Enterprise-Level Packaged Software Adaptation: An Empirical Study of Firm-Initiated and Vendor-Initiated Strategies

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Abstract

This paper empirically investigates the relationship between two IT adaptation strategies: firm-initiated and vendor-initiated adaptation, and managerially reported levels of satisfaction with information technology performance. It does so in the context of 60 implementations of Customer Relationship Management information technology. Firm-initiated adaptations originate with the implementing firm during the implementation process. Two types of firm-initiated IT adaptation are investigated: database modification, and software functionality modification. Vendor-initiated adaptations originate with the producer of the software package: the software vendor. These adaptations frequently take the form of versions of the software package that are designed to address the specific needs of particular industries. This paper also investigates whether firms' use of vendor-adapted software versions is related to lower levels of firm-initiated adaptation.

Findings suggest that database modification, when used in moderation, leads to improvements in satisfaction. However, excessive database modification can reduce satisfaction, leaving the firm no better off than if it had minimized this kind of adaptation in the first place. No evidence is found to support the notion that software functionality modification yields improvements for the measured outcome. Findings also support the assertion that the use of vendor-adapted software versions leads to increased satisfaction. In contrast, however, companies that use these vendor-adapted software versions do not demonstrate lower magnitudes of firm-initiated adaptation.

Taken together, the findings suggest a contingent view of IT adaptation strategies. Adaptation type and magnitude interact to differentially influence satisfaction. Managers can use these findings to better evaluate when and how to use IT adaptation strategies. Researchers can build on these findings to further improve an understanding of how and in what circumstances IT adaptation influences performance.

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1. Introduction

Enterprise-level information systems are the information technologies (IT) that firms use to support their core business processes, such as order management, finance, and logistics processes. Well-known examples of these technologies include Enterprise Resource Planning systems, Customer Relationship Management systems, and Supply-Chain Management systems. The firms that implement these systems to support their business processes, almost inevitably, face a difficult decision early in the implementation process. To what extent should the information technology be adapted to fit existing business processes?

The question of whether adaptation should be undertaken is important for several reasons. First, enterprise-level information technologies are often purchased in the form of software packages. These packages are created to support the requirements of a wide variety of firms, and so may not perfectly address specific needs of individual businesses. Thus, firms may perceive a need to adapt the technology in order to achieve a better fit.

Second, the stakes are high. In 2001 alone, firms were expected to invest more than $47 billion in enterprise-level IT (AMR 2001). Billions of additional dollars were invested in the services and computer hardware required to implement and maintain these systems (Mabert et al. 2000; Willcocks et al. 2000). The firms that make these investments would presumably want to take all the steps necessary to maximize the benefits that accrue from them.

Third, implementation failure rates are high (Austin et al. 1998). When failures do occur, results can be dramatic. The ERP implementation cases of Nike, Inc. (Konicki 2001; Songini 2001) and Hershey Foods Corporation (Stedman 1999a; 1999b) represent two high-profile examples of the operational and financial consequences of poorly implemented enterprise

systems. In response to these failure rates, firms may reasonably seek to avoid those actions that will lead to increased implementation risk.

This paper empirically investigates the relationship between two IT adaptation strategies: firm-initiated and vendor-initiated adaptation, and managerially reported levels of satisfaction with information technology performance. It does so in the context of 60 implementations of Customer Relationship Management (CRM) information technology. Firm-initiated adaptations originate with the implementing firm during the implementation process. Two types of firm-initiated IT adaptation are investigated: database modification, and software functionality modification. Vendor-initiated adaptations originate with the producer of the software package: the software vendor. These adaptations frequently take the form of versions of the software package that are designed to address the specific needs of particular industries. This paper also investigates whether firms' use of vendor-adapted software versions is related to lower levels of firm-initiated adaptation.

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Taken together, the findings suggest a contingent view of IT adaptation strategies. Adaptation type and magnitude interact to differentially influence satisfaction. Managers can

use these findings to better evaluate when and how to use IT adaptation strategies. Researchers can build on these findings to further improve an understanding of how and in what circumstances IT adaptation influences performance.

This paper proceeds as follows. The next section briefly reviews the literature on the subject of IT adaptation, and proposes three hypotheses to be tested. Section 3 describes the technology context in which the study took place and the data that were used in its execution. Section 4 presents the results of the statistical analysis. Section 5 discusses the results.

2. Literature Review and Hypotheses

Investments in enterprise-level information technologies often take the form of a software package purchase from a third-party supplier. These packages are developed by software vendors who embed within them an implicit view of the way business processes should work (Austin et al. 1998; Davenport 1998; 2000; Upton et al. 2000). These software-embedded views are based upon the vendor's perceptions of what constitutes "best practice" for their customers' business processes. Manifestations of these perceptions within the software package may be simple – as in the determination of the number of characters needed to capture part numbers – or complex – as in the ways in which pricing can be calculated for products and services.

Despite the efforts of software vendors to embed best practices, gaps frequently arise between the requirements of firms' business processes and the functionality provided by the IT. These process-technology gaps have alternatively been referred to as misfits (Soh et al. 2000), discrepancies (Lucas et al. 1988), and misalignments (Leonard-Barton 1988). Process-technology gaps have been argued to have a negative influence on the implementation success of specific types of IT such as Materials Requirements Planning (Cooper et al. 1990), Decision Support Systems (Vessey 1991), and Group Support Systems (Zigurs et al. 1998). They have

also been identified as negatively influencing implementation success in more general studies of IT (Goodhue et al. 1995), and even more broadly, in general technology surveys (Tornatzky et al. 1982).

