The influence of centrifugal and centripetal forces on ERP project success in small and medium-sized enterprises in China and Taiwan

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Abstract

Successful implementation of Enterprise Resource Planning (ERP) systems has become a critical facilitator for efficient operations management in both developed and developing economies. The study presented in this paper uses a novel “Centripetal and Centrifugal Forces” (CCF) model developed in the context of global new product development projects, to examine the way that the interaction of factors relevant to project management contributes to successful ERP implementation processes. Based on regression analysis of responses from 244 small and medium-sized manufacturing firms in Taiwan and China collected in May 2006, we find that the balance of centrifugal and centripetal forces fosters ERP project success, a result which has significant impacts on ERP project management practice. The study also opens up a new direction for future research on ERP implementation processes in that it suggests a novel way to model the interaction of project management factors. In addition, the new measures regarding project success and project management developed and validated in this study should prove to be useful for researchers studying ERP implementation processes.

Keywords: Enterprise Resource Planning (ERP); Small and medium-sized enterprises (SMEs); Implementation; China; Taiwan

1. Introduction

Mainland China has successfully encouraged foreign investment with an open-door policy. This has resulted in larger and more complex networks of R&D, manufacturing and service operations, and supply chains, all of which address the increasing desire for investment in China (Martinsons, 2000). At the firm level, these developments have increased the
requirements for a sophisticated IT infrastructure. Today, China is the third largest market for information technology (IT), after the United States and Japan. Within the Asia-Pacific region, China’s IT-services revenue is expected to top $43.9 billion in 2008, as China surpasses South Korea to become one of the three largest IT-services markets in the region along with Japan and Australia (Quan et al., 2005).

These developments have placed tremendous pressure on firms in China to improve their operational performance based on new IT-systems. One class of such systems is Enterprise Resource Planning (ERP) that seeks to synchronize the planning of processes across all functions within an organization. Many organizations in China have invested billions of dollars in ERP systems (Martinsons, 2004). However, previous studies on ERP implementations focused mainly on large companies in Europe or the United States, and very few focused on enterprises in developing nations such as China and Taiwan (He, 2004; Tsai et al., 2005; Reimers, 2003). As developing countries may face different challenges from those faced by developed countries, there is a gap in the ERP literature that needs more research attention.

The present study aims to narrow the above gap in the ERP literature by presenting results of an empirical study of ERP implementation in China and Taiwan. The context of these two regions offers the potential for new insights for several reasons. First, the results should complement findings from developed economies in North America and Europe. Second, as firms in China and Taiwan are usually much smaller than those in Europe and North America, the present study identifies the characteristics of ERP implementation projects in small and medium-sized enterprises (SMEs). Third, the comparison between China and Taiwan offers an interesting contrast since while both economies share the same culture (Hofstede, 2001) they differ in their stage of economic development.

2. ERP implementation as team effort

As indicated by prior research, many ERP implementation cases in China fail to meet their project deadline because of poor schedule estimates and uncertainty about the ERP implementation timeframe (Martin, 1998). In addition to the above weakness in implementing ERP systems, two major ERP challenges to SMEs in China contain weaknesses in both IT infrastructure and IT human resources (Liu and Zhou, 2001). However, SEMs in Taiwan face different obstacles in ERP implementation. According to Tsai et al. (2005), the three most important obstacles were: difficulties in transition to new systems, unavailability of skilled people, and high turnover of key project persons.

Because of the increasingly important role that of ERP plays in organizations, a substantial amount of the IS literature has focused on issues related to ERP implementation. Extant research has addressed both the software engineering and the user acceptance dimension. The software engineering dimension addresses the challenges of creating a cost-effective ERP code basis that is reliable, easy to modify, and easy to upgrade to new hardware platforms (e.g. Sprott, 2000). The user-acceptance dimension is based on system users’ evaluations regarding, for example, relevance, usefulness, ease of use, satisfaction with outcomes, and ability to exchange information with other participants (e.g. Boudreau, 2003).

However, ERP system implementations that take into account only the principles from consider the above two dimensions do not always guarantee successful organizational outcomes. Although ERP systems may be perceived as well-built systems from a software-engineering perspective, ERP systems do not, in themselves, lead to a satisfactory organizational outcome without effective teamwork in ERP project teams. For example, when no incentives are available to encourage team members to input their individual knowledge into the implementation process, errors related to business processes may be presented in the ERP system. In other words, successful ERP implementations require good teamwork. Today, more than ever, work is performed in groups and teams. Organizations increasingly rely on team-based arrangements, such as project teams, task forces, quality circles, autonomous work groups, and cross-functional teams to gain competitive advantage and to improve employees’ experience of work (Guzzo and Shea, 1992). The general characterization of work teams also applies to ERP project teams which—in an analogy to definitions of teams in the teamwork literature (Janicik and Bartel, 2003, p.125)—can be defined as an inter-dependent collection of individuals whose primary function is to perform a complex task requiring a specific output (a functioning and useful ERP system) by some deadline after which they disband. Clearly, the importance of teamwork in ERP implementation has not been addressed by the
above two research dimensions in the ERP literature. The neglect of the roles that teamwork plays in ERP implementation may overlook the complex dynamics of ERP success and therefore teamwork in ERP implementation deserves more research attention.

