case, all stakeholders became twice as cautious about quality issues.
4.7. Information systems methodology

In the case of information systems development, it is reasonable to assume that there are differences in the needs for management of the project in each phase. For instance, Hughes needed to do some testing in real time, implying a large amount of concurrent access to data and computing power.

“And that is the part we are just finishing now, is the integration of the system. . . . We did not have the full test environment in LA. We tried to come up with a way to set up a strip-down test environment . . . because of the complexity they basically need a full-time person whose sole job is to maintain a configuration environment that they can test in. And given the size of the team out there, had about ten people, that was a rather hard tax on them. . . . the company has a T1 dedicated link between Denver and LA. We are using substantial bandwidth . . . Sending data back and forth, CM data as well as everything else. About two or three months ago the company changed into a frame relay to improve costs, which we have not fully recovered from yet. We lost a lot of our availability. And it did . . . badly, I had availability on the T1 link ninety-nine plus percent. We are seeing an availability on our frame relay that is in the 85 to ninety percent range. And that’s really killing us”.

The issue of systems methodology brings various levels of complexity for a project manager. Let us take two system methodologies as an example - the waterfall lifecycle and the object-oriented lifecycle. In some ways these represent opposite ends of the spectrum.

The first issue might be to examine the differences in tools. The following tools might be used in each of the projects (see Table 1):

<table>
<thead>
<tr>
<th>Waterfall lifecycle project</th>
<th>Object oriented project (universal modeling language)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hierarchical diagrams</td>
<td>Use-case diagrams</td>
</tr>
<tr>
<td>Matrix affinity analysis</td>
<td>Class diagrams</td>
</tr>
<tr>
<td>Entity-relationship diagrams</td>
<td>State-transition diagrams</td>
</tr>
<tr>
<td>Dataflow diagrams</td>
<td>Interaction diagrams</td>
</tr>
<tr>
<td>Flowcharts</td>
<td>Component diagrams</td>
</tr>
<tr>
<td>Program structure charting</td>
<td>Deployment diagrams</td>
</tr>
</tbody>
</table>

The CMM defines levels of process improvement in software development. Each succeeding level indicates an improvement in the institutionalization of project management and software development methodologies within an organization.
A project manager with a clear understanding of the variance in systems methodologies will have a better ability to understand and mitigate the variances in project communications, project plans and project quality.

4.8. Existence of policies/standards

In this variable, we refer not only to the existence, but also to the extent to which the policies or standards are actually upheld in a given organization. Critical standards areas include scope control, estimating methodology, communications standards, scheduling methodology and programming standards. This variable could take the following values: existent (strictly upheld, generally upheld, weakly upheld) and non-existent.

The extent to which standards are in place and upheld has a significant effect on an organization’s ability to maintain project integrity. Those organizations that do not have standards are unlikely to be able to maintain any standards between groups. The Capability Maturity Model can be used as a benchmark for the standards of different parts of the project organization. Here is where knowledge management systems come in play. Desouza and Evaristo (2003) uncovered several knowledge management platforms and architectures in global corporations - headquarter commissioned and executed, headquarter commissioned and regionally executed, and regionally commissioned and locally executed. Each strategy has advantages and disadvantages as to how knowledge is shared and contexts are maintained. Moreover, it is also important to note that also if knowledge management systems are in place it will be difficult to get buy-in from organizational members (Desouza, 2003).

4.9. Level of dispersion

The perceived distance within the members of a given stakeholder group - as well as among clusters of stakeholders - is called level of dispersion. For instance, all systems analysts in a project would qualify as a group of stakeholders sharing a role. The perceived distance among the members sharing this role is a measure of the level of dispersion of that group. Another measure would be the perceived distance among this role group and all the others (say, programmers, testers, users, etc.) Another way to think of this would be the gravity center or distance across clusters of stakeholders. The systems analysts in one project, for example, were not dispersed at all. They were located in the same physical area. Programmers and software engineers, on the other hand, were highly dispersed, located in multiple locations.

The higher the level of dispersion the more difficult is to monitor the behavior of different groups as they relate to each other. Therefore, again we can see the relevance of both Transaction Cost Theory and Agency Theory to this variable explaining the distributedness of the team effort.

