

**ERP in the minds of supervisors:
Joint roles of task interdependence and cultural norms**

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1. Introduction

Existing research into ERP adoption and implementation has suggested that national culture can have a significant impact on the types of difficulties encountered by managers on the effectiveness of specific management tactics in such contexts (cf. Soh et al. 2000). In these studies, comparisons between collectivistic cultures and individualistic cultures have been prominent. With the reported level of growth in the ERP market in China (Martinsons 2004), any significant roles that collectivistic culture may play on the effective management of these technologies is of vital interest to the myriad of vendors, consultants and adopting firms poised to profit from this growth. Given the association of the collectivistic cultures with an emphasis on shared objectives and encouraged exchanges of information (Early 1989), it is likely that intra-organizational communication capabilities of such systems would receive considerable attention in collectivistic settings.

Other non-cultural issues can have a similar effect on management interests in these capabilities. For example, in settings involving increasingly sequential or reciprocal task interdependencies (Thompson 1967), individual business units, sub-units and workers are increasingly subject to difficulties associated with breakdowns in information flow (Galbraith 1977). Intra-organizational information-sharing mechanisms, such as those provided by ERP, help to augment such flow by enabling cross-functional or interpersonal visibility of related and relevant information (Child and McGrath 2001). Thus, managers confronted with increasingly interdependent settings may be more inclined to support technologies that provide such capabilities.

Modern resource planning systems have popularly been characterized in terms of their transaction processing and data structure capabilities (Cotteleer and Bendoly 2006; McAfee 2002; Davenport 2000). However, reviews of research and practitioner articles suggest that, regardless of their integrative features, few operating managers think of these systems as more than transactional and automated planning mechanisms (Jacobs and Bendoly 2003). Few provide in-depth considerations or evaluations of these systems as tools for communication and collaboration. The burgeoning potential of the Chinese ERP market and the importance placed on intra-organizational communications in collectivistic cultures and / or in highly interdependent work settings suggest that such evaluations are overdue. Since the recognition of capability benefits can strongly influence the motivation behind managerial support of technologies, an investigation into this line of logic therefore clearly presents a unique and relevant contribution to the management of technology literature.

Our study takes an experimental approach to investigate managerial assessments of the usefulness of resource planning systems as tools for intra-organizational communication. We specifically consider the joint role that cultural norms and interdependence among internal operational activities have on these managerial views. In our design and analysis, we simultaneously include a range of controls accounting for prior managerial experiences in an attempt to disentangle various exogenous effects from those effects under investigation. The next section will describe the theoretical foundations of our research questions and will be followed by a detailed description of our experiment. We will then describe the analysis and overview of our results and discuss the implications for both future research and practice.

2. Theoretical foundations

The role of interdependence at the operational level of a firm poses several implications with respect to information needs and means of exchange. To ground these considerations, we adapt a traditional interpretation of interdependence defined as the degree to which two or more activities interact to determine an outcome jointly (Thompson 1967; McCann and Ferry 1979; Dean and Snell 1991). Highly interdependent environments thus represent settings in which regular exchange of information is necessary in safeguarding against operational conflicts.

While information-sharing between interacting activities can be essential, Sorenson's (2003) recent study of vertical integration as a proxy for interdependence also suggests that highly interdependent environments create barriers to learning and effective exchange. This phenomenon is attributed largely to increased difficulty in pinpointing sources of error and constraints in these increasingly complex settings (March and Simon 1958; Simon 1962; Rivkin 2000). As a result of these two issues acting in tandem (i.e. the greater need for information and greater barriers to exchange), the effectiveness of such complex, highly interdependent settings is extremely reliant on the existence of management and organization-wide efforts aimed at facilitating information-sharing (McCann and Ferry 1979; Child and McGrath 1991).

Ultimately, one of the principle roles of managers is to "mitigate problems caused by interdependent processes within firms" (King 1999). This mitigation can take the form of direct policy changes or assistance in the synchronization of delegated worker responsibilities (Macneil 2004; Galbraith 1977). More specifically, Galbraith's information processing theory (IPT) suggests two mechanisms for supporting worker activities in complex, highly interdependent settings (1977). One of these mechanisms

involves the fostering of lateral relations, such as work teams, to augment interpersonal information exchanges. Alternately, information systems designed to facilitate information-sharing capabilities, in a perhaps more codified form, are thought to enable similar benefits (Bendoly and Jacobs 2005; Bendoly et al. 2006). The view that specific forms of information technology can meet the information processing requirements of particularly interdependent contexts has been reiterated in a number of recent operational studies (Eg. Stock and Tatikonda 2000; Tatikonda and Rosenthal 2000; Flynn and Flynn 1999). In fact, Flynn and Flynn (1999) as well as Morgan (1998) cite the replacement of isolated legacy systems by enterprise-wide, fully integrated transaction-processing systems as a recent instantiation of this need. The findings of Gattiker and Goodhue (2004) further suggest that the greater the extent of interdependence, the greater the potential, or at least perceived potential, for resource planning system utility. Yet while the mechanisms (eg. increased communication) available to assist workers in these interdependent tasks have received some consideration in the literature, oddly, little attention has been given to the factors motivating managers to champion the use of these mechanisms in specific contexts (King 1999; Therkelson and Freibich 2003).