Much work in organizations is carried out in teams because the synergy of team members often leads to greater and faster achievements. Moreover, the complexity of tasks often requires that individuals with different knowledge, skills, and expertise work together to accomplish tasks. Although teamwork may provide many benefits, such as increased flexibility and creativity, it is also known to be associated with problems of coordination and motivation (Steiner, 1972). For example, differences in members’ knowledge and work routines may lead to conflict about how to perform a task or about which procedures to use. In addition, the fact that others are present to do a job may encourage free-riding behavior. Given the fact that individual team members often work on multiple projects (Wang et al., 2005), members may abandon plans owing to conflicting demands on their time use; this abandonment may, in turn, lead to delays in the flow of work. Because of these problems, teams that fail to integrate their members may perform below their potential and display deficiencies in outcomes.

We therefore suggest that ERP research needs to incorporate the teamwork dimension and thus propose the Centripetal and Centrifugal Forces (CCF) model for this purpose (Sheremata, 2000). The CCF model proposes that forces exist in teams can be characterized as either centripetal or as centrifugal. Carmel (1999) describes centripetal forces as those forces that pull the team together, making the team more effective. Some of the centrifugal forces may also be considered useful outside the context of project teams, for example in the context of cross-functional interaction (Kraut and Streeter, 1995; Crowston and Kammerer, 1998; McChesney and Gallagher, 2004). Centripetal force is the opposite of centrifugal force, which Carmel defines as a “force that propels things outwards from the center as it disperses developers to the far corners of the world.” Although Carmel (1999) suggested that centrifugal forces are the problems that pull a team apart and therefore inhibit its performance, the author also argued that centrifugal forces can have positive effects on project results. It appears that not only the force itself, but the relationship between two forces may affect team effectiveness of ERP implementation project teams. Specifically, we propose that both centrifugal and centripetal forces can have positive effects on project outcomes if the right balance between the two can be achieved. However, what the right balance is may depend contextual on factors such as the country.

Focusing on the project management of ERP implementation, this study endeavors to examine the roles that centrifugal and centripetal forces and their interaction play in the success of ERP implementation projects initiated by manufacturers in China and Taiwan. In an effort to identify viable equilibrium between opposing forces in ERP implementation, this study is geared primarily to answering the following question: How does the relationship (balance) between centrifugal and centripetal forces affect project success in SMEs operating in the context of a developing economy?

3. Theoretical development and hypotheses

3.1. Centrifugal and Centripetal Forces Model (CCF model)

To explain how the coexistence of opposing and contradictory elements of structures and processes can increase the probability of successful ERP system implementation, we draw an analogy between that a successful cycle of ERP implementation and the earth’s orbit around the sun. Centripetal forces prevent the earth from flying off into space while centrifugal forces prevent it from colliding with the sun. Dynamic equilibrium between a pair of forces with equal magnitude but directions keeps the earth stay in the orbit (Sheremata, 2000). To encourage innovation within a team, the team needs to have enough freedom and a positive climate (centrifugal force) so that team members feel they can freely express their ideas. However, if team members do not have similar perceptions of the goals of their information sharing (centripetal force), the communication between team members may be too divergent to lead to any productive conclusions. In other words, a balance of centrifugal and centripetal forces is critical to the synergy and effectiveness of teamwork.

Centrifugal forces, in the organizational context, are structural elements and processes that increase the quantity and quality of ideas, knowledge, and information for an organization (Sheremata, 2000).
These forces push project team members outward, enabling them to have access to new ideas and information freely (Brown and Eisenhardt, 1995). Because centrifugal forces tend to abolish the structure and norms within a work team, teams high in centrifugal forces may take more time and effort to integrate team members’ ideas and to make decisions. This may inhibit successful ERP implementation when an ERP project has a tight schedule. In contrast, centripetal forces serve as structural elements and processes that integrate dispersed ideas, knowledge, and information into collective action (Sheremata, 2000). Centripetal forces pull a project team together to ensure unified effort among team members (Brown and Eisenhardt, 1995). Because centripetal forces tend to impose a structure and norms, teams high in centripetal forces may be more time-effective and focused in the execution of the project and with regard to their decision-making. With good ERP planning, centripetal forces may lead to timely completion of the ERP project. However, the team sacrifices its creativity and synergy for effective execution and this may inhibit successful ERP implementation when ERP project requires ongoing modification (see Fig. 1).