2.1 Firm-initiated Adaptation

Firms that are confronted with process-technology gaps may choose to address them using strategies that incorporate both business process and technology change. Business process change, especially in the context of IT implementation, has been extensively cited as a means for delivering substantial performance improvements (Davenport 1993; Davenport et al. 1990; Hammer et al. 1993; Scott Morton 1991). Some researchers, however, argue for conservatism in this area. If the activities that make up the business process comprise a key source of competitive advantage, then their alteration or abandonment may represent a strategically risky decision (Porter 1996). Where process change is warranted, researchers have advocated a balanced approach (see, for example, Leonard-Barton 1988). Firms are expected to benefit more from a mutual adaptation strategy in which the implementing firm both alters business process and modifies IT in order to reduce gaps between the two (Lassila et al. 1999).

In contrast to the study of business process change, there is less research that addresses the efficacy of firms' attempts to close process-technology gaps through technology adaptation. In one notable exception, Leonard-Barton (1988) studied 12, primarily custom developed, technology implementations. Leonard-Barton pointed out firm-initiated technology modification examples that worked well, and that worked poorly. Within the packaged software domain, research has been conducted that advocates software adaptation in order to enhance the fit and performance of Electronic Data Interchange (EDI) (Paulson 1993) and Materials Requirements

Planning (Neeley et al. 1991) applications. This paper builds on these findings in an attempt to provide guidance on the general effectiveness and limits of technology adaptation strategies.

In contrast to the literature, software vendors tend to discourage firm-initiated adaptation of their products. In some circumstances, they may even withdraw technical support for the product if it is altered significantly. Vendor resistance to firm-initiated adaptation arises for several reasons: 1) deviation from the best practices embedded in the software may impede implementation success. Vendors may believe that, as developers of the software package, they have the best perspective on how it should be implemented (Rogers 1995); 2) the complexity of the software package makes firm-initiated adaptation strategies difficult. In the face of this complexity, customers may generate unintended negative consequences when modifying the software (e.g., changing a piece of functionality or data that is relied upon for a different function); 3) firm-initiated adaptations create impediments to future software upgrades. Changes made by implementing firms to the earlier version may create conflicts that delay or prevent the upgrade process (see, for example, Leonard-Barton 1988).

The current state of knowledge around firm-initiated IT adaptation approaches creates a conflict. The literature suggests that such adaptations can represent a viable strategy for closing process-technology gaps. Information technology vendors disagree, stating that firms should not initiate these adaptations. At stake is a significant driver of the financial and operational performance of the firms that, collectively, are investing billions of dollars in these technologies, and are often using them to support mission critical processes. This paper attempts to shed light on this conflict by first testing for the existence of the relationship implied by the literature.

Hypothesis 1: Information technology performance will improve as the magnitude of firm-initiated software adaptation increases.

A distinction is made in the testing of this relationship between the number of adaptations and the magnitude of adaptations. Magnitude refers to the extent to which the software was adapted, not the total number of changes made. We explicitly chose magnitude as our measure for two reasons. First, all adaptations may not be equal in complexity or effect. For example, a firm might make many simple changes, such as adding a set of data elements to be used for simple record keeping. Alternatively, the firm might make a single modification that radically changes some aspect of the software. Second, it is difficult to discern what constitutes a single change versus multiple instances of adaptation.

2.2 Vendor-Initiated Adaptation

Despite objections to firm-initiated adaptations, software vendors are sensitive to calls for a closer fit between their software packages and the specific needs of businesses. In some cases, vendors respond to these calls by adapting their package to the needs of a particular, influential, client. More often, vendors adapt their products in order to create industry-specific versions of the software.[1]

For example, Siebel Systems, Inc., the leading provider of CRM systems, offers industry-specific versions of its software in many markets, including: automotive, financial services, life sciences, and communications. Special adaptations have been incorporated in Siebel's eAutomotive version, for instance, in order to facilitate vehicle configuration by fleet salespeople, and to ease the preparation of price quotes, sales proposals, and presentations. All of these adaptations are based on the automotive industry's unique requirements.

Similarly, Siebel's eFinance package emphasizes functionality that allows financial institutions to analyze customer data from across multiple sales channels (e.g., branch, telephone,

internet) and service lines (e.g., brokerage, insurance, banking). Seibel is unambiguous about its motivation for pursuing these types of industry-specific adjustments to its software:

> eFinance allows organizations to reduce customization and maintenance costs, shorten implementation time, and lower risks, while increasing share of wallet and long-term customer satisfaction.[2]

Vendors anticipate that versions of the software package that are adapted to meet the industry-specific needs of potential clients will create a better fit than is available from the standard version of the software package. This improved fit is expected to result in better IT performance for these firms, motivating the following hypothesis:

> Hypothesis 2: Implementers of industry-specific software versions will experience higher levels of information technology performance than implementers of standard versions.

In addition to higher levels of performance, firms that use industry-specific software versions are expected to initiate fewer adaptations than firms that use standard software versions. If the use of industry-specific software versions results in improved process-technology fit for firms, then there should be fewer process-technology gaps to close relative to instances where standard software is used. Thus, we test the following hypothesis:

> Hypothesis 3: Implementers of industry-specific software versions will attempt firm-initiated adaptations less than implementers of standard software versions.