2.1. Resource planning system capabilities

Viewed as a set, resource planning (RP) systems represent a range of IS architectures specifically geared towards the improved planning and accounting of resources, processes and materials managed by firms (Gumaer 1996; Chase et al. 2001). Though distinctions between specific resource planning system types (eg. ERP and MRPII) are often discussed with respect to system evolution and the state-of-the-art research has been careful to point out some of the fundamental conceptual differences among these types (Stratman and Roth 2002; Mabert et al. 2001; Sarkis and Gunasekaran 2003). Most notably, research into ERP systems emphasizes the presence of a centralized database and standardized protocols that cross

functional boundaries as the key features distinguishing them from MRP II systems (Gatiker and Goodhue 2004; Austin et al. 2003; Mabert et al. 2001; Davenport 1998). Yet in practice, managers still remain critical of the true distinctions suggested by potentially misleading system 'labels' alone (eg. Robinson 2004; Jacobs and Bendoly 2003). This should not be surprising to academics due to at least two issues: 1) Not all implementations of systems sold by ERP vendors span all business units and functions in practice, and 2) Many MRP II systems have undergone enterprise-wide extensions by firms. If an interest truly exists in distinguishing these types of systems, therefore, it should not follow 'label' or 'vendor' categorizations but rather in-depth descriptions of RP system capabilities and the features that support them. In describing the RP systems referenced in our experiment, we are therefore careful to provide details of the kinds of features (ie. standardized protocols, centralized databases, standardized interfaces, etc.) we intend our subjects to associate with these systems rather than assume a single standard definition exists among all subjects. This is particularly critical given that the subjects in question (managers enrolled in evening, executive and part-time MBA programs) had no prior course work in their affiliated program that already defined and distinguished various resource planning system types.

Given adequate descriptions of features of any specific information technology, a range of potential applied capabilities can be implied. In the existing research, both transactional and non-transactional communicative capabilities have been designated with regards to information-system benefits. Weill (1992) specifically differentiated "informational" from "transactional" benefits, describing communicative capabilities for knowledge diffusion as paramount in achieving strategic "informational" benefits that went beyond tactical gains of enhanced transactions. Mirani and Lederer (1998) later validated the proposition that such benefits were distinct, defining informational benefits through such communicative characteristics as "easier access", improved quality for use in operational control, and clearer presentation.

Such characteristics can similarly apply to the more specific information-technology case of RP systems. The standardization of data definitions and structures, through the use of a common conceptual schema, represents what several authors refer to as “data-integration” and is typically characteristic of modern resource planning systems (Goodhue et al. 1992; Litwin et al. 1990). The “common language” formalization provided by standardization eliminates the need for additional data translation (Huber 1982) and thus enables the coordination that Thompson (1967) claims is most critical in highly interdependent operating environments. If high levels of interdependence are not only possible but more fundamentally required to support competitive strategies, such intra-organizational communication capabilities may provide critical support mechanisms (Ettlie 1988; Kern and Schumann 1990; Dean and Snell 1991). Regardless, such intra-organizational communicative strengths have often been ignored with focus in research studies instead falling on transactional characteristics (eg. Bendoly and Schoenherr 2005). Our specific focus on management views of such non-transactional capabilities thus represents a break from this tradition.

2.2. Managerial perceptions and support

Managerial support has a long history in IS literature as playing a large role in the diffusion of technology changes within firms. While top-management support has often been cited as a key contributor to the successful management of new technology deployment (Leonard-Barton and Deschamps 1988; Purvis et al. 2001), lower level and particularly supervisory managers have been known to play particularly influential roles when it comes to the acceptance of change and use among front-line workers (Larkin and Larkin 2000; Therkelsen and Fiebich 2003). Furthermore, supervisors “through their devolved responsibility for people (which, by implication, includes learning and development) have an influence as facilitators promoting knowledge sharing” through communication among their subordinates (MacNeil

2004). Individuals with greater supervisory experience have a stronger impression of the relevance of these roles and the importance of mechanisms that can facilitate these agendas.

This line of thought opens the discussion to the general concepts of information system perceptions, acceptance and support. Aside from the potential capabilities of a system in resolving informational requirements, research has established that many measures of information system 'success' depend not simply on the presence of a technically functional system, but specifically on *perceptions of usefulness* (Jackson et al. 1997; Szajna and Scamell 1993). Such research discusses how the underutilization of existing system capabilities, due in part to negative perceptual biases, continues to be a problem, limiting appropriate assessments of system value. While perceptions may be justified based on the sheer lack of fit between systems and contexts or tasks (Goodhue 1995), they may also be simple artifacts of past experiences established in alternate contexts to which managers are exposed.

