

# The Phenomenon of Distribution in Software Development Projects: A Taxonomy Proposal

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## Abstract

This article is an investigation of the complex phenomenon of distribution in software development. Therefore it contains a literature review of distributed software development and a dimensional analysis of the phenomenon. Four dimensions of distributed development are identified: the physical distribution among locations, the organizational distribution among working structures, projects, institutes etc., the temporal distribution, and the distribution among different stakeholder groups. The distribution of people, artifacts, power etc. as well as single software development challenges in distributed projects can be discussed in these dimensions.

**Keywords:** Distributed development, global software development, open source software development

## 1 Introduction

Software development projects are more and more confronted with distributed project settings. For many economical and technological reasons projects need to be globally distributed (Holz, Goldmann & Maurer 1998) and such projects are becoming increasingly common (Paasivaara 2003). Furthermore, distribution requires new techniques for project coordination, document management and communication (Goldmann & Kötting 1999).

However, distribution in software development projects is a complex phenomenon: Different project types such as global, inter-organizational, or open source software projects are confronted with distribution; and such projects are distributed in different ways and deal with different challenges. In addition, distribution can be seen either as disadvantage or advantage for

software development: Some studies report on problems of (global) distribution and related lessons learned (Coar 2004, Krishna, Sahay & Walsham 2004, Turnlund 2004), whereas distribution in OSS projects is seen as an advantage to speed the process (Feller & Fitzgerald 2001).

For analyzing existing methods and tools for their applicability in distributed project settings, or for proposing new methods or tools, a comprehension of the phenomenon of distribution itself seems to be necessary. For example, the negotiation of requirements in distributed projects is related to distributed project stakeholders, whereas the problem of consistency of requirements documents might be related to distributed artefacts.

Goal of this paper is to understand the phenomenon of distribution in software development. Particularly, the purpose is to provide a basis for discussing single challenges distributed software development projects have to face.

The remainder of this paper is structured as follows: Section 2 presents issues in distributed software development gained from literature review. In Section 3, dimensions of the phenomenon of distribution are identified and described. Section 4 contains examples of how to use the dimensional model. The paper concludes with section 5 by drawing a result and depicting consequences for future research.

## 2 Issues in Distributed Software Development

The problem of understanding challenges of distributed projects is related to different software development research areas like open source software (OSS) development, global software development (GSD), and computer-supported cooperative work (CSCW). Even if the viewpoints are different, in all areas technical solutions as well as social challenges are discussed. In addition, one can find several papers considering distribution from specialized software engineering fields like requirements engineering (Damian, Eberlein, Shaw & Gaines 2003, Herlea & Greenberg 1998) or participatory design (Finck, Gumm & Pape 2004, Oostveen & van den Besselaar 2004).

Most of the work reports about case studies where special challenges of distributed people or artifacts are faced, or where solutions for dealing with single problems are discussed. Some papers aim at giving a broader view on the phenomenon of distributed development projects: Evaristo & Scudder (2000) identify in their detailed case study dimensions of distributed projects, and Paasivaara (2003) identifies types of distributed projects.

This section gives an overview of work related to distributed software

projects, development and cooperation. The collection is not complete but aims at illustrating the variety of the work. The focus lies on experiences gained from software development and the challenges observed rather than on the description of single solutions. We refrain from consulting theoretical approaches, e.g. organizational theories.

## 2.1 Challenges Caused by Distributed People

The main challenges caused by the dispersion of people among several locations are related to communication and cooperation. For example, the physical distance between people hampers informal communication (Lanubile, Damian & Oppenheimer 2003) that might lead to a lack of information in a project. Extended communication effort, on the other hand, can lead to information overhead. Thus, projects have to aim at a trade-off between lack of information and information overhead (Holz et al. 1998, Turnlund 2004, Coar 2004).

