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Control and Coordination Approaches for Management of Software Development Projects

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INFLUENCE OF GEOGRAPHIC DISPERSION ON CONTROL AND COORDINATION APPROACHES FOR MANAGEMENT OF SOFTWARE DEVELOPMENT PROJECTS

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Abstract

In the recent past, the Indian information technology industry has been able to grow at double-digit figures, thanks to the burgeoning demand for software services and products in the international market. Some of the Indian software companies have benefited from these changes, as they have been able to provide quality services at competitive prices to their offshore clients. However, these new work arrangements have brought in complexities in managing software projects. Separation of resources in time and space leads to problems in controlling and coordinating these activities. Various formal and informal approaches used for controlling and coordinating the collocated projects need to be applied differently in the case of geographically dispersed projects. Preponderance of electronic mediated communication in place of face-to-face communication necessitates some changes in their application. At the same time, projects with different levels of complexity need different mix of these approaches. This mix also changes with the progress of the project over the software development life cycle. This research studies the different formal and informal approaches that are used to manage the geographically dispersed projects through field studies in four firms. Qualitative research methods will be adopted for conducting this study and analyzing data.

Introduction

Geographically dispersed software development activities have dramatically increased over the last few years. Alliances, outsourcing, mergers, acquisitions and market demands are some of the reasons why companies have distributed development across geographically dispersed regions. The majority of software project activities carried out by the Indian companies belong to the category of geographically dispersed activities.

A typical software development life cycle begins with requirements, proceeds through design, development, testing, implementation and maintenance. Geographically dispersed software development projects are characterized by activities like coding and unit testing carried out at one geographical location while other activities like requirement analysis, implementation and quality assurance are done at some other location. These projects are different from the collocated projects as there is a preponderance of electronic mediated communication and transactions. Software development projects require significant coordination and control of activities. The different parts of the life cycle must proceed in a coordinated way across the geographically dispersed regions, and each step of the process must proceed seamlessly to the next. Separation of resources in time and space can lead to problems in coordinating these projects. Coordination and control systems are one of the dimensions in the proposed framework for successfully managing the global software alliances (Heeks, et al., 2000, Carmel, 1999).

Managers are finding it increasingly difficult to employ traditional means of controlling and coordinating team members in the changed scenario (Piccoli, Powell and Ives, 2001). One reason is provided by the findings from studies of work that show that informal, unplanned, ad-hoc communication is extremely important in supporting collaboration. Role of traditional theories that are applicable in the case of collocated teams needs to be re-examined for distributed work. One needs to consider as to what needs to be modified taking into account the dispersion over space. Also entirely new theories may be needed to adequately

understand new ways of distributed work arrangements. These questions form the motivation for our study of geographically dispersed projects.

In popular literature there is naïve belief in the efficacy of communication technologies and media like email, video and audio conferencing to coordinate distributed work. However, geographically dispersed interaction needs to be structured taking into account the nature of the task, task interdependence, support tool characteristics, distribution of expertise and personal relationships.

Theoretical Background

Control and coordination of activities has been an area of interest for researchers and practitioners for quite some time now. Control has found a mention in the management theories right from the beginning of scientific tradition of managing the organizations (Henri Fayol, 1841-1925) till today in the age of empowerment and downsizing (Jermier, 1998). At an organizational level, the failure to match controls with a firm's unique context is likely to lead to organizational decline in the long run (Ouchi, 1979).

Formal control has been defined as a performance evaluation mechanism, where behaviors, outcomes or both are measured, evaluated and rewarded (Eisenhardt, 1985). Whereas informal control approaches relies on social or people strategies (Eisenhardt, 1985; Jaworski, 1988), such as belief systems (Simons, 1994) and peer-to-peer control (Barker, 1993). Similarly in organizations, coordination is formally undertaken through vertical means, such as authorized entities, project managers and steering committees (Nidumolu, 1995). Also, coordination is informally facilitated through mutual adjustments and communications, whether on individual basis or in groups (Nidumolu, 1995). Use of these different formal and informal approaches needs to be studied in the context of geographically dispersed software development projects.

Research & Development literature suggests that projects should be managed differently depending upon project characteristics such as risk, ambiguity and non-routineness (Keller, 1994; Ettlie et al., 1984; Katz & Tushman, 1979). Cardinal (2001) studied the different control approaches that are used in the case of different kinds of R&D projects. In this study R&D projects were classified as radical or incremental depending on the risk, ambiguity and non-routineness of the projects. Similarly, we have categorized the software development projects into service and development projects depending on the risk, ambiguity and non-routineness of the activities.

Most of the researchers who have studied software development agree on use of both formal and informal approaches, but there is no clear agreement on which approach is dominant over other. Some authors have shown that behavioral factors are more important then technical factors (Guinan et al., 1998) whereas some others have shown that formal controls are always present (Kirsch, 1996). We think that use of different approaches will change over the life cycle of a project and hence this needs to be investigated.