### 3.2. Centrifugal forces

Organizations seek for ways to create centripetal forces that assist their employees to identify with the organization. While centripetal forces refer to the extent to which employees focus their effort on, and devote themselves to, the company’s goals, centrifugal forces are becoming more important as the business environment changes rapidly. These forces, external to the organization external to the organization such as networking with employees of other companies, shift employees’ attention from inside the organization to outside the organization. Whether or not these forces are work-related is not a criterion of centrifugal forces. These forces can provide employees with information and materials that promote innovation in the company. Therefore, centrifugal forces may actually benefit organizations (Sheremata, 2000). For example, a sales representative who often skips internal meetings but spends a lot of time chatting with customers may actually generate more sales revenue. This is because through the conversations, the sales representative develops a good understanding of business trends by noticing the valuable information regarding the needs of the customers, the demands of the industry and current status of the competitors. In a competitive business environment, talented staffs that utilize and channel centrifugal forces into useful information and resources are critical to a company’s survival. However, when talented employees are only interested in information outside the company and fail to integrate such information into their work, centrifugal forces will result in low in commitment to the company and lead to lack of cohesion in work teams. As a result, staffs may leave and even become competitors. Clearly, a delicate balance between centrifugal and centripetal forces is required to bring a company a competitive edge through the retention of loyal employees knowledgeable about business trends. With the advances in information management systems and a flat organization structure, employees who bring valuable information from outside the organization are increasingly able to share their thoughts through various communication media.

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**Fig. 1.** The Centrifugal and Centripetal Forces model.
In the current study, we conceptualize centrifugal forces by the following three constructs:

- Free flow of information in the project team;
- Connectedness with user departments;
- Unfocused information-seeking.

The term free flow of information refers to the extent to which large quantities of rich information can be transferred across individuals and organizational boundaries without encountering resistance (Sheremata, 2000). Our study focuses on free flow of information in project teams with regard to both project team individuals’ access to information and project team individuals’ transfer of information among one another. An ERP project requires a cross-functional, multi-skilled implementation team because of its enterprise-wide scope (Davenport, 2000). To be effective, the team needs cooperation and free information sharing among its individual members. However, such free-flowing information may also lead to unanticipated changes to the project scope when opportunities for streamlining business processes or automating tasks are discovered during project implementation which may threaten on-time, on-budget implementation.

The term connectedness with user departments refers to team members making efforts to frequently connect with end users. Thus, connectedness goes beyond communication within the project team. Rather, it comprises frequent discussions between project team members and individuals from various functional departments. Moreover, interaction should include feedback from the end users as this can increase user acceptance. As a way to avoid various interaction failures, an open information policy has to be maintained for the project. However, connectedness with user departments may also endanger project goals or indeed threaten project completion, as connectedness may open the floodgates for unreasonable or idiosyncratic change requests which may bloat project scope.

The term unfocused information-seeking refers to information collection activities of project team members on information unrelated to the immediate project goals (Mahaney and Lederer, 2003). Employees today demonstrate an increasing awareness of issues beyond the confines of the enterprise itself. They show greater interest in collecting information not directly related to their job responsibilities and in building their personal connections. Vigorous and frequent contacts with new information have the benefit of stimulating the employees’ development of creative ideas and innovative solutions for application to the employees’ work, and therein lay the major advantage of unfocussed information-seeking to the enterprise. For example, in every visit to end users, a member of the ERP project team may enjoy chatting on topics unrelated to work. This seemingly idle conversation may bring out new understandings and valuable information that help refine the ERP system to better fit the needs of the organization. Similarly, unfocused surfing on the Internet can serendipitously generate valuable information for the project. However, such behavior may also threaten project goals because scarce company resources are wasted.

3.3. Centripetal forces

Top management should note that centripetal forces do not imply conservativeness or fustiness. Furthermore, top management should prevent nearsighted middle managers uses centripetal power to suppress employee creativity. Without an appropriate level of centrifugal forces, an organization will lose its competitive edge quickly.

We conceptualize centripetal forces through the following three constructs:

- Centralization of decision making;
- Temporal pacing;
- Existence of superordinate goals.

The construct centralization of decision making refers to the extent to which project decisions are controlled by project management or their superiors (e.g., members of the steering committee). Tight control over project decisions can ensure that system implementation is consistent with overarching company goals. Furthermore, conflicts among project team members or between the project team and functional departments can be quickly and efficiently resolved. However, centralization of control also restrains innovative energies of project team members and may negatively affect their motivation to contribute time and ideas to the implementation process.