It is therefore striking that, while research into technology adoption by users within firms has acknowledged both the impact of management support (eg. Eder and Igbaria 2001; Rai and Patnayakuni 1996; Libertore and O'Neill 1985; Zmud 1984) and worker perceptions of usefulness (eg. Amoako-Gyampah and Salam 2003; Szajna 1996; Davis 1989), no formal models have taken a serious look at issues that give rise to the perceptions of *managers* regarding these systems. This is all the more striking given the critical supportive and facilitative roles attributed to managers in driving technology diffusion. The study of contextual effects and prior experiences that influence managerial views of system usefulness therefore remains an important though underexplored topic for technology management research.

Not to confuse the concept of managerial perceptions of technology usefulness with the established construct of *perceived usefulness* as it applies to users in technology adoption models (eg.

Davis 1989; Agarwal and Prasad 1999), we instead use the term *management assessed usefulness* to specifically describe managerial perceptions of the usefulness of specific system capabilities in designated contexts. Ultimately, our present interest lays in the management assessed usefulness of RP systems as communication mechanisms (above and beyond their use as transactional systems) in contexts that differ by the level of worker task interdependence.

2.3. The role of interdependence

Recent research by Sharma and Yetton (2003) has suggested a strong relationship between interdependence and management support. Their study focuses on task interdependence as a general contextual descriptor and its role in potentially moderating the relationship between management support and IT success. They do not, however, investigate the direct impact of such interdependence on managerial perceptions of IT (a key motivator of support itself). Figure 1 presents the general structure of the Sharma and Yetton (2003) model along with specific elements not covered but of interested to the research discussed here.

[Insert Figure 1 about here]

As suggested by the extension to this model in the above figure, since context has a large impact on perceptions its direct impact on support poses a research question that needs to be addressed if the full impact of operational context on technology management is to be faithfully pursued.

Similar to Gattiker and Goodhue's (2004) interpretation of IPT, the present study in part considers the extent to which interdependency in specific operational contexts relates to perceptions of resource planning system potential. While resource planning systems have traditionally been examined in terms of the efficiency of transaction standards or infrastructural provisions, this study focuses on the potential capability of such systems to serve as alternate media for regular intra-organizational communication (as suggested in Flynn and Flynn 1999). Although prior experience may have a significant effect on subsequent perceptions of usefulness, we posit that the role of interdependence promoted by IPT should be clearly observable if prior experience is adequately accounted for.

Hypothesis 1: Managers are more likely to view the intra-organizational communication capabilities of resource planning systems as "useful" in environments with high levels of operational interdependence than in those with low levels.

2.4. The role of national culture

In contrast to task interdependence, attributes of national culture such as depicted by the Individualism-Collectivism (I-C) continuum reflect the level of social interconnectedness among individuals. Such cultural orientations tend to vary in systematic ways across both societies and individuals within those societies (Hofstede 1980; Earley and Gibson 1998). An important attribute of contexts characterized by a collectivistic character is that individuals within those contexts view and identify themselves as members of in-groups (cf. Triandis 1988), which tends to have systematic effects on social behavior within team settings (Earley 1989, 1993; Tajfel and Turner 1986). For individualists, personal interests are more important than the interests of the (in)group, as are the attainment of individual (as opposed to group) goals. In contrast, for collectivists, the interests of the group are paramount (Triandis 1989; Yamaguchi 1994). As noted by

Earley (1989), the “driving force within a collectivistic culture is cooperation so as to attain group goals and safeguard welfare” (p. 567). This can be observed largely in a *decreased* tendency towards social loafing (ie. the tendency for certain individuals in group settings to contribute less and rely on others more) in collectivistic cultures as contrasted to individualistic cultures.

Empirical research, dealing with the moderating effects of I-C on social loafing on one end of the performance continuum (Earley 1989, 1993), and the direct of effects of I-C on organizational citizenship behavior (Organ 1988) on the other end of the performance continuum (Moorman and Blakely 1995), support these characterizations of the behaviors of individuals within contexts dominated by individualistic or collectivistic cultures. In the same way that managers focus on contextual information that is familiar to them (Simon 1957), they not only develop limited views of reality which reflect their underlying culturally influenced value-orientation (Geletkanycz 1997), but also make decisions that are consistent with those values (Hambrick and Brandon 1988). Given the above characterization of managers in collectivistic contexts, it is reasonable to expect them to place a higher value on technologies that facilitate interconnectedness and cooperation between employees in their unit relative to managers in individualistic contexts.

Although researchers such as Tan et al. (1998) have shown that collectivistic cultures generally exhibit a reluctance to use computer-mediated communication due to fears that such use could lead to a questioning of majority interests, no direct research has actually demonstrated this to be true. We aim to dispel the myth of this overgeneralization by specifically focusing on the constructive nature of communicative capabilities in furthering the cause of collectivistic cultures (ie. performance improvement for the collective). Our second hypothesis therefore follows:

Hypothesis 2: Managers from collectivistic cultures are more likely to view the intra-organizational communication capabilities of resource planning systems as “useful” than those from relatively individualistic cultures

Collectivism has an added implication regarding management views of system usefulness. As noted above, individuals in contexts characterized principally by collectivistic cultural values will be more likely to expect cooperative behaviors from individuals in their in-group than individuals in more individualistic contexts. There is a higher level of social interconnectedness among in-group members in collectivistic contexts than in individualistic contexts (Hofstede 1980; Earley and Gibson 1998) as well as a greater emphasis on interpersonal harmony (Leung et al. 1992).