Carmel's (1999) study indicates that technical factors, like development methodology, product architecture, and collaborative technology, and management factors, like team building and managerial techniques, are important for managing geographically dispersed projects. There have been other some other studies dealing with this issue but none of them have gone into the details of how these different approaches are implemented.

Sahay and Krishna (2000) have conceptualized that global software development is carried over in "local", "global", and "shared" arenas. The "local" domain is one in which people work in their respective individual locales. The "global" represents the domain when an individual physically goes to work in their counterpart's site. The "shared" electronic spaces enable developers to share messages, data or software programs with each other. In this research we are studying the use of different approaches in the local, global and shared domains.
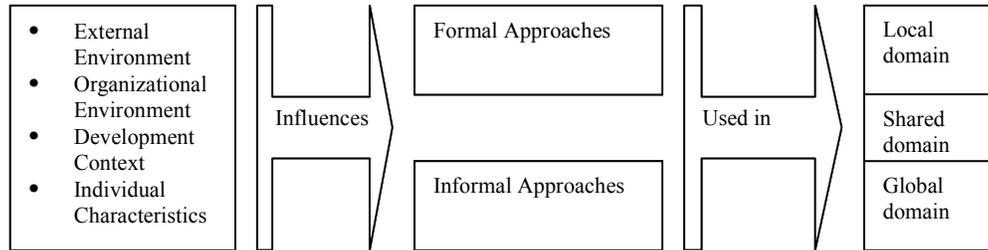
Therefore our study plans to answer the following questions:

- Question 1: What formal and informal approaches are used in local, shared and global arenas for control and coordination of the geographically dispersed software development projects?

- Question 2: How does the mix of formal and informal approaches change in these different arenas?

- Question 3: How do the above approaches relate to complexity (risk, ambiguity, structure) of the projects?

Conceptual Framework

Research has shown that task programmability (or degree of knowledge about the transformation process), task interdependence, information (measurable output), work unit size, and uncertainty (macro-environment, operating environment and internal environment) determine to a large extent the kind of control and coordination approaches to put in place (Jaworski, 1988; Eisenhardt, 1985; Ouchi, 1980, 1979; Van De Ven et al., 1976). In our study we have categorized these factors into external environment, organizational environment, software development context and individual characteristics.

External Environment · Organizational Environment · Development Context · Individual Characteristics	Influences	Formal Approaches	Used in	Local domain
		Informal Approaches		Shared domain
				Global domain

Figure 1. Conceptual Framework

Research literature (Lacity and Willcocks, 2000, Carmel, 1999) broadly agrees that technology domain, business domain and cultural characteristics comprise the external environment that is expected to have an impact on the use of different approaches.

- Technology domain: This is the functional domain in which the software will function, e.g. telecom software, database management system, embedded software, etc.

- Business domain: It is the business activity of the customer where the software will be used, e.g., financial services, operations management, consumer electronics, etc.

- Cultural characteristics: This tries to capture the cultural differences among the geographically dispersed team members, e.g., revering hierarchy, individualism versus collectivism, risk avoidance, long term orientation, etc.

Organizational environment comprises of histories of task accomplishment, cultural beliefs, organization of work and work unit size (DeSanctis and Poole, 1994; Fitzgerald, 1998). For example, organization that is into provision of services like "porting" can be expected to have tighter output control mechanisms in place as compared to an organization that is into development of banking solutions.

Development context includes business opportunity, problem situation and technological infrastructure to facilitate software development (Fitzgerald, 1998).

- Future potential of the business domain (business opportunity/duration) for which an organization is developing software has an impact on the processes that will be used by it.

- Problem situation (risk, ambiguity, task programmability, task interdependence, etc.) will determine the intensity with which formal and informal approaches are used in a project.

- Technological infrastructure: Role played by the infrastructure includes project management (improved visibility and reduced risk); Economic (skill specialization, division of labor); Epistemological (systematization and transfer of knowledge, template for inexperienced developers, learning from past project); Reduction of variety and complexity; Facilitation of intercommunication among groups

Developers play an important role in software development (Fitzgerald, 1998). Some of the characteristics of developers that have an impact on management of the process are:

- Skills and ability
- Experience and expertise (repertoire of strategies developed over a period of time)
- Application domain knowledge
- Commitment and motivation
- Level of trust in internal and external specialists

All the factors mentioned above are expected to have an impact on the different formal and informal approaches that are used over a software development project lifecycle. The different approaches that are being studied in this research are:

- Formal control and coordination approaches: Some of the work done earlier has taken into consideration output control, managerial behavior control, and vertical coordination as formal approaches for effectively carrying out the development activity (Guinan et al., 1998; Kirsch, 1996; Nidumolu, 1995; Kraut and Streeter, 1995; Henderson & Lee, 1992; Zmud, 1980). Some of these studies have also considered software development methods as an instrument for facilitating formal control (Guinan et al., 1998; Kirsch, 1996; Zmud, 1980).