Communication problems arise also because of cultural and social differences between distant sites (Evaristo & Scudder 2000, Krishna et al. 2004). Organizational culture and the project orientation of the organization are part of the people's background and implicit assumptions. The difference between backgrounds and assumptions on different sites might be one source of misunderstandings (Evaristo & Scudder 2000). An example for cultural differences is e.g. that US companies prefer "working with extensive written agreements and explicit documentation (...). Japanese clients tend to prefer verbal communication, more tacit and continuously negotiated agreements (...)" (Krishna et al. 2004).

Time separation is another source of communication problems (Lanubile et al. 2003, Coar 2004, Espinosa & Carmel 2003). People are separated by time "when there are differences in working hours, time zones, and/or working rhythms that reduce the time available for same-time (i.e., synchronous) interaction" (Espinosa & Carmel 2003). More coordination effort is necessary and tools supporting asynchronous communication are used (Coar 2004, Feller & Fitzgerald 2001) – which cause new problems like (lacking) awareness (Divitini, Farshchian & Tuikka 2000) or problems of tools' acceptance and usage (Holz et al. 1998, Grudin 1993). Furthermore, separation by time and space causes the "difficulty of building trust among remote developers" (Lanubile et al. 2003, p. 4).

Evaristo & Scudder (2000) found that the level of dispersion of people is related to the "perceived distance within the members of a given stakeholder group – as well as among clusters of stakeholders". They mention an

example of system analysts as a stakeholder group who might have a level of dispersion in one project. In another project of their study, this group was not dispersed at all (“they were located in the same physical area” (Evaristo & Scudder 2000)), but dispersed relatively to other stakeholder groups like software engineers. The consideration of stakeholder groups reveals that in addition to the management of distributed individuals, the management of relationships between teams has to be taken into account, e.g. in projects with outsourced parts (Krishna et al. 2004, Evaristo & Scudder 2000).

In addition to the distribution among physical space, distributed projects also deal with the distribution of people among organizations or projects. The analysis of OSS projects on SourceForge by Madey, Freeh & Tynan (2002) shows that developers are not only distributed geographically, but also on several OSS projects. Furthermore, besides their activity in OSS projects, many developers work in other software development companies (Feller & Fitzgerald 2001).

In global software development projects, different organizations themselves are involved in a given project. Examples are given in the survey by Evaristo & Scudder (2000): Such organizations might be divisions of one company (specialized on different tasks like design or manufacturing); or they act as subcontractors of another organization.

Organizational distribution might cause problems regarding the different background, interests and motivations of the people. The involvement of different companies implies diverging organizational cultures that can lead to misunderstandings (Holz et al. 1998). An inhomogeneous development environment caused by tools favored by different sites, also cause problems” only exacerbated in distributed development environments” (Turnlund 2004). The different background of sites can also refer to the existence and extent to which standards are upheld in a given organization (Evaristo & Scudder 2000).

The dispersion of people asks for internet-based tools to coordinate and connect the community (Feller & Fitzgerald 2001). However, the usage of tools like e-prototyping for revealing web user requirements (Jeenicke, Bleek & Klischewski 2003), groupware for user participation in product development (Divitini et al. 2000) or mediated feedback (Finck et al. 2004), or tools to support the coordination of the development process in general, might cause new challenges by itself.

Social impacts of using communication and cooperation tools in teams have been discussed for a long time in the field of CSCW. Grudin (1993), for example, reports on the problems of usage of groupware tools. The problems are attributed, among other factors, to the additional work they cause, to

social, political and motivational factors or to the decentralization of control (Grudin 1993).

## 2.2 Challenges Caused by Other Distributed Entities

The challenges in distributed development are not only related to the distribution of people themselves, but also to the distribution of tasks (Evaristo & Scudder 2000), of artifacts like documentations or specifications (Beuschel, Bødker, Keil-Slawik & Minneman 1994, Scacchi 2001), of power and control (Feller & Fitzgerald 2001), of involved organizations or projects (Paasivaara 2003, Evaristo & Scudder 2000), of interests and motivations (Feller & Fitzgerald 2001), of (decision-making) power (Feller & Fitzgerald 2001) or skills and knowledge (Turnlund 2004, Holz et al. 1998, Beuschel et al. 1994).