As a result, collectivists will be more likely to expect in-group members to be focused on the accomplishment of group (as opposed to individual) goals (Triandis 1989; Yamaguchi 1994); to have feelings of mutual dependence (Triandis 1988); and feel bound to one another by common goals, interests, and mutual commitment (Earley and Gibson 1998). Although there is some empirical evidence that the nature of interdependence relationships among tasks may affect self-definitions in the short-term (Breer and Locke 1965), these effects appear to be temporally bounded (Wagner et al. 1997). Therefore, given the general patterns of expectation regarding behavior, cooperation, and dependence among collectivists, it is reasonable to expect contextual information dealing with task interdependencies to be less relevant among evaluators from contexts influenced by collectivistic as opposed to individualistic values. This lower level of sensitivity to the interdependence of tasks in collectivistic culture is embodied in H3.

Hypothesis 3: National culture moderates the role of interdependence in shaping the views of managers regarding the “usefulness” of intra-organizational communication capabilities of resource planning systems.

2.5. Experiential controls

Established research has pointed out that additional factors key to forming views of technology capabilities involve both prior use of the IT in general and prior use of the specific capabilities of the technology being studied (Carlson and Zmud 1999; Venkatesh and Davis 1996; Hackbart et al. 2003). For example, managers with strongly negative previous experiences with a system type may carry a negative bias across contextual boundaries (Lyytinen 1988; Szajna and Scamell 1993). At the same time however, those with a greater understanding of the needs of specific operational contexts (eg. highly interdependent settings) and capabilities of specific systems have the potential for a more realistic view of the potential usefulness of the technologies in specific contexts (Anderson 1978; Ginzberg 1981; Maccoby 2003). In general, the idea that prior experience impacts perceptions of technology usefulness in other contexts remains compelling as illustrated by the popularity of Expectancy theory and the number of studies involving the focus on such antecedents (see, for example, Jackson et al. 1997). In examining the effect of context on usefulness of a technology, such prior experiences should be accounted for to help clarify the sources of effects in analysis. For completeness, we consider these issues as controls in later analysis along with a control for prior experience with highly interdependent contexts.

3. Methodology

3.1. Design and participants

To conduct our study, we solicited the participation of experienced managers enrolled in part-time programs at leading U.S. and Chinese business schools. The selection of subjects from the U.S. and China in particular was done to provide proxies of individualistic and collectivistic cultural orientations respectively. A breakdown of the demographics of our sub-samples is provided in the following table:

[Insert Table 1 about here]

An analysis of the demographic characteristics of the two samples was then conducted to identify any potential confounds to the study design. The results from an independent samples t-test revealed significant differences across the two samples with respect to: gender, years with most recent organization, # of direct reports, and # of indirect reports ($p < .05$). In order to determine whether these variables had systematic effects on the measured variables in the study, hierarchical regression analysis was conducted. These four variables were entered into a regression. Results from this analysis revealed no significant effects on the perceived impacts of ERP systems.

3.2. Experimental procedure

In both the U.S., and the PRC, subjects participated in a behavioral lab where they were randomly assigned to an interdependence condition (hi or low) taking the form of a written case. Once assigned, participants were asked not to communicate with one another, and were read a set of instructions wherein they were informed they were participating in a decision-making task, the goal of which was to examine

how supervisors operating under alternate cultural norms view ERP capabilities in specific contexts. To establish these contexts for evaluation, the written cases that the participants were exposed to involved variants of description of a production process in a cellular phone factory differing only in the extent to which task interdependency was depicted. To ensure the manipulation had its intended effect, we conducted pilot studies in both the PRC and U.S. to test it. Piloting in the PRC also involved check on the interpretation of the translated version of our definition of RP systems, questionnaire items and case, through the use of a professional translator. Responses from PRC subjects taking the translated version were compared against PRC nationals fluent in English who took the non-translated version, without significant distinctions observed. Furthermore, the overall results from both pilot studies indicated that the interpretation of the RP definition was consistent and that the manipulation produced the intended effects on perceptions of interdependence. The English version of the RP system definition and manipulation can be seen in Appendices A and C respectively.

3.3. Dependent variables

In order to develop a representative set of questions specifically aimed at a variety of mechanisms by which resource planning systems can be used as mediums for intra-firm data communication/exchange, we first developed a set of fourteen pilot items based on discussions of resource planning systems in an on-line practitioners' forum. This forum consisted of special interest group members of APICS (the American Production and Inventory Control Society). Twenty managers from this group were asked to rate the extent to which the pilot items represented feasible mechanisms for meaningfully communicating information in production settings. They were then asked to rate the percentage of firms that they believe have made use of resource planning systems in such a fashion. The distribution of these responses were then examined in terms of skewness along these pilot scales, as suggested by Converse and Presser

(1986), to increase the chances that a more select set of items used in the full study would provide appropriate breadth of scale delineation for statistical purposes. As a result of this procedure, items that did not tend to be viewed as feasible mechanisms were effectively dropped, as were items that were either consistently rated to be nearly in universal use or universally absent from consideration. The remaining five items would be used in both measuring views of system usefulness in prior personal contexts *as well as* in the subsequent experimental contexts (See bottom of Appendices B and C).