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[1]Vendors often refer to industry-specific software versions as *vertical solutions,* in contrast to the standard package version that may be referred to as a *horizontal solution.*

[2] Source: Siebel Systems, Inc. website, January 10, 2002. URL http://www.siebel.com/products/industries/financial/product_medule_descr.shtm

We note that this paper investigates the relative advantages of industry-specific versus standard software versions across multiple industries rather than within a single industry. There is, therefore, a possibility that our findings for this hypothesis speak to differences between industries, and their ability to implement and use the IT, rather than to differences in the software itself. This risk is particularly significant in this study because adoption rates of industry-specific software versions average approximately 85 percent in the industries for which they are available. We address this issue in the discussion of our results.

In summary, this research tests relationships between three sets of measures representing firm-initiated adaptation, vendor-initiated adaptation, and IT performance satisfaction. Figure 1 illustrates the hypothesized relationships. The next section describes the data collection approach, including the research context, used to investigate our hypotheses.

Insert Figure 1 About Here

3. Data Collection

3.1 Research Setting

Data were collected from 60 randomly and anonymously selected implementations of Siebel Systems, Inc. CRM software. CRM software ties together multiple business processes in what is often thought of as the "front office" of the business: the processes through which the firm interacts with its customers. Common applications of the software include sales force automation, call center management, marketing program management, and field service management.

We selected CRM as our research setting for three reasons. First, these systems exhibit many characteristics that have been identified as promoting technology modification during implementation.[3] Second, CRM systems offer firms the implicit choice of adaptation strategies for improving the fit between information technology and business processes. And, third, CRM systems account for a sizable portion of firm IT investment, with spending on application licenses estimated at $15 billion for 2001 (AMR 2001).

3.2 Satisfaction with Information Technology Performance

Data on performance were drawn from quarterly surveys of both business and information technology managers responsible for the 60 Siebel implementations that were studied. Survey responses were collected for the quarter ended March 30, 2001. This selection approach resulted useable performance data on 46 firms (77 percent response rate). An average of 1.7 responses were received from each of the firms for which data were available.

The outcome of interest for this paper is managers' satisfaction with the performance of the information technology. Satisfaction with information technology has been linked to improved operational and economic performance (Bailey et al. 1983), implementation success (Bailey et al. 1983; Galletta et al. 1989), quality of work life, and information technology utilization (Galletta et al. 1989). Measures of information technology satisfaction are broadly accepted and used, both as complements to more objective analyses of information technology effects (Hamilton et al. 1981), and as measures of software products' utility to the firms that use them (Ravichandran et al. 2000).

[3] Rogers (1995) defines these characteristics to include the following: 1) High product complexity; 2) Tendency for adopters to lack full knowledge about the technology; 3) Characterization as an abstract concept or tool (like computer software programs); 4) Application to a wide range of user problems; and 5) Existence of local pride of ownership.

In adopting satisfaction as our measure, we note that a high level of satisfaction does not necessarily translate to either perceived or objective increases in the operational or financial performance of the firm. However, a focus on satisfaction mitigates concerns about managers' biasing performance assessments in order to appear more successful (Levitt et al. 1988), by instead focusing on their contentment with the performance of the applications. Furthermore, measurement of satisfaction also mitigates concerns that the performance of the associated business processes prior to implementation influences the assessment of performance subsequent to the implementation.[4] Use of a satisfaction measure allows managers to implicitly consider these types of factors when making their assessments. Of course, this approach does not control for unreasonable expectations on the part of managers. This limitation should be kept in mind when interpreting results.

Four survey items were used that related to managers' satisfaction with the performance of the information technology. The four items include assessments of manager's satisfaction with the application's overall ease of use, effectiveness, reliability, and speed.[5] Ease of use and effectiveness have received widespread attention in the literature as the focus of study in their own right (Montazemi et al. 1996; Venkatesh 2000), as predictors of IT usage (Taylor et al. 1995), or both (Adams et al. 1992; Davis 1989).[6] Speed (i.e., the response time of the application) and reliability are also frequently used as outcomes in information technology research, both as objects of analysis (Okumoto 1985; Schuff et al. 2001; Westland 2000) and as

[4] For example, it may be easier to demonstrate significant improvement, in percentage or absolute terms, for a process with relatively poor initial performance, than for a process with relatively good initial performance.
[5] The limitation to four scale items is appropriate given the sample size we were working with (Tinsley et al. 1987).
[6] Effectiveness represents essentially the construct measured by Davis (1989), among others, as usefulness, and by Rogers (1995), as comparative advantage. In this sense, it is intended to measure the extent to which use of the technology facilitates improved execution of the firm's business processes.

contributors to the development of performance scales such as the one used here (see, for example, Bailey et al. 1983; Galletta et al. 1989; Ravichandran et al. 2000).

The appropriateness of the four selected items for combination into a single scale was evaluated by checking the five attributes suggested by Tinsley, et al (1987). These attributes include the composition and significance of the data matrix, sample size, and association (i.e., correlation) and independence of items. The survey items were deemed appropriate in each respect.

The four survey items were subsequently subjected to principle components analysis with varimax rotation. All four items loaded with values between 75 and 86 percent on a single factor, which we conceptualized as information systems performance satisfaction. Other potential factors were evaluated and excluded through a check of their eigenvalues to see if they were greater than one, and through the evaluation of a screeplot (Tinsley et al. 1987). The reliability of this potential scale was tested through a calculation of Cronbach's Alpha, which returned a value of 75 percent, greater than the 70 percent deemed acceptable for this kind of analysis (Nunnally et al. 1994). Given the prevalence of a single factor, and the adequate reliability of the four-item scale, a composite satisfaction score was created by calculating a mean of the ratings for each item. Analysis and results presented in this paper use this scale.[7]

3.3 Firm-Initiated Adaptation

This paper focuses on two types of firm-initiated IT adaptations: database modification and software functionality modification. The process-technology gaps these modifications address are among the most difficult for firms to accommodate (Soh et al. 2000). Database gaps

[7] As a check, results were also calculated using a scale developed from the results of the factor analysis. Findings from that analysis are identical to those presented here.

arise from incompatibilities between the firm's needs, and the format and relationships among data entities provided in the package's underlying data model.[8] Functionality gaps represent mismatches between the firm's business process needs and the package's processing approach (Soh et al. 2000).