- Informal control and coordination approaches: Some of the work done earlier has taken into consideration clan control, self-control and horizontal coordination mechanism (Kirsch, 1996; Nidumolu, 1995).

These different approaches mentioned above are being studied in the context of geographically dispersed work. Geographically dispersion has increased the complexity of managing the software development. Some of the researchers have proposed that this complexity is the result of the struggle to negotiate place-space duality in the context of global software alliances (Sahay and Krishna, 2000). Place and space are the two central time-space configurations of modernity (Giddens, 1984, 1991).[1]

Globally dispersed projects have become possible not by the substitution of informal means of managing projects by formal means but there is a distribution of both formal and informal means across individuals, tasks, locations, and moments. In this study we have concentrated on the set of formal and informal approaches that cope with the tensions of place and space inherent in the geographically dispersed work arrangements. We are studying the use of different approaches in the local, global and shared domains.

Research Methodology and Sites

Research question that this study plans to answer begin with a what and how, as this is an initial foray into the field to describe what is going on. In addition to this, there are a large number of factors influencing the use of different approaches and there is no clear existing theory that explains their relationships in the given context. Therefore these conditions present us with a unique opportunity for conducting a grounded theory approach based study in its natural settings (Creswell, 1998).

A grounded theory research based study uses a systematic set of procedures to develop an inductively derived theory about a phenomenon. In these studies, the concepts and relationships among them are not only generated but also provisionally tested. In these studies data is collected on the basis of theoretical sampling; the study begins with studying some homogenous sample and after developing a theory undertakes studies of heterogeneous samples. The rationale for studying heterogeneous sample is to confirm or disconfirm the conditions under which the model holds (Creswell, 1998). Tools associated with grounded theory (Corbin &Strauss, 1990) like theoretical sampling, basic coding techniques, indexing, constant comparative analysis, and summarizing processes are being used in this research.

The grounded theory method results in concepts and constructs grounded in data that reflect theoretical sensitivity and have imagery and contextual validity for those involved in the experience. A grounded theory approach produces interpretive analysis and conceptual schemes that depict, explain and predict the variations of behavior given certain contextual conditions. The resulting findings link contextual factors to the formation of knowledge structures with respect to control and coordination of geographically dispersed projects.

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[1]Place refers to the experience of being in a bounded locality with unique qualities in which traditions are important determinants of behavior. In time-space configuration of place, there is a sense of being in place and of comfort in the familiar. Space, in contrast, refers to a time-space configuration experienced as being boundless, universal and infinite. There is a sense of freedom in a limitless expanse in which movement and change are welcome and possibilities are endless (Schultze & Boland, 2000).

We have collected data in the form of interviews, visits to the worksites and electronic documents, etc. For the purpose of collecting data, we interviewed the top management, project managers, and team members. For conducting the interviews, a brief interview guide was prepared so as to facilitate the interviewing process as well as facilitate the comparison of the data collected from different sources. A total of forty-five interviews have been conducted in a four development centers located in India. This data collected from different sources is being analyzed according to the processes described by Corbin and Strauss (1990).

Preliminary Findings

From the analysis of the data obtained so far, we find both formal and informal approaches being used in geographically dispersed software development projects. Formal control approaches like output control (project health meter, scope tracking, effort tracking, review status, etc.) and behavior control (in-house method for software development) are used. At the same time informal control approaches like peer-to-peer control and self-control also play an important role in software development. Similarly, organizations constitute committees (coordination-teams, product teams, implementation teams etc.) for formally coordinating the different activities while at the same time informal coordination gets facilitated through emails and teleconferencing.

Most of the managers interviewed informed us that when they started working on the projects they had to put in more processes and rules, for example, definition of exit-entry criteria for moving from one phase to another or for changing the source code, etc. Some of these managers said that initially their counterpart in U.S. resisted imposition of these rules, as they also had to follow them but after using it for some time they realized that these rules lead to improvement in quality and productivity of the Indian team. Hence we can say that organizations have implemented certain new processes and tools that were not there at the beginning of the geographically dispersed work arrangements to facilitate better control and coordination of efforts. Some of these processes have been put in place formally whereas others have evolved informally over a period of time.

Our initial results therefore point to the fact the global software development when implemented in the right manner leads to better quality and shorter development time. We are continuing our studies with further interviews, data collection and analysis. Some of the findings of this research are going to be presented at IFIP 8.2+9.4 at Athens, Greece and IRMA 2003. These results will be presented at the time of AMCIS 2003 Doctoral Consortium.

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