Our interests in this study specifically focus on the extent to which managers view resource planning systems as useful communication tools in increasingly interdependent contexts. Given our expectation that prior experience can impact these views, we pursue an experimental approach using a controlled manipulation of context (i.e., our experimental treatment: high vs. low interdependence) rather than relying on self-reports of on-the-job contexts. The use of a controlled experimental design (as recommended for example by Cook and Campbell (1979) for studies of work context distinctions) and the associated explicit control of the contextual independent variable allow us to mitigate risks of common source biases in our analysis as well as limiting the risks of other unknown exogenous effects in a section of our analysis. To help avoid risks of halo effects and hypothesis guessing on the part of the manager respondents, our design involved the collection of data in two separate phases. While the first was designed to gather preliminary demographic and control data (Appendix B), the second phase required subjects to review written case settings (our controlled contexts) and provide their assessments of the relative usefulness of communication capabilities of RP systems specifically in these contexts (Appendix C).

4. Data and analysis

4.1. Manipulation checks and descriptives

We used Van der Vegt and Janssen's (2003) five-item scale to measure task interdependence. Examples of these items include: Employees in this unit "...need information and advice from their colleagues to perform their jobs well," and "...need to collaborate with colleagues to perform their jobs well." Previous research using this scale has shown it to have acceptable reliability ($\alpha = .85$) (cf. Bachrach et al., 2006). To determine the manipulation's effectiveness, an independent-samples t-test was conducted. Results indicated that interdependence reported for the high (6.17, sd = .87) and low (4.21, sd = 1.70) conditions was significantly different, $t(302) = 12.58, p < .001$, and in the anticipated order.

Means, standard deviations, reliability estimates, and correlations across other key variables and controls considered in this study are reported in Table 1 for each treatment combination.

[Insert Table 2 about here]

It is important to again note that while the use of the 'task interdependence' scale to provide manipulation checks for our treatments is essential, given the fact that they are reported by the same individuals that provide the key dependent variable in our study (i.e. managerial assessed usefulness of RP systems), their use in the analysis of antecedents of our key dependent variable would be inappropriate due to the risk of halo effects and other forms of common-source bias. In later analysis we therefore conservatively rely on the fully controlled-for treatment levels as independent variables.

4.2 Hypothesis testing

Whereas our first hypotheses focus on the direct impact of contextual task interdependence as observable in the presence of experiential controls, our second and third hypotheses were designed to consider in turn the direct and moderating roles of national culture on management assess usefulness of ERP communicative capabilities. An evaluation of these effects involved a GLS (general least squares) approach to estimating management assessed usefulness by introducing the task interdependence treatment, national cultural orientation (ie. US vs. Chinese as proxies for individualistic vs. collectivistic comparisons) along with other experiential controls as predictors. GLS was specifically chosen to account for potential heteroskedasticity effects in our data. To assess the potential for moderating effects (H3), an additional interactive term (Interdependence x Culture) was also included. Since each of the independent variables and their combined interaction term are binary in form, it is not necessary to take additional corrective tactics (eg. mean centering) in such analysis (see Cohen et al. 2003: Chp 7). In our case additive and multiplicative effects are clearly distinguishable. This approach furthermore lends to a much clearer interpretation of the results in the regression form presented below. Additionally, while equivalent results could be generated through MANCOVA approaches to analysis, the format of such results do not lend themselves as easily to a discussion of the full interactive nature of the dependent variables.

[Insert Table 3 about here]

As illustrated by our results, the dynamics associated with low interdependence conditions differ markedly from those of the high operational interdependence condition. At the same time, culture provides

both a significant direct effect on management assessed usefulness as well as a moderating effect on the role of interdependence. Specifically, the specific collectivistic culture studied (i.e., Chinese) seems to be less sensitive to changes in perceived interdependence when it comes to judging the importance of ERP communicative capabilities. A clearer and more direct contextual contrast is provided by a simple graphical effect comparison (Figure 1).

[Insert Figure 2 about here]

In addition to providing support for all three of the main hypotheses, these results also help emphasize the role of alternate experimental controls (i.e., past management observed usefulness, familiarity with RP systems in general and past experience with interdependent contexts). In the high interdependence context, these controls contributed 23% of the total variance accounted for. The immediate implication for research is the criticality of accounting for such priors in analysis, since neglecting to do so might severely skew contextual effects, thus leading to overstated implications. For practitioners, firms hiring outside managers or making major organizational changes need to deal with the reality of lingering priors if they intend to take greater advantage of their technologies.

5. Discussion

These results provide support for the study hypotheses and suggest that the effects of task interdependence on perceptions of the importance of ERP communicative capabilities may be moderated by culture. In particular, in the U.S., the perceived importance of these capabilities may depend largely on task interdependence such that ERP systems are recognized as being more important for intra-

organization communication in contexts characterized by higher levels of task interdependence. Conversely, in the PRC sample, there was relatively little effect of task interdependence on the importance attributed to ERP communication capabilities, where in both treatment conditions such capabilities were perceived to be of nearly equivalent importance.