Database and software functionality adaptation data were gathered from a survey of the Siebel Systems, Inc. Technical Account Managers associated with each implementation. Technical Account Managers are responsible for the overall technical and process coordination of the implementation projects to which they are assigned. In this capacity, they have visibility into firms' implementation efforts and how they compare to one another. They were, thus, in a better position to judge the relative magnitude of modification than the firms that actually implemented the software. Use of TAMs to assess the magnitude of firm-initiated adaptation also reduced the risk of a single-method bias in which either TAM or managerial a priori perceptions of the link between firm-initiated adaptation and IT performance could influence survey responses.

TAMs were asked to rate the overall magnitude of firm-initiated adaptations on a five-point Likert scale ranging from 1 (very small) to 5 (very large). These assessments were grouped into three roughly balanced categories representing Low (1-2), Moderate (3), and High (4-5) magnitude modifications. Data were successfully collected for 50 implementations (83 percent response rate).[9]

[8] More information on the data models underlying Customer Relationship Management and other kinds of enterprise-level IT can be obtained from Cotteleer (2001).

[9] Although no information was available on the degree of modification exercised by the unrepresented firms, testing was performed to see if early respondents differed from late respondents, on the grounds that late respondents would be most like non-respondents (Armstrong et al. 1977). T-tests performed on the first 25 percent and the last 25 percent of the responses received revealed no significant difference in the magnitude of modifications performed ($p<.10$).

3.4 Vendor-Initiated Adaptation

Data on vendor-initiated adaptation were anonymously collected from Siebel records. For each implementation on which performance data was collected, data were also sought on whether the firm implemented a standard or industry-specific software version.

3.5 Implementation Context

Success with the implementation of information technology can depend on many factors beyond the extent to which the technology is adapted. In particular, the context in which the implementation takes place can have a substantial effect (Brynjolfsson et al. 1998). Contextual data were collected from the same survey of business and information technology managers that was used to collect the satisfaction data. This paper considers three categories of contextual variables that might be expected to moderate the relationship between information technology adaptation and satisfaction: initial process-technology fit; perceived adaptability of the applications, and ongoing technical supportability.

Initial process-technology fit assesses the extent to which managers perceived that the non-adapted software package met the business needs of the implementing firm. *Perceived adaptability* addresses the possibility that satisfaction might be influenced by technical attributes that are not directly linked to business requirements. These attributes might include the ease with which the information technology can be configured and the ease with which it can be integrated with other information technologies already resident within the firm. *Ongoing technical supportability* accounts for the possibility that satisfaction with the information technology might be influenced by factors relating to the ongoing technical maintenance of the applications. These factors might include the ease with which the applications can be kept up and running, the ease with which use of the technology can be extended (i.e., scaled) to

additional users and higher transaction volumes, and the quality of supporting technical documentation.

In addition, there are many other contextual factors that are potentially important in explaining the relationship between information technology and satisfaction. These might include factors such as training and deployment strategies, change management approaches, use of third-party implementers, and top management commitment, to name a few. However, the adaptation of information technology might be categorized as a technical undertaking. As such, in the interest of parsimony, we chose to emphasize more technically oriented factors in this model. This emphasis should be kept in mind when interpreting the findings of the model. Future research might consider the influence of less technical implementation characteristics on the relationship between adaptation and information technology performance.

3.6 Variable Definitions

The variables that were used in the analysis are summarized in Table 1 and described as follows.

Information technology performance was measured using the variable **satisfaction**. This variable is a composite of four items that asked managers about the ease of use, effectiveness, reliability, and speed of the information technology. Each underlying item was measured on an 11-point Likert scale. The composite measure is a mean of these four items for the firm.

Database modification, the first of the two firm-initiated adaptation strategies studied, was operationalized using four variables.[10] The first three are the indicator variables **db_low**, **db_med**, and **db_high**. These variables were set equal to 1 when database modification

[10] Database modification refers to changes in the tables, columns, and joins that make up the underlying data structure of the software applications.

magnitudes were low, medium, or high, respectively.[11] The fourth variable, **db**, represents the same data categorically on a scale of 1 (low magnitude) to 3 (high magnitude)

Software functionality modification, the second of the two firm-initiated adaptation strategies studied, was also operationalized using four variables. The first three are the indicator variables **fun_low**, **fun_med**, and **fun_high**. These variables were set equal to 1 when software functionality modification magnitudes were low, medium, or high, respectively.[12] The fourth variable, **fun**, represents the same data categorically on a scale of 1 (low magnitude) to 3 (high magnitude)

The use of a vendor-adapted software package was captured using the indicator variable **specific** to identify implementations that used industry-specific software versions. The indicator variable was set equal to 1 when an industry-specific version of the software was used.