Within a project where people and their skills are spread over places and organizations, the tasks might be spread, too, and therefore communication needs might increase. However, to minimize communication overhead, it is recommended to compose “the teams to discrete tasks on a geographic basis” (Turnlund 2004). The distribution of tasks is related to their management and the level of synchronicity (Evaristo & Scudder 2000).

The problem of information distribution and management is discussed in (Čubranić & Booth 1999). This issue is related to documents, code and other artifacts spread among several locations. In OSS projects, the physical distribution of developers cause distributed code (Scacchi 2001, Feller & Fitzgerald 2001). Tasks regarding distributed parts of code are, for example, the merging and version controlling as well as decision-making which contributions should be included.

In projects where developers are separated from other stakeholder groups, the distribution of documents, like a requirements specification, might be the focus. For example, in OSS projects, requirements appear from different stakeholder groups (developers, other users) or from vision documents, and are “spread across different kinds of electronic documents including Web pages, sites, hypertext links, source code directories, threaded email transcripts, and more” (Scacchi 2001). The dispersion of requirements documents and other artifacts can cause problems like a lack of information, inconsistency or undiscovered incompleteness.

Distribution of (decision-making) power is a social challenge, especially faced by OSS projects as well as Participatory Design (PD) projects. In OSS projects, the vesting of decision-making power can be distributed, e.g. among a group of 20 people (Apache project), or assigned to one person (Linux) (Feller & Fitzgerald 2001). Considering the usual geographical dis-

tribution of OSS developers, the power may also become physically distributed. The Scandinavian PD projects “subscribe to the notion of increasing workplace democracy” (Howcroft & Wilson 2003) and thus aim at transferring power from the top of organizational hierarchy to the users. Since the early PD projects took place for one company, the power was supposed to be distributed among groups rather than among several organizations or locations. Nowadays, PD projects, too, have to face globalization and therefore distributed environments; thus power becomes as distributed as the power-owning people are distributed.

### 2.3 Summary

This analysis of the literature shows that the discussed topics regarding distribution concern different perspectives. One perspective is represented by the question of who or what is distributed: For example, the distribution of people may cause problems of how to deal with communication, coordination or cultural differences. The distribution of artifacts may cause problems regarding the responsibility for them or their version control. Another perspective is represented by the question about distribution itself: For example, the distribution of stakeholders among different geographical locations must be distinguished from the distribution among different organizations. A third perspective deals with the challenges which are caused by the distribution. Challenges might be the previously mentioned version control, time separation, cultural differences, coordination of synchronous or asynchronous communication. A fourth perspective looks at solutions. Some challenges are met by social solutions (project management, mutual understanding etc.), others by technical solutions (like tools for coordination and communication or for managing the programming process); and the usage of technology itself can cause new social problems. Table 1 summarizes the discussed topics grouped by the afore-mentioned viewpoints.

However, the phenomenon of distribution in software development seems to be very complex: it includes many aspects regarding social and technical challenges and addresses different entities that are distributed and different ways in which they are distributed. In the next section, these issues are discussed on a more abstract level by introducing the concept of *dimension*.

## 3 Dimensions of Distribution: A Taxonomy

The issues of distribution are manifold and raise varied problems. To clarify the phenomenon of distribution and distributed project settings, it might

<b>Issues in Distributed Development</b>	
Distribution of	individuals, teams, skills, background, interests, power, involved organizations
Distribution among	physical places, organizational structures, teams, stakeholder groups
Challenges of	information management: <ul style="list-style-type: none"> <li>– right information at the right place at the right time</li> <li>– lack or overhead of information</li> </ul> coordination and communication cultural differences awareness synchronicity version controlling perceived distance time separation and management involvement of people
Solutions with	tools for coordination and communication tools for managing the programming process