With reference to the existing research literature, these findings provide a unique contribution to understanding the significance of contextual, cultural and experiential influence on the kind of managerial support that is assumed to be so critical in technology adoption and diffusion among workers. It extends existing applications of information processing theory by showing how informational needs posed by such theory in specific (ie. collectivistic or highly task-interdependent) contexts can be used to suggest influences on managerial views. The findings thus provide a potentially powerful link between IPT and alternate theoretical frameworks involving managerial support as antecedents of successful technology application (eg. Eder and Igbaria 2001; Zmud 1984).

Our results also have interesting implications for the burgeoning ERP market in China, not to mention other national settings in which high levels of collectivism are the norm. If managers in China (as compared to their U.S. counterparts) can be characterized as highly enthusiastic of the communication capabilities provided by ERP systems regardless of the extent to which internal processes are interdependent, then the business cases that support ERP adoption and extension should be expected to emphasize the benefits of such capabilities. In particular, this emphasis should be much greater and more clearly delineated than those developed in the U.S. on average. With the myriad of bolt-ons now available to ERP architectures, one would imagine choices related to bolt-on adoption to be similarly biased. Ultimately, the prototypical characteristics of extended ERP architectures may become so distinct that they

give rise to competitive opportunities (Bendoly and Jacobs, 2005) out of reach of engrained U.S. socio-technological architectural designs.

In light of the potential significance of these findings it is relevant to scrutinize the potential limitations of the current work. In the design of this study, several precautions were taken to limit the role of exogenous factors in the analysis. Prior experience with resource planning systems, interdependent settings and existing views of the usefulness of these systems were included to help account for potentially significant sources of variation. The general experimental design in which respondents are exposed to one of two conditions (high vs. low interdependence cases) provided a critical level of control for delineating the effects studied, reducing the risk of halo effects associated with common source bias. However, regardless of the precautions taken in this study, the results and phenomena suggested should be carefully interpreted. Although the effectiveness of our experimental manipulation was validated statistically (Cook and Campbell 1979), the contexts considered in these treatments may not provide meaningful comparisons that can be extended to certain alternate manufacturing and service settings. Furthermore, the choice of the manufacturing settings used in our treatment cases may have created unanticipated biases in interpretation that subsequently influenced the results.

An added limitation may come from our specific operationalization of concepts in this study. For example, while we base our measure of interdependence (used in our manipulation checks) on the work of Van de Vegt and Jansen (2003), alternate scales (eg. McCann and Ferry 1979; Wybo and Goodhue 1995) may have yielded somewhat modified results. While our results do not suggest that this was an issue in distinguishing our treatment contexts, further studies might be strengthened by the incorporation of multiple views of such widely applied concepts.

Another possible limitation has to do with the selectivity of the sample studied. Convenience sampling has been viewed as an acceptable approach in recent OM studies (see for example Hausman, Montgomery and Roth 2002; Schultz et al. 2003) due in part to the benefits of increased internal validity and control from such selection (Hoyle, Hausman and Judd 2002). These added benefits were particularly relevant to this study since the timing and control of the experimental treatments was necessary to ensure the interpretability of the results. Nevertheless, it should be recognized that such an approach may imply sample biases that limit the robust application of results – i.e., much in the same way that the initial selection of many survey target-populations limit interpretation. Future work with alternative samples should be conducted to further validate or refine the results described here.

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Appendix A: Definition of RP systems accompanying each phase of the study

A resource planning system is one of a set of related information technologies (eg. ERP, MRPII, etc.) that provides standardized interfaces for the entry and retrieval of data relating to both within-day and long-term operating horizons. The associated database contains all information relating to the monitoring of inputs, outputs, resources and process descriptors (eg. status, schedules, pre-requisites, etc.) for a range of activities managed. The system ensures that such information may be visible and available to all workers affiliated with these activities.

Note: This definition was based off of recent personal experience with the implementation of such systems, the past specifications of Davenport (2000), Chase et al. (2001) and Mabert et al. (2003), as well as on direct discussions of such a general definition with several of these authors.

Appendix B: Questions administered prior to case summaries and follow-ups

- 1a. Gender: M / F
 2a. Age: _____
 3a. Years of Education: _____ (e.g., BA, MBA, etc.)
 4a. Country of birth: _____
 5a. First language: _____
 6a. Years of full-time work: _____
 7a. Industry in which you are currently employed: _____
 8a. Years with current organization: _____
 9a. Current job title: _____
 10a. Number of years in current position: _____
 11a. Number of employees for whom you have had supervisory responsibility: *Direct*: _____ *Indirect*: _____
 12a. Number of months that you have spent in a supervisory capacity of some kind: _____

Please rate the extent to which you agree with the following statements about employees in the production unit just described, using the scale below.