Contextual factors were operationalized using six variables. Each was measured using an 11-point Likert scale. Initial process-technology fit was captured using a single variable **functionality**. Perceived adaptability was captured using two variables: **integration** to assess the ease with which the technology could be integrated with the existing information technology infrastructure, and **configuration** to assess the ease with which the implementing firm was able to configure the software package. Ongoing technical supportability was captured using three variables: **sysad** to assess the ease with which the applications could be kept running on a day-to-day basis, **scalability** to assess the ease with which the usage base of the application, in users or transaction volume, could grow, and **qualdoc** to assess the quality and usability of the technical documentation provided with the applications.

[11] For the purpose of the analysis, **db_med** was dropped from the model.
[12] For the purpose of the analysis, **fun_med** was dropped from the model.

Insert Table 1 About Here

4. Analysis and Results

The first hypothesis was tested using the following models:

$$satisfaction = \alpha + \beta_1 functionality + \beta_2 integration + \beta_3 configuration + \beta_4 sysad + \beta_5 scalability + \beta_6 qualdoc + \beta_7 db\_low + \beta_8 db\_high + \varepsilon \quad \textbf{(1a)}$$

$$satisfaction = \alpha + \beta_1 functionality + \beta_2 integration + \beta_3 configuration + \beta_4 sysad + \beta_5 scalability + \beta_6 qualdoc + \beta_7 fun\_low + \beta_8 fun\_high + \varepsilon \quad \textbf{(1b)}$$

These models report whether there is a relationship between the magnitude of firm-initiated IT adaptation and managerially reported levels of satisfaction with technology performance, controlling for technical aspects of the implementation. OLS regression results are summarized in Table 2.

Insert Table 2 About Here

The results suggest that database modification influences managers' satisfaction with the performance of the information technology (Model 2). Specifically, findings indicate that an increase in database modification magnitude from low to moderate yielded increases in satisfaction. However, increases in database modification magnitude from moderate to high levels tended to reduce satisfaction, leaving managers no more satisfied than if the firm had adopted a low modification strategy. The findings offer no evidence to suggest that modifications to software functionality influenced satisfaction (Model 3).

To test Hypothesis 2, we used the following model.

$$satisfaction = \alpha + \beta_1 functionality + \beta_2 integration + \beta_3 configuration + \beta_4 sysad + \beta_5 scalability + \beta_6 qualdoc + \beta_7 specific + \varepsilon \quad \textbf{(2)}$$

This model reports whether a standard or industry-specific software version was used, and tests the influence of the software version on managers' subsequent level of satisfaction with information technology performance, controlling for technical aspects of the implementation. Results are presented in Table 3.

Insert Table 3 About Here

Results suggest that package type does influence the level of satisfaction reported by managers following implementation. Specifically, managers report higher levels of satisfaction following the implementation of industry-specific versions of the software package.

To test Hypothesis 3, we used the following model:

$$db = \alpha + \beta_1 functionality + \beta_2 integration + \beta_3 configuration + \beta_4 sysad + \beta_5 scalability + \beta_6 qualdoc + \beta_7 specific + \varepsilon \quad \textbf{(3a)}$$

$$fun = \alpha + \beta_1 functionality + \beta_2 integration + \beta_3 configuration + \beta_4 sysad + \beta_5 scalability + \beta_6 qualdoc + \beta_7 specific + \varepsilon \quad \textbf{(3b)}$$

These models report whether the type of software package used (standard or industry-specific) affects the level of firm-initiated adaptation that is performed, controlling for technical aspects of the implementation. OLS regression results are presented in Table 4.

Insert Table 4 About Here

Results suggest that there is no difference in the magnitude of firm-initiated adaptations performed by firms using standard versus industry-specific software package versions.

5. Discussion and Conclusions

This paper investigates the effectiveness of two IT adaptation strategies that are used in the attempt to mitigate process-technology gaps in the context of enterprise-level software packages. Using the first strategy, adopting firms adapt the software in order to improve fit. In the second strategy, software vendors adapt their products to meet the needs of specific industries. The aim of this paper has been to add to the discussion of whether IT adaptation can meaningfully contribute to the success of these implementations. In this sense, it makes both general and specific contributions.

Generally speaking, this study makes a distinction between different kinds of adaptation strategies, first by differentiating between firm- and vendor-initiation, and second by differentiating within firm-initiated adaptations between database and software functionality modifications. Results suggest that the influence of IT adaptation may, in fact, be contingent on the adaptation strategy being pursued. Future research can build on this general finding in at least two ways. First, it can investigate other types of IT adaptation to see where additional categories and subcategories exist. Second, it can seek to develop theoretical models that explain the contingencies that implementing firms face, and in what circumstances these contingencies apply.

More specifically, the findings suggest that some types of firm-initiated adaptation can be beneficial. However, over-reliance on these approaches may at best be a waste of resources, and at worst be detrimental to managers' satisfaction with the technology. In particular, satisfaction was seen to be higher in implementations that involved moderate rather than low levels of database modification. This trend reversed itself as the magnitude of database modifications increased from moderate to high, leaving the firm no better off than if it had minimized the

magnitude of database modification in the first place. These findings do not extend to the case of software functionality modification. Here, firms were seen to be neither better nor worse off, regardless of the magnitude of adaptation they initiated.

The results emphasize the need for managers to judiciously review proposals for modification of enterprise-level IT, attempting them only where a clear need exists. This is particularly true for high magnitude adaptations, not only because they may be expensive and time consuming, but because they may subject the firm to diminishing returns for their efforts. Future research might consider ways for managers to prospectively identify when the point of diminishing returns is reached for those types of firm-initiated adaptation that have the potential to be effective. Until such guidance is available, managers may be advised to err on the side of conservatism when it comes to information technology adaptation. Conservatism may be most advantageous in the case of software functionality modification, where opportunities to benefit the firm are less clear.