Table 1: Issues in Distributed Development from Different Perspectives

be useful to understand which issues describe the phenomenon itself and which are caused by the phenomenon. The analysis of literature brings to light at least four aspects related to distribution: 1) The phenomenon of *distribution itself* (see second section in Table 1); 2) People or other entities that *are distributed* (see first section in Table 1); 3) Challenges that are *caused by* distribution (see third section in Table 1); 4) Approaches (e.g. tools, methods) to *deal with* distribution (see fourth section in Table 1). They are illustrated in Figure 1

The dimensional description presented in this section refers to the phenomenon itself and allows us to develop a preliminary taxonomy of the phenomenon of distribution. The taxonomy describes the relationship between the dimensions which can be seen as elements of a classification. These dimensions represent aspects of distribution, i.e. *in what way* people and entities are distributed in software development projects. Single challenges and solutions are not included since they are the results of such project settings rather than part of the phenomenon itself. However, the challenges can be discussed and analyzed along the dimensions (see 4).

The term *dimension* describes an ordered variation range (normally used to describe a physical property). According to the Merriam-Webster Online Dictionary, dimension is “d: the range over which or the degree to which

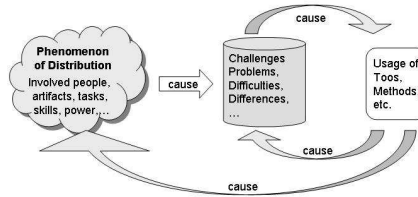


Figure 1: Phenomenon of Distribution

something extends”. The term distribution describes “the positioning or allocation of items (...) within an area” (Hornby 1989). Since the aspects/variables of the phenomenon of distribution occur in different degrees and seem to be located in a continuum (like space), the description of this phenomenon using the concept of dimensions seems adequate. For example, the physical and organizational distribution as well as the distribution by time can vary from less to heavily distributed.

The investigation of issues in distributed development as presented in the last section unearths four dimensions:

1. Physical distribution;
2. Organizational distribution;
3. Temporal distribution;
4. Distribution among stakeholder groups.

Literature provides indication of the fact that individuals and stakeholder groups can be distributed among physical space, organizations and/or time, whereas other entities can be distributed among physical space, organizations and/or stakeholder groups. These findings are illustrated by Figures 2 and 3. The dimensions of distribution for individuals and stakeholder groups are presented in Figure 2. They can be separated physically (x-axis), organizationally (y-axis) or by time (dashed z-axis). The dots represent individuals and groups distributed among the three dimensions.

The dimensions of distribution for artifacts, skills, power and other entities are presented in Figure 3. The two dimensions on the x- and y-axis

present two dimensions of the question *In what way?*. The dashed z-axis represents the dimension of *Among whom?*. The dots represent artifacts, skills, power etc. that can be distributed among all three dimensions. The dimensions will be now discussed in detail.

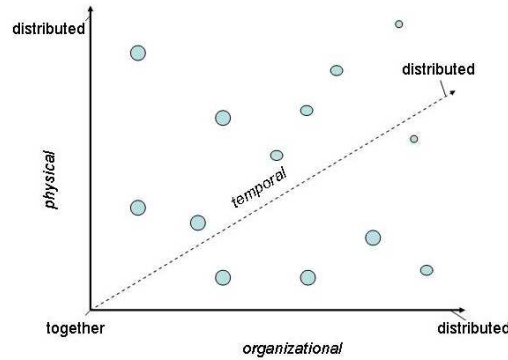


Figure 2: Dimensions of Distribution for Individuals and Groups

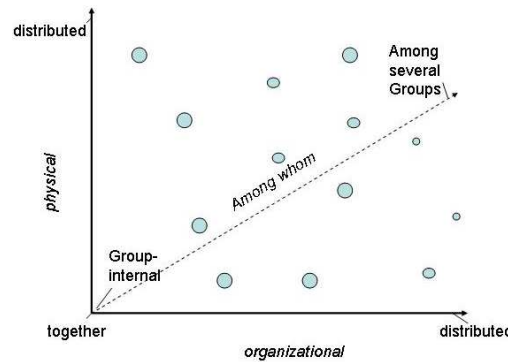


Figure 3: Dimensions of Distribution for Artifacts and Other Entities

### 3.1 Physical Distribution

Physical distribution refers to different locations of people or things and can vary between different degrees of distribution. In some projects, the distribution among different floors in the same building is perceived as a

challenging distance. Other projects deal with distribution among different locations in the same city, different countries or even different continents.