1	2	3	4	5	6	7
highly disagree	moderately disagree	slightly disagree	neither agree nor disagree	slightly agree	moderately agree	highly agree
<u>13a. I have extensive on-the-job experience using ERP systems (Enterprise Resource Planning systems such as those developed by SAP, People Soft, etc.; Resource planning systems that provide access to transactional, planning and scheduling data among multiple functional areas including manufacturing, marketing, sales, purchasing, accounting, human resources, etc.).</u>						
<u>14a. I have extensive on-the-job experience using MRPII systems (Manufacturing Resource planning systems that provide access to planning mechanisms and scheduling data relating to materials and manufacturing capital and resources, but little data regarding other functional area activities).</u>						
<u>15a. I have extensive on-the-job experience using MRP systems (Materials Requirements Planning systems that provide access to planning mechanisms and scheduling data relating to material inputs, but little information regarding equipment, staff schedules or other functional area activities).</u>						

Based on your prior work experience, please indicate your agreement with the following statements regarding the extent that resource planning systems are used to facilitate each of the following activities (7 point scale as above)

Based on your prior work experience, planning systems are frequently used in...

- 16a. The communication of production requirements among employees.
17a. The communication of production recommendations among employees.
18a. The identification of production problems and issues by employees.
19a. Goal-oriented production planning and collaboration among employees.
20a. Production activity coordination and scheduling among employees.

Appendix C: Experimental cases and questions administered in second phase

Case summary for Low Interdependency conditioned sub-sample:

A production unit in a small factory produces a single cellular phone model for Nokia. Each of the ten members of the production unit is responsible for one of ten sequential operations. Factory policy allows large buffer stocks of work-in-process to be maintained between operations. Although all ten individuals are required to work eight hours each day, they can begin and end their activities according to a flexible work schedule because of the buffer-stock policy. Workers at this factory do not have to communicate information regarding color, stock, or equipment to each other because the phone that they make leaves the factory in only one color, cabinet style, and functionality package. All of the workers at this factory have their own equipment, and so do not have to coordinate their use of production facilities. Over the last several years, neither the product design nor the production process has changed.

Case summary for High Interdependency conditioned sub-sample:

A production unit in a small factory produces several cellular phone models for Nokia. The ten members of the production unit rotate responsibility for each of ten sequential operations. Factory policy allows no buffer stocks of work-in-process to be maintained between operations. Although the unit's members are required to work eight hours each day, they must work together to determine work schedule because of the buffer-stock policy. Workers at this factory have to communicate information regarding color, stock, and equipment to each other because the phone that they make leaves the factory in five colors and cabinet styles with ten functionality packages. Because half of the workers at this factory share equipment, they have to coordinate their use of production facilities. Over the last several years, both the design of the product and the production process have changed extensively.

Please rate the extent to which you agree with the following statements about employees in the production unit just described, using the scale below.

1	2	3	4	5	6	7
highly disagree	moderately disagree	slightly disagree	neither agree nor disagree	slightly agree	moderately agree	highly agree
<u>1b. Employees in this unit need information and advice from colleagues to perform their jobs well.</u>						
<u>2b. Employees in this unit have a one-person job; it is not necessary for them to coordinate or cooperate with others.</u>						
<u>3b. Employees in this unit need to collaborate with colleagues to perform their jobs well.</u>						
<u>4b. Employees in this unit need information and advice from one another to perform their jobs well.</u>						
<u>5b. Employees in this unit regularly have to communicate with colleagues about work-related issues.</u>						

Based on the production facility just described, please indicate your agreement with the following statements regarding the potential usefulness of resource planning systems in facilitating the following activities.

In the production facility described above, resource-planning systems would be useful in...

- 6b. The communication of production requirements among employees.
- 7b. The communication of production recommendations among employees.
- 8b. The identification of production problems and issues by employees.
- 9b. Goal-oriented production planning and collaboration among employees.
- 10b. Production activity coordination and scheduling among employees.

Table 1. Demographics of the two sub-samples used in analysis

	U.S. Sample <i>(Proxy for individualistic culture)</i>	PRC Sample <i>(Proxy for collectivistic culture)</i>
Sample size (N)	154 <i>(Male 79%, 91% US born)</i> <i>(89% English 1st language)</i>	150 <i>(Male 67%, 99% PRC born)</i> <i>(98% Chinese first language)</i>
Average Age	28.87 (std.dev. 2.79)	29.15 (std.dev. 2.44)
Yrs of Graduate Educ.	1.05 (std.dev. 0.66)	1.03 (std.dev. 0.32)
Yrs Full Time Work	6.04 (std.dev. 3.49)	6.05 (std.dev. 2.46)
Yrs with Most Recent Organization	3.35 (std.dev. 2.29)	4.31 (std.dev. 2.59)
Yrs in Most Recent Job Position	2.03 (std.dev. 1.24)	2.10 (std.dev. 1.33)
Avg number of Individuals...		
...directly supervised	4.55 (std.dev. 6.77)	6.85 (std.dev. 10.60)
...indirectly supervised <i>(by respondent)</i>	10.55 (std.dev. 17.59)	25.71 (std.dev. 53.89)