Findings support the Hypothesis 2 contention that managers' level of satisfaction with the information technology tends to be higher for implementations of industry-specific versions. The evidence suggests that the software vendor, in this case, has been successful in identifying and addressing some of the industry-specific requirements that affect managers' satisfaction with the performance of the software product. A legitimate question to arise from this finding is whether it implies anything about software vendors' ability to actually identify and embed the best practices they claim in their software. The heightened satisfaction reported by users of specialized software versions suggests that this may be the case. Future research might further investigate the ways in which industry practices are captured within a software package in order to better understand this phenomenon. Future research might also consider the exact manner in

which vendors are adapting their product offerings for specific industries, in order to understand whether firm-level contingencies (i.e., difference in the effectiveness of database and functionality modifications) generalize to the vendor-level.

We note that an alternative explanation for the findings from Hypothesis 2 may exist. Since implementations tend to be dominated by the use of industry-specific software versions where they are available, our findings may say more about the industries themselves than the information technology. Specifically, it may be that some industries are simply more amenable to the implementation and use of the information technology than others. This amenability may simultaneously promote higher levels of managerial satisfaction and a greater tendency on the part of software vendors to create specialized versions to serve them. Future research might attempt to sort out possible industry effects by controlling for the types of companies that are implementing the technology.

When interpreting the findings for Hypothesis 1 and Hypothesis 2, it is important to note that manager's satisfaction with the information technology does not necessarily suggest that the firm is better or worse off financially or operationally. Future research should seek to use more objective measures of implementation success. Nonetheless, IT satisfaction is still an important dimension of performance on which to measure the success of an information technology implementation, since it can significantly influence the firm's overall perception of whether the implementation effort was justified.

Hypothesis 3 findings contrast with expectation. They suggest that firms adapt the technology equally, regardless of the type of package they have purchased. One software company executive that we spoke to suggested that this phenomenon could be explained by the ability of managers to continuously identify differences across firms, below the industry level,

and to generate lists of requirements to which the software might be adapted. Future research should consider the efficacy of this hypothesis, and others, to explain why vendor-initiated adaptation does not reduce the incidence of firm-initiated adaptation.

The findings presented here may have implications beyond the realm of CRM applications. The kind of IT studied, CRM applications, shares many of the characteristics Rogers (1995) identified, that promote a tendency to adapt in other kinds of technological innovation. As such, this study may provide some evidence of the general relationship that exists between technology adaptation and performance, suggesting that succumbing to the urge to adapt may not always lead to positive outcomes. Future research can add to an understanding of this relationship by expanding beyond the context of CRM. Other candidates within the realm of enterprise level information technologies include Enterprise Resource Planning and Supply Chain applications.

Continued research in this vein has the potential for realizing substantial benefits for firms. In addition to increasing the payoffs from successful technology investments, the prospect for reducing failure rates should not be ignored. One thing this study does not do is offer prescriptions on how managers should evaluate specific modification proposals. Additional research in this area could make important contributions to the field.

References

Adams, D.A., Nelson, R.R., and Todd, P.A. "Perceived Usefulness, Ease of Use, and Usage of Information Technology: A Replication," *MIS Quarterly* (16:2), June 1992, pp 227-247.

AMR "The Report on Enterprise Management," Report, AMR Research, Inc., 2001 p. 42.

Armstrong, J.S., and Overton, T.S. "Estimating Nonresponse Bias in Mail Surveys," *Journal of Marketing Research* (14:3), August 1977, pp 396-402.

Austin, R., and Nolan, R. "How to Manage ERP Initiatives," Working Paper 99-024, Harvard Business School, Boston, MA, 1998.

Bailey, J.E., and Pearson, S.W. "Development of a Tool for Measuring and Analyzing Computer User Satisfaction," *Management Science* (29:5), May 1983, pp 530-545.

Brynjolfsson, E., and Hitt, L. "Beyond the Productivity Paradox: Computers are the Catalyst for Bigger Changes," *Communications of the ACM* (Vol. 41, No. 8:August 1998) 1998, pp 49-55.

Cooper, R.B., and Zmud, R.W. "Information Technology Implementation Research: A Technological Diffusion Approach," *Management Science* (36:2), February 1990, pp 123-139.

Cotteleer, M.J. "Relational Data Models in Enterprise-Level Information Systems," Technology Note 602-114, Harvard Business School, Boston, MA, 2001.

Davenport, T. *Process Innovation: Reengineering Work through Information Technology* Harvard Business School Press, Boston, 1993, p. 336.

Davenport, T. "Putting the Enterprise into the Enterprise System," *Harvard Business Review* (76:4), July/August 1998, pp 121-131.

Davenport, T. *Mission Critical: Realizing the Promise of Enterprise Systems* Harvard Business School Press, Boston, MA, 2000, p. 335.

Davenport, T.H., and Short, J.E. "The New Industrial Engineering: Information Technology and Business Process Redesign," *Sloan Management Review* (31:4), Summer 1990, pp 11-27.

Davis, F.D. "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology," *MIS Quarterly* (13:3), September 1989, pp 319-340.

Galletta, D.F., and Lederer, A.L. "Some Cautions on the Measurement of User Information Satisfaction," *Decision Sciences* (20) 1989, pp 419-438.