The term temporal pacing refers to the use of a formal procedure with clear guidelines, rules, and schedules for orchestrating a project team’s activities (Gersick, 1994; Griffin, 1997). In such circumstances, an ERP team is motivated to implement its
project on the scheduled date, even if this would negatively affect other project goals. For example, a quick implementation approach may not provide the time necessary for team members to learn about the system and appreciate its potential value. Hence, *temporal pacing* enhances the likelihood of meeting deadlines by infusing ERP project teams with a sense of urgency and an awareness of the need to solve implementation failure early. It also helps facilitate effective senior management monitoring of a project (Brown and Eisenhardt, 1995). However, this comes at the cost of neglecting or ignoring important problems faced during project implementation.

The term **existence of superordinate goals** refers to the degree to which a project team accepts and identifies with the project goals. (Pinto et al., 1993). A **superordinate goal** enhances the likelihood of finding good-quality solutions in a timely manner because team members with a common goal become more open to the diverse perspectives of each other and more effective in integrating a larger pool of quality ideas and information (Hyatt and Rudy, 1997). In addition, structuring **superordinate goals** involves organizing them in a manner that enables the project team to describe in detail what the company strives to achieve and to incorporate these superordinate goals appropriately into the decision model. On the flip-side, the existence of a superordinate goal may prevent innovative ideas from being incorporated into the project because they are outside the officially sanctioned goal. Therefore, consideration of such ideas would require to extend the scope of the superordinate goal first; an effort which may not be undertaken because the results are uncertain and the effort may not be appreciated.

### 3.4. Dependent variables and controls

**Successful project management** is the main dependent variable in the study. Differing from the typical way of measuring information system success through the perspective of users, this study measured successful project management through the lens of project team members. ERP implementation project success is frequently defined in terms of the achievement of some predetermined goals, which normally include multiple parameters such as time, cost, and function (Markus et al., 2000). In this study, successful project management is measured in terms of the perceived deviation from the expected project goals such as meeting deadlines, staying within the budget approved at the outset, matching the ERP system with specific business objectives and achieving a specified system performance level (Hong and Kim, 2002; Zhang et al., 2003).

On the basis of previous studies on IS success, we also separate out the potential influence of the following control variables:

- size of project team;
- firm size;
- project leader expertise;
- characteristics of organizational incentive structure;
- location (China vs. Taiwan).

**Size of the project team** is a proxy for project scope; the larger the scope, the more people will usually be involved in the effort. Naturally, project management difficulties increases as the size of the project team becomes larger. In addition, it has been shown that project team size affects the implementation success of large software projects (Tsai et al., 2005).

Project team size may be correlated with **firm size** but larger project teams do not necessarily indicate larger firm sizes. Yet, firm size may have an independent effect on project management difficulties since larger firms usually display more complex organizational structures which should negatively affect ERP implementation processes.

**Project leader expertise** refers to the degree to which a project’s manager possesses skills, knowledge, and experiences that are relevant to both the technical and the management aspects of the project (Nord and Tucker, 1987; Sheremata, 2000). A project manager should be an integrator who is able to motivate a team for collective action (Atuahene-Gima, 2003). He or she is responsible for reducing ERP implementation failure and, in this regard, should be able to coordinate cooperation and solve conflicts among and between team members and other functional groups. While project leader expertise has been shown to have a significant and strong effect on software implementation projects (Tsai et al., 2005), it is not of primary interest in this study. We therefore include it as a control variable.

The organizations within which ERP projects are set may have addressed the general principal-agent problems implied in delegating tasks to paid agents more or less effectively (Harrison and Harrell, 1993). The degree to which principal-agent problems
Table A1 (continued)

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<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Measure</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERP implementation success</td>
<td>SP1</td>
<td>The ERP project took significantly longer than expected.⁎</td>
<td>Hong and Kim (2002)</td>
</tr>
<tr>
<td></td>
<td>SP2</td>
<td>The system performance of ERP is significantly below the expected level.</td>
<td>Tsai et al. (2005)</td>
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<tr>
<td></td>
<td>SP3</td>
<td>The cost of ERP project was significantly higher than the expected budgets.</td>
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<td></td>
<td>SP4</td>
<td>There is no match between ERP systems and specific planned objectives.</td>
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<td></td>
<td>SP5</td>
<td>User’s attitudes towards ERP are negative.</td>
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<td></td>
<td>SP6</td>
<td>ERP systems did not match user’s expectations.</td>
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⁎Reverse-coded.

References