Physical distribution of people is the most discussed topic in the presented literature: in large OSS projects where developers from all over the world contribute (Feller & Fitzgerald 2001) as well as in global software development where organizations from different countries work together as partners or suppliers (Krishna et al. 2004, Turnlund 2004, Coar 2004). Geographical distance has been identified as one characteristic of distributed projects (Paasivaara 2003).

### **3.2 Organizational Distribution**

Organizational distribution is related to the structures people are working in. Organizational distribution means that the given project people are involved in does not necessarily present the structure of their everyday-work or employer organization. The term organization is used to refer to companies as well as to non-commercial organizations or any other (project) structure describing the condition or state of organized work.

Organizational distribution is given if more than one organization is involved in the project. The resulting organizational distance has been identified as a project characteristic for (globally) distributed projects (Paasivaara 2003). In the presented literature, organizations can have different roles: they might be partners, subcontractors (Paasivaara 2003, Turnlund 2004), suppliers (Krishna et al. 2004), customers, consultants, or they might be involved in even other roles.

In customer-specific software development projects, the people involved normally come from different organizations such as the software supplier, the customer and a consulting firm. In OSS development projects, developers involved are often employed by different companies while working for a given OSS project (Feller & Fitzgerald 2001); the companies themselves do not necessarily play any specific role (even if they do in some cases) for that project but present the working background of the developers. A project among several divisions of one company (a case project in Evaristo & Scudder (2000)) might be a second example of organizational distribution. Also research projects, where people from different institutions work together on one problem, have to deal with organizational distribution (Doerry, Douglas, Kirkpatrick & Westerfield 1997).

### 3.3 Temporal Distribution

The temporal distribution refers to the synchronicity of working hours, i.e. the time people are available for same-time interaction (Espinosa & Carmel 2003). The separation by time can be rooted in physical distribution and thus distribution among different time zones; but also caused by shift work or working rhythms (e.g. if people are only part-time involved as in OSS projects).

Temporal distribution has been identified as one main characteristic of distributed projects (Coar 2004, Espinosa & Carmel 2003, Evaristo & Scudder 2000). Evaristo & Scudder (2000) call this aspect *synchronicity*. In OSS projects, the time separation is seen as an advantage to speed the development progress (Feller & Fitzgerald 2001).

### 3.4 Distribution among Stakeholder Groups

Artifacts, skills and other entities can be distributed not only among locations and organizations but also among stakeholder groups. For example, requirements specifications are often distributed among different stakeholder groups like users, managers, analysts and developers. Such a distribution would require much effort of document management that becomes a challenge if the requirements are documented not only from different viewpoints and on different detail levels, but also with varying documentation tools.

The distribution among stakeholder groups is relevant for different entities: For example, the distribution of tasks is mentioned by Evaristo & Scudder (2000) or Turnlund (2004); the distribution of artifacts is mentioned in Scacchi (2001) or Feller & Fitzgerald (2001).

## 4 Using the Dimensions

In the last section, the focus was on the phenomenon itself. In this section, examples are given to show a) how people and other entities can be distributed among the dimensions, b) how challenges and solutions are related to the dimensions and c) that the dimensions are interrelated and influence each other. In addition, the concept of “perceived distance” (see 4.1) is introduced and some advice is given how the distributedness of a project can be measured or evaluated respectively (see 4.2).

First we return to distributed individuals and stakeholder groups. Group-internal distribution of individuals is typical in OSS projects (Čubranić & Booth 1999). The community of developers is distributed geographically as

well as organizational. According to Evaristo & Scudder (2000), this would be the dispersion of one stakeholder group.

The distribution of single stakeholder groups where the members in one group might not be dispersed at all, for example developers and customers, are actually the normal setting of traditional software development projects: A software company builds a software for users in other companies or, at least for other application fields. This can be a customer-specific project as well as product development for unknown users.