Goodhue, D.L., and Thompson, R.L. "Task-Technology Fit and Individual Performance," *MIS Quarterly* (19:2), June 1995, pp 213-235.

Hamilton, S., and Chervany, N.L. "Evaluating Information System Effectiveness -- Part 1: Comparing Evaluation Approaches," *MIS Quarterly*), September 1981, pp 55-69.

Hammer, M., and Champy, J. *Reengineering the Corporation: A Manifesto for Business Revolution* HarperBusiness, New York, 1993, p. 233.

Konicki, S. "Nike Just Didn't Do it Right, Says I2 Technologies," *Information week* (1:827), March 5 2001, p 32.

Lassila, K.S., and Brancheau, J.C. "Adoption and Utilization of Commercial Software Packages: Exploring Utilization Equilibria, Transitions, Triggers, and Tracks," *Journal of Management Information Systems* (16:2), Fall 1999, pp 63-90.

Leonard-Barton, D. "Implementation as mutual adaptation of technology and organization," *Research Policy* (17:5) 1988, pp 251-267.

Levitt, B., and March, J.G. "Organizational Learning," *Annual Review of Sociology* (Vol. 14) 1988, pp 319-340.

Lucas, H.C., Walton, E.J., and Ginzberg, M.J. "Implementing Packaged Software," *MIS Quarterly* (12:4), December 1988, pp 537-549.

Mabert, V.A., Soni, A., and Venkataramanan, M.A. "Enterprise Resource Planning Survey of US Manufacturing Firms," *Production and Inventory Management Journal* (41:2), Second Quarter 2000, pp 52-58.

Montazemi, A.R., Cameron, D.A., and Gupta, K.M. "An Empirical Study of Factors Affecting Software Package Selection," *Journal of Management Information Systems* (13:1), Summer 1996, pp 89-105.

Neeley, P.S., and Jurczewsky, J.L. "Chaining the Beast: Limiting the Damage of Long MRP Run Times with Postmortem and Pro Forma Analyses," *Production and Inventory Management Journal* (32:3), Third Quarter 1991, pp 77-81.

Nunnally, J.C., and Bernstein, I.H. *Psychometric Theory*, (3rd ed.) McGraw-Hill, New York, 1994.

Okumoto, K. "A Statistical Method for Software Quality Control," *IEEE Tranactions on Software Engineering* (SE11:12), December 1985, pp 1424-1431.

Paulson, J. "EDI -- An Implementation Review," *Production and Inventory Management Journal* (34:2), Second Quarter 1993, pp 77-81.

Porter, M.E. "What Is Strategy?," *Harvard Business Review* (74:6), November/December 1996, pp 61-78.

Ravichandran, T., and Rai, A. "Total Quality Management in Information Systems Development: Key Constructs and Relationships," *Journal of Management Information Systems* (16:3), Winter 2000, pp 119-155.

Rogers, E.M. *Diffusion of Innovations*, (Fourth ed.) The Free Press, New York, NY, 1995, p. 518.

Schuff, D., and St.Louis, R. "Centralization vs. Decentralization of Application Software," *Communications of the ACM* (44:6), June 2001, pp 88-94.

Scott Morton, M.S. (ed.) *The Corporation of the 1990s*. Oxford University Press, New York, Oxford, 1991.

Soh, C., Kien, S.S., and Tay-Yap, J. "Cultural Fits and Misfits: Is ERP a Universal Solution?," *Communications of the ACM* (43:4), April 2000, pp 47-51.

Songini, M.L. "Nike Says Profit Woes IT-Based," *Computerworld* (35:10), March 5, 2001 2001, pp 1,13.

Stedman, C. "ERP Flops Point to User's Plans," *Computerworld* (33:46), November 15 1999a, p 1.

Stedman, C. "Failed ERP Gamble Haunts Hershey," *Computerworld* (33:44), November 1 1999b, p 1.

Taylor, S., and Todd, P.A. "Understanding Information Technology Usage: A Test of Competing Models," *Information Systems Research* (6:2), June 1995, pp 144-176.

Tinsley, H.E., and Tinsley, D.J. "Uses of Factor Analysis in Counseling Psychology Research," *Journal of Counseling Psychology* (34:4) 1987, pp 414-424.

Tornatzky, L.G., and Klein, K.J. "Innovation Characteristics and Innovation Adoption-Implementation: A Meta-Analysis of Findings," *IEEE Transactions on Engineering Management* (EM-29:1), February 1982, pp 28-45.

Upton, D.A., and McAfee, A.P. "A Path-Based Approach to Information Technology in Manufacturing," *International Journal of Technology Management* (20:3,4) 2000, pp 354-372.

Venkatesh, V. "Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model," *Information Systems Research* (11:4), December 2000, pp 342-365.

Vessey, I. "Cognitive Fit: A Theory-Based Analysis of the Graphs Versus Tables Literature," *Decision Sciences* (22:2), Spring 1991, pp 219-240.

Westland, J.C. "Research Report: Modeling the Incidence of Postrelease Errors in Software," *Information Systems Research* (11:3), September 2000, pp 320-324.

Willcocks, L.P., and Sykes, R. "The Role of the CIO and IT Function in ERP," *Communications of the ACM* (43:4), April 2000, pp 32-38.

Zigurs, I., and Buckland, B.K. "A Theory of Task/Technology fit and Group Support Systems Effectiveness," *MIS Quarterly* (22:3), September 1998, pp 313-334.

