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Identifying and managing coordination complexity in global product development project

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Abstract

The complexity of communication and coordination stemming from teams distributed across geographic locations and time zones is a fundamental feature of the global product development (GPD) project. The GPD project is also a complex web of interactions involving many overlapped activities and interdependent components. In order to manage coordination complexity, this paper presents a systematic method for identifying and measuring coordination drivers and coordination barriers in GPD projects. For characterizing coordination drivers, this paper builds quantitative models to measure dependency strengths related to product features and overlapped processes based on Multi-Domain Matrix (MDM) and Design Structure Matrix (DSM). For characterizing coordination barriers, the concepts of *daily overlapping working hours ratio* and *relative spatial distance* between GPD teams are presented for modeling dependency strengths related to temporal separation and spatial distance. Further, this paper proposes a new dependency rating scheme of organization DSM to evaluate the integrated coordinative dependency strength (ICDS). A two-stage clustering criteria minimizing the total coordination cost is used to reduce complexity of GPD organization. An industrial example is provided to illustrate the proposed models. Optimization results provide a more integrated managerial insight for evaluating ICDS and reducing total coordination cost.

Keywords: Global product development project; Coordination complexity; Organization optimization; Design structure matrix (DSM); Dependency strength; Clustering analysis

1. Introduction

Global product development (GPD) is becoming a tendency in high technology companies. As a report by IBM stated, "Companies continue to expand globally, distributing their teams around the world. As globalization becomes more prevalent, many companies are evolving their approach and practices of the distributed model." (Fryer and Gothe, 2008). The GPD project is characterized by significant complexity in communication, information sharing and information dependency among teams that are distributed across geographic locations and across time zones. It is particularly interesting to study the structure of communication in geographically distributed PD teams, because of the highly interdependent nature in design organizations (Sosa et al., 2002) and its pressure for achieving high performance (Tripathy and Eppinger, 2011, 2013).

The geographic dispersion reduces communication frequency, generates coordination delays and misinterpretation in lateral communication. Spatial separation due to geographic distance and time dispersion due to time zone differences are two key geographic characteristics that impact on how GPD team members work together (Herbsleb and Mockus, 2003). Spatial separation negatively impact coordination because it reduces the likelihood of face-to-face contact and spontaneous communication (Sosa et al., 2002), making it more difficult to resolve work issues (Cummings et al., 2009). Time separation (i.e., temporal

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dispersion) can introduce severe disruptions in the workflow among members, which can impact team coordination (Carmel and Tjia, 2005).

The stronger communication strength between PD teams is required if the stronger dependency between product's technical features exists. Hence, the communication frequency resulted from the coupled process and communication strength resulted from product's technical features are main sources of influencing technical communication in PD projects.

Structured methods are useful tools to explain dependency relationship between elements and reduce management complexity in PD projects. The Design Structure Matrix (DSM) proposed by Steward (1981) is a powerful structural method to represent the dependency strength of communication between teams. Organizational units (e.g., teams or individuals) with strong dependency can be relocated next to each other, or clustered into the same group (Eppinger and Browning, 2012; Yang et al., 2014a). The major benefits of clustering include reduced complexity and reduced coordination cost. So, how to measure the dependency strength between teams in GPD projects is a fundamental issue for clustering the numerical DSM and optimizing the GPD project.

In this paper, we extend previous GPD models proposed by Espinosa et al. (2012) and Cummings et al. (2009) to measure the dependency strength of communication between teams and clustering the GPD project organization. This paper seeks to explore the following questions:

1) How to identify coordination drivers and coordination barriers in GPD projects and model their impact on dependency strength between geographically distributed PD teams?
2) How to measure the integrated coordinative dependency strength between teams in GPD projects using DSM models and reduce coordination complexity of GPD projects using DSM clustering method?

To address the above issues, we contribute a systematic method for identifying coordination drivers and coordination barriers in GPD projects and present a new dependency rating scheme to measure dependency strengths between GPD teams using organization DSM. Further, a two-stage clustering criteria minimizing the total coordination cost is used to reduce complexity of GPD projects. The rest of the paper is organized as follows. In Section 2, we review the literature on coordination and communication in GPD projects. We discuss in Section 3 coordination drivers and coordination barriers in GPD projects organization. In Section 4, we formulate dependency strengths related to temporal distance and spatial distance, and build quantitative models to measure dependency strengths related to product features and overlapped processes based on MDM and DSM models. In Section 5, we propose a new dependency rating scheme of organization DSM to evaluate the integrated coordinative dependency strength and present a two-stage clustering algorithm. In Section 6, the proposed models are tested using an example from an Italian-based company. We conclude the paper in Section 7.

2. Literature review

2.1. Coordination and communication in GPD projects

GPD projects are generally complex and involve highly interdependent collaborative activities carried out by multiple teams and individuals, so, an efficient communication is necessary condition for increasing the performance of GPD projects. Coordination-based communication is defined as the integration or linking together different parts of the organization to accomplish a collective set of tasks (Dietrich, 2007). Higher coordination needs imply more task/component interdependencies and more technical communication strength resulted from product features (Gomes and Joglekar, 2008; Tripathy and Eppinger, 2013; Wolf et al., 2009). Technical communication strength between PD teams mainly depends on problems when integrating different components from heterogeneous environments (Kwan and Damien, 2011). Additionally, overlapped process is a main concurrent approach which may increase communication and coordination frequency between teams (Greze et al., 2011; Loch and Terwiesch, 1998, 2000). If there is no dependence related to overlapping, there is no need to communicate or coordinate. Further, if the information from the upstream activity suggests a change in downstream activity, the later the downstream activity receives this information, the more coordination frequency will be required. For the overlapped process, team's interaction is mainly determined by the degree of overlapping and the coordination frequency (Yang et al., 2014a,b).

In GPD project, geography is a main source of coordination barriers (Cummings, 2011). Geography barriers involve spatial, temporal, cultural, work and organizational dispersions (Smite et al., 2010). The spatial distance leads to a decrease in communication frequency (Colazo and Fang, 2010; Sosa et al., 2002) and technical team performance (Gopal et al., 2011), an increase in coordination problems (Lanubile et al., 2010; Nguyen-Duc et al., 2015) and a difficulty in communication and coordination related to culture and language difference between teams (Aubert et al., 2011; Gurung and Prater, 2006). Spatial distance is a nonlinear factor for communication in PD projects (Allen, 1997; Carmel and Abbott, 2007). Temporal dispersion is measured by working time difference and time zone difference across locations of teams (Espinosa et al., 2012). It leads to delays in communicating tasks (O'Leary and Cummings, 2007), difficulty in scheduling meetings (Cummings, 2011; Cummings et al., 2009) and asynchronous communication (Espinosa et al., 2012; Herbsleb and Mockus, 2003). The temporal dispersion can be a major hurdle for geographically dispersed teams (Kayworth and Leidner, 2000). The largest issue of cultural dispersion is misinterpretation during the development activity: communication, development, maintenance, and testing (Noll et al., 2011). Besides, mismatches in language capability influence the choice and quality of communication (Aubert et al., 2011). Work dispersion and organizational dispersion are associated with coordination issues at management level rather than at the technical level. The main coordination issue of organizational dispersion is the misinterpretation of tasks and goals which hinder site-cross communication and the ability to satisfy coordination requirement (Nguyen-Duc et al., 2015). The