The boundaries between stakeholder groups are blurred. For example in OSS projects, users can become members of the development community without having to program themselves (Feller & Fitzgerald 2001). Furthermore, Participatory Design approaches aim at decreasing the distribution of users and developers so that either designers participate in users' worlds, or users directly participate in design activities or a mix of both (Muller, Wildman & White 1993). If this happens successfully (i.e. the development team consists of users and developers) in a distributed project, the distribution between stakeholder groups may change to distribution within the developer group.

The distribution of artifacts, tasks, power etc. can be discussed in the same way. The first example is a distributed requirements specification document: In one project, it is organizationally distributed among the customers' and the suppliers' organization. In a second project, it might be distributed within a customer's organization but among different stakeholder groups such as users and managers. The physical distribution mostly comes along with the organizational distribution. Still, the level of physical distribution can vary between different folders on a hard disk and computers in different countries. And in a third project, the document can be dispersed among all dimensions.

The same situation can be imagined for a program's code since it is data as well as a specification document. Whereas the documentation and storage of requirements at different places complicates the consolidation to a single specification document, the distributed development of code and its consolidation can be well-organized by tools (CVS to handle contributions of different contributors) or is an immanent characteristic of the software itself (distributed systems).

As we have seen previously, the distribution of (decision-making) power is especially faced by OSS projects as well as PD projects. In one project, the decision-making power might be distributed among stakeholder groups like users, managers and developers. In another project, the strategic decision-making power might be distributed among several partner organizations.

In a third project, the power of decision among code contributions might be distributed geographically. However, the distribution of power is dependent on the distribution of the power-owning people (since individuals are simultaneously subjects and objects of power (Hyysalo & Lehenkari 2002)).

These examples already show that the dimensions are not independent from each other and connected in several ways. The distribution of power among individuals can, but does not need to imply organizational distribution (if the people do not belong to the same organization or project) and physical distribution (if the people are geographically dispersed). The distribution of an artifact among groups often implies also physical distribution. In addition, the interdependence can also be affected by the distribution of tasks. For example, if the task of requirements documentation is assigned to one group that is neither organizationally nor physically distributed, the document itself might be less distributed than if the task were distributed. In the next paragraphs, some challenges of distributed projects are discussed within the dimensions which make their interconnection more obvious.

Temporal distribution (Coar 2004) can be a result of organizational and/or physical distributed participants. If the physical distance is big enough, people are located in different time zones. This can either be an advantage to speed the process (Feller & Fitzgerald 2001) or a disadvantage when people have to wait for contributions of others. The separation of tasks can lead to an organizational and physical distribution, which itself can cause that people “work[ing] almost exclusively with such impersonal media – e-mail in particular” (Coar 2004). In both situations, synchronous work and face-to-face meetings can be problematic. However, the solutions might differ, depending on whether temporal distribution among time zones or concurrently working groups has to be faced.

Cultural differences (the second example) refer not only to national cultures, but also to project or organization cultures (Evaristo & Scudder 2000). Thus, cultural differences can be related to physical as well as to organizational distribution. Indeed, the approaches to dealing with them are dependent on the dimension. The proposal of choosing the appropriate projects or sub-projects to be outsourced (Krishna et al. 2004) deals with the physical and organizational dimension. The approach to facilitate mutual understanding between stakeholder groups, e.g. between developers and users (Carmel, Whitaker & George 1993) deals with the organizational dimension and the dispersion of stakeholder groups rather than of individuals.

As the last example, communication in distributed settings is discussed. The technical solution of using communication tools (software as well as hardware) is normally related to the physical and temporal dimension of

distribution. The proposal of containing “the teams to discrete tasks on a geographical basis” (Turnlund 2004) aims at reducing the communication overhead between groups and therefore deals with the physical and organizational distribution. The proposal of using communication tools combined with a human mediator (Finck et al. 2004) aims at overcoming the physical as well as the organizational distance between users and system designers.