Figures and Tables

Figure 1: Relationship among hypotheses

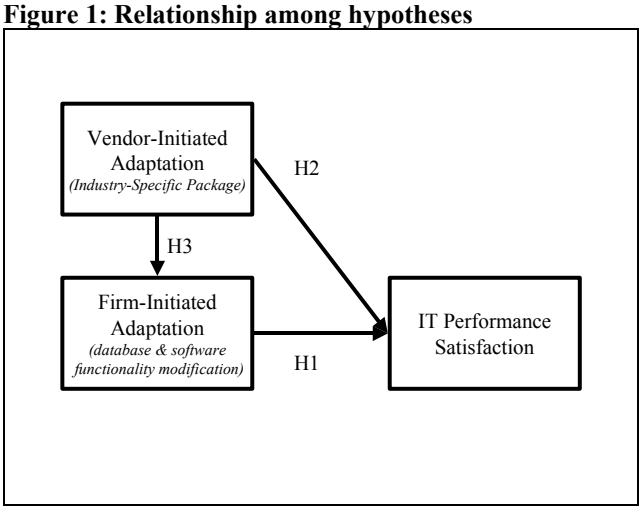

Table 1: Summary of analysis variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
satisfaction	46	7.83	0.957	5.13	9.25
db_low	50	0.38	0.490	0.00	1.00
db_med	50	0.36	0.485	0.00	1.00
db_high	50	0.26	0.443	0.00	1.00
db	50	1.88	0.799	1.00	3.00
fun_low	50	0.28	0.454	0.00	1.00
fun_med	50	0.40	0.495	0.00	1.00
fun_high	50	0.32	0.471	0.00	1.00
fun	50	2.04	0.781	1.00	3.00
specific	60	0.48	0.504	0.00	1.00
functionality	44	7.55	1.135	4.00	10.00
integration	36	7.18	1.323	4.00	9.00
configuration	42	7.71	1.240	5.00	10.00
sysad	41	7.65	1.231	5.00	9.500
scalability	41	7.83	1.349	5.00	10.00
qualdoc	40	7.16	1.734	2.00	9.00

Table 2: Summary of OLS Regressions on Firm-Initiated Adaptation for Information Technology Satisfaction (t-values in parentheses).

	Model					
	1		**2**		**3**	
constant	3.101	***	3.539	***	2.962	***
	(4.05)		(4.78)		(3.83)	
functionality	-0.024		0.043		0.085	
	(-0.23)		(0.36)		(0.64)	
integration	0.010		-0.008		0.032	
	(0.09)		(-0.08)		(0.27)	
configuration	0.604		0.025		0.010	
	(0.47)		(0.19)		(0.07)	
sysad	0.295	**	0.258	**	0.263	**
	(2.60)		(2.44)		(2.24)	
scalability	0.311	**	0.234	**	0.236	*
	(2.68)		(2.11)		(1.86)	
qualdoc	-0.040		0.047		0.032	
	(-0.31)		(0.38)		(0.22)	
db_low			-0.516	**		
			(-2.35)			
db_high			-0.471	*		
			(-1.86)			
fun_low					-0.361	
					-1.40	
fun_high					-0.114	
					-0.40	
R-Square (adj.)	0.646		0.710		0.650	
N	33		30		30	

For two tailed tests:
* = Significant at p<0.10,
** = Significant at p<0.05,
*** = Significant at p<0.01

Table 3: Summary of OLS Regressions on Package Type for Information Technology Satisfaction (t-values in parentheses).

	Model			
	4		**5**	
constant	3.101	***	2.954	***
	(4.05)		4.06	
functionality	-0.024		-0.037	
	(-0.23)		-0.38	
integration	0.010		-0.019	
	(0.09)		-0.18	
configuration	0.604		0.120	
	(0.47)		0.92	
sysad	0.295	**	0.287	**
	(2.60)		2.68	
scalability	0.311	**	0.282	**
	(2.68)		2.55	
qualdoc	-0.040		-0.020	
	(-0.31)		-0.17	
specific			0.381	**
			2.04	
R-Square (adj.)	0.646		0.684	
N	33		33	

For two tailed tests:
* = Significant at $p<0.10$,
** = Significant at $p<0.05$,
*** = Significant at $p<0.01$

Table 4: Summary of OLS Regressions on Package Type for Magnitude of Database and Software Functionality Modifications (t-values in parentheses).

	Database Modification Model				Software Functionality Modification Model			
	6		**7**		**8**		**9**	
constant	2.381	**	2.391	**	2.362	**	2.293	**
	(2.2)		(2.15)		(2.17)		(2.09)	
functionality	-0.415	**	-0.413	**	-0.445	**	-0.456	**
	(-2.54)		(-2.47)		(-2.72)		(-2.75)	
integration	-0.039		-0.037		0.025		0.012	
	(-0.25)		(-0.23)		(0.15)		(0.07)	
configuration	0.137		0.132		0.0287		0.064	
	(0.69)		(0.63)		(0.14)		(0.31)	
sysad	-0.025		-0.023		0.111		0.098	
	(-0.15)		(-0.14)		(0.68)		(0.59)	
scalability	0.070		0.071		-0.025		-0.034	
	(0.41)		(0.41)		(-0.15)		(-0.20)	
qualdoc	0.202		0.201		0.257		0.264	
	(1.10)		(1.07)		(1.40)		(1.42)	
specific			-0.035				0.239	
			(-0.11)				(0.79)	
R-Square (adj.)	0.134		0.095		0.184		0.170	
N	30		30		30		30	

For two tailed tests:
* = Significant at $p<0.10$,
** = Significant at $p<0.05$,
*** = Significant at $p<0.01$