4.10. Stakeholders

Different types of groups of stakeholders exist in each project, each with different perceptions about a project. At Fujitsu, the technical stakeholders were clearly siding with
the physical plant construction people - against the commercial group. We could think of their different interests adding another measure of “distributedness”. Another alternative is to look at different subcontractors. In software design, this can many time means the outsourcer. Sometimes there is a neat tie-in between software design and project subcontractors, such as in this case:

“You can get a real challenge getting these satellites in orbit. We are having to use all kinds of launch vehicles. We are going up on the shuttle, on Ariadne. I think we still have a few along March 2. We took them off for a while, they were having launch problems . . . There is a company now who is modified an oil-drilling platform. They towed it to Long Beach Harbor, set the rocket up on it, . . . and the payload, tow it out to sea, take it directly down to the equator so you get the maximum throw-away, and then launch off of the oil platform on the equator”.

Eventually, this dimension may evolve into a subjective evaluation of how many types of different stakeholders are involved. The larger the number, the larger the distributedness of the project.

5. Data summary

The different case studies conducted illustrate the various dimensions. They are shown in Table 2, and represent a first attempt to empirically observe the way in which projects are distributed. Our analysis is mostly qualitative, employing vignettes taken from the actual interviews conducted in three continents. The results already suggest that some of these dimensions will need to have a different definition, such as “types of stakeholders”, or “synchronicity”. They may need further definition.

Several critical issues are highlighted in these cases. One of them is the issue of project control and communication, represented in our study by the dimension “structure”. Bell Core (another case study done in this first phase but not detailed in this paper) had to initially deal with five layers of responsible parties and multiple relationships between those layers.

<table>
<thead>
<tr>
<th>Dimensions of distributedness</th>
<th>Fujitsu</th>
<th>US West</th>
<th>Training Corp.</th>
<th>Baxter</th>
<th>Hughes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Software Plant</td>
<td>Software</td>
<td>Training</td>
<td>Manufacturing</td>
<td>Software, hardware</td>
</tr>
<tr>
<td>Structure</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Perceived distance</td>
<td>Medium</td>
<td>Far</td>
<td>Close</td>
<td>Far</td>
<td>Close</td>
</tr>
<tr>
<td>Need for synchronicity</td>
<td>Low</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Complexity</td>
<td>Medium</td>
<td>Medium</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Culture differential</td>
<td>High</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Information systems methodology</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>N/A</td>
<td>Yes</td>
</tr>
<tr>
<td>Standards</td>
<td>High</td>
<td></td>
<td></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Level of dispersion</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Types of stakeholders</td>
<td>Multiple</td>
<td>Multiple</td>
<td>Multiple</td>
<td>Multiple</td>
<td>Multiple</td>
</tr>
</tbody>
</table>
They shortened the chain of communication between the ultimate client within US West and the software developers. It also was one of the keys to their success. Hughes, on the other hand, recognized the issue of a lengthy communication chain from the start. They used several techniques, including high bandwidth communications, embedding project members at geographically diverse locations, and flying in team members for joint work at critical junctures in the project. This becomes particularly relevant in the “perceived distance” and “level of dispersion” (for participants, both were perceived as lower than one may assume based on the actual case description).

The five case studies described here give us some examples of how managers are stepping up to that challenge, holding promise on improving the understanding of the state of the art on distributed software development. Clearly the level of complexity involved in all these cases is fairly high, but they do differ on the level of structure or even knowledge of the possible solutions available, on the time frame involved, on the amount of dispersion, on the number of time zones involved, and on the objective of the system (control versus support).

6. Conclusions and future research

The current report presented a brief description of a multi-site field study involving US, European and Japanese corporations. It uses the data from these studies to suggest a more complete way to understand what the word “distributed” really means in the context of project management. Much work has been done in this area assuming the underlying meaning of “distributed” or even taking only a few of its many dimensions. Although those approaches are valid, we found in our data that it may be worthwhile to probe deeper in this area. In fact, we hope that our results will be helpful to other researchers in project management.

Our study can be improved in the future by collecting more data from other case studies. The additional data may provide subsidies to improve upon our original selection of dimensions. In a positivistic way, we may be able to “test” our definition of the dimensions, refine and even eliminate some of them. The crucial finding, of course, will be to discover which dimensions are more critical under which situations. The eventual result of this stream of research will be to suggest better ways to manage distributed projects.

References