## 4.1 Perceived Distance

In contrast to observable project settings that can be analyzed e.g. by project documents (who is involved, where are participants located etc.) also the perceived distance in each dimensions plays a major role in a project’s dispersion.

The term “perceived distance” is taken from Evaristo & Scudder (2000). They speak about a “Level of Dispersion” that refers to the dispersion of people within a group of stakeholders (sharing a role, e.g. system analyst) or among different groups. The level of dispersion is measured by the “perceived distance among the members sharing this role” as well as by the “perceived distance among this role group and all the others (say, programmers, testers, users, etc.)” (Evaristo & Scudder 2000).

Even if they seem to have the physical distribution in mind, the concept of perceived distance can also be applied to organizational or temporal distribution. Project members that are organizationally distributed but work closely together at the same place and during the same working hours might perceive the organizational distance not that high, whereas under other circumstances the differences between organization cultures might cause a higher perception of distance.

The perceived temporal distance might vary with the established communication in a project. If project members are, for example, familiar with and not scared of using asynchronous communication tools, the established communication culture might decrease the perceived distance.

## 4.2 Understanding Distribution of a Given Project

To understand the degree of distribution in a given project it needs to be analyzed along the previously described dimensions. It is not the purpose here to give any definition for a distributed project. Rather, the aim is to give advice for understanding several aspects of distribution. Two perspectives should be considered for analysis:

1. Observable project settings: organizations and locations of people involved can be identified and count as well as relevant other distributed entities.
2. Perceived distance: the distance perceived by the individuals can differ from the observable distance.

Figure 2 and 3 may help to get a picture of a project's distribution. The aim is to estimate the distribution of single stakeholders, stakeholder groups or other entities – observable project settings as well as perceived ones – rather than to classify an entire project in the dimensions. The dots would represent the single estimations.

## 5 Summary and Conclusion

In this study, we have discussed the nature of distribution – its dimensions and related challenges. In particular, the purpose has been to provide a basis for discussing the appliance of software development approaches in distributed development projects.

For this purpose, literature about distributed software development has been studied and evaluated, and a proposal for a taxonomy of distribution has been presented. Most of the literature is very focused and discusses single aspects of distributed software development. One paper aims at drawing a bigger picture: Evaristo & Scudder (2000) present a dimensional analysis of global distributed project teams. These project dimensions are discussed regarding their impact on distribution or how they are affected by distribution. For example, they discuss the distribution of sites and the related perceived distance as well as the dispersion of members and their stakeholder groups. The dimensions are more related to projects than to the phenomenon itself. Some dimensions are project characteristics, for example project type (i.e. software or hardware development), complexity (i.e. project size, scope and goals, used technology), or information system method (i.e. life-cycle or waterfall model). Other dimensions are challenges caused by distribution such as need for synchronicity or cultural differences. However, their analysis was very helpful for this study, since it provides a deep insight in distributed development issues and hints for the dimensions of distribution presented here.

In this study, four dimensions of distribution have been identified: the physical distribution among locations, the organizational distribution among working structures, projects, institutes etc., the temporal distribution, and

the distribution among different stakeholder groups. The distribution of people, artifacts, power etc. as well as single challenges in distributed projects can be discussed in these dimensions.

The dimensions of distribution can be applied for evaluating software development practices against distributed project settings. In addition, underlying goals or values can be evaluated whether they fit or contradict distribution.

The taxonomy of distribution presented here can be criticized. For example, the taxonomy is based on a literature study that could be broadened – be it within the discussed areas or by consulting literature on virtual teams or project management. In addition, the selected literature reports mainly on case studies about problems and practices regarding distribution. It does not include social or organizational theories. This might be a weakness since it makes the model probably incomplete. It might also be a strength since the dimensions are grounded in practical challenges. Further on, the correlations between the dimensions as well as single challenges should be discussed in more detail.

Therefore, further work has to be done in two areas: 1. The dimensional description of distribution should be verified or modified by further studies. 2. The usefulness of the dimensional description should be analyzed by applying it to single software development methods, tools or processes.

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