Table 2. Correlations between the key dependent variable and experiential controls by treatment

		Low Interdependence					High Interdependence				
		Mean (SD)	1	2	3	4	Mean (SD)	1	2	3	4
Individualistic Culture	1 Management assessed usefulness of RP systems [main dependent variable studied]	5.75 (1.09)	<i>(0.87)</i>				6.10 (0.85)	<i>(0.84)</i>			
	2 Management past observed usefulness of RP systems [experiential control]	4.79 (1.25)	0.44**	<i>(0.86)</i>			4.78 (1.41)	0.47**	<i>(0.82)</i>		
	3 Management familiarity with resource planning systems [experiential control]	3.56 (1.51)	0.14	0.22*	<i>(0.8)</i>		3.40 (1.64)	0.14	0.36**	<i>(0.83)</i>	
	4 Management experience with highly interdependent task settings [experiential control]	4.71 (1.02)	0.09	0.02	0.04	<i>(0.87)</i>	4.62 (1.11)	0.15	0.05	0.14	<i>(0.81)</i>
Collectivistic Culture	1 Management assessed usefulness of RP systems [main dependent variable studied]	4.94 (1.42)	<i>(0.87)</i>				5.92 (0.90)	<i>(0.84)</i>			
	2 Management past observed usefulness of RP systems [experiential control]	4.01 (1.32)	0.59**	<i>(0.85)</i>			4.43 (1.17)	0.66**	<i>(0.8)</i>		
	3 Management familiarity with resource planning systems [experiential control]	3.85 (1.16)	0.10	0.32*	<i>(0.8)</i>		3.92 (1.31)	-0.04	-0.01	<i>(0.85)</i>	
	4 Management experience with highly interdependent task settings [experiential control]	3.36 (1.84)	0.07	0.07	0.13	<i>(0.84)</i>	3.27 (1.95)	0.16	0.10	0.20	<i>(0.82)</i>

Note: Chronbach (α) reliability estimates appear in parenthesis in italics along the diagonals

** $p < 0.01$ one-tailed, * $p < 0.05$ one-tailed

Table 3. Regression results and tests of hypotheses

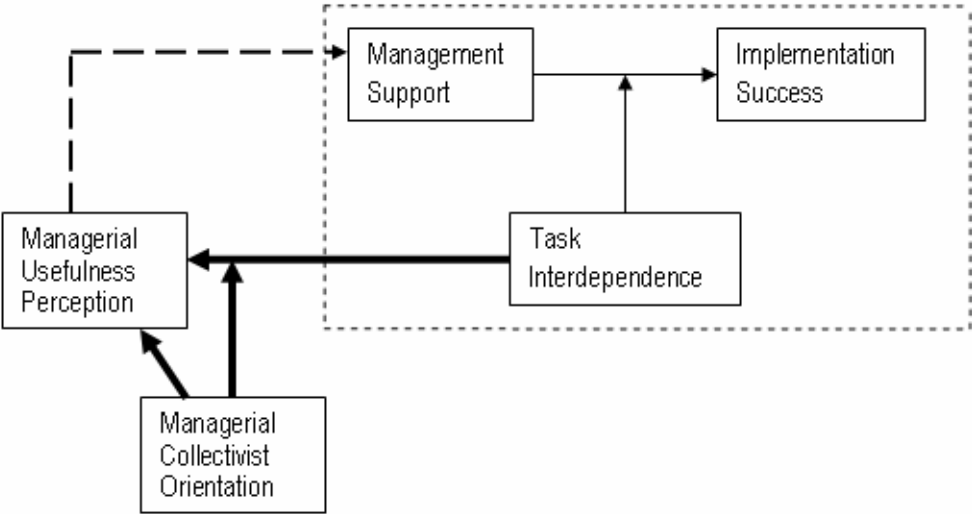
**Dependent Variable: Management assessed usefulness of RP systems
in the Experimental Contexts**

	Parameter Estimates	Standard Error	Significance (p-value)
Constant	3.64	(0.23)	0.00
Interdependence (High =1) : [H1]	0.35	(0.15)	0.02
National Culture (Individualistic = 1) : [H2]	-0.49	(0.16)	0.00
Culture x Interdependence : [H3]	0.45	(0.22)	0.04
<hr/>			
Management past observed usefulness of RP systems [experiential control]	0.45	(0.04)	0.00
Management familiarity with resource planning systems [experiential control]	-0.05	(0.07)	0.47
Management experience with highly interdependent task settings [experiential control]	0.02	(0.05)	0.72
	R²	0.386	

Unstandardized coefficients provided above

*** p < .01, one-tailed, * p < .05, one-tailed*

Figure 1. Extension of Sharma and Yetton's (2003) model



- Notes to Figure 1:
- 1. Model in dashed box is Sharma and Yetton's (2003) model.
 - 2. Relationships shown in bold are hypothesized and tested in the current research.
 - 3. Relationship shown in dashed line is implied but not hypothesized or tested here.
- * We would like to acknowledge the recommended use of the above presentation by one of our reviewers

Figure 2. Average Management Assessed Usefulness across main independent variables

