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The importance of management practices in IS project performance

An empirical study

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Abstract

Purpose The literature on software project management is extended into the broader domain of large-scale IS management by studying enterprise-wide system upgrade projects. In particular; examines the role that the intervention of project management practices (formal project methodologies and outsourcing) play in large and/or complex IS projects, which result in good project performance.

Design/methodology/approach – A survey instrument was completed by 449 information systems managers about a specific upgrade project. The primary analytical approach used was structural equation modeling (SEM).

Findings It was found that neither project complexity nor project size are good indicators of meeting a project's target date. Large projects that adopted formal project management practices were more probable to meet the project target date. Projects with a high degree of complexity which involved outsourcing and adopted formal project management practices, were more likely to meet the project target date.

Practical implications Clearly, the message to managers of IS projects is to establish a project methodology, especially in large, enterprise-wide projects, and when some degree of outsourcing is required.

Research limitations/implications – Future research should consider additional measures of performance such as cost, end-user satisfaction and business value.

Originality/value – Much had been written in the literature about how large, complex IT projects have high failure rates. Our study provides conclusive evidence that, the greater the degree of methodology implementation, the greater the chance for meeting the project's target date. Prior to this research, this had not been explicitly shown in the research literature.

Keywords Information systems, Project management, Research methods, Outsourcing

Paper type Research paper

Introduction

The management of enterprise-wide information system (IS) projects is increasingly important to information system managers. Large-scale IS projects such as the

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deployment of enterprise resource planning (ERP) systems, the upgrade and patching of operating systems across an organization and the installation of enterprise network management software have required managers to develop project management practices that are successful in a global, integrated and highly distributed computing environment. A study by the Standish Group found that only 28 percent of IT projects were completed on time and on budget, and that IT projects were, on average, 45 percent over original cost estimates and 63 percent over original "time to completion" estimates (Standish Group International, 2001). This same report recommends improving the performance of IT project management through the use of better tools to monitor and control progress, through assigning skilled project managers that use good project management practices, and through a reduction in the scope and scale of IT projects.

Much of the academic research on information system project management has been done in the context of software development and maintenance in the "traditional" computing paradigm of centralized mainframe processing, in which the majority of software projects involve the custom development of applications using a procedural programming language (Rockart *et al.*, 1996). For example, Banker *et al.* (1998) investigated software development practices, software complexity and maintenance performance in a study of 29 software enhancement projects in a large IBM COBOL environment. While Kirsch (1996) investigated managerial control tasks in the systems development process by surveying 35 system development projects with varying size and complexity, 27 of the 35 projects were mainframe-oriented and project team size varied from three to approximately 100 participants. There is a lack of empirical investigation of the issues related to the characteristics associated with information system (IS) projects, the formal project management practices used within an IS project, and the performance of the project. While prior research by Zmud (1980) suggests that project characteristics directly affect the management practices of successful IS projects, the importance of understanding "exactly how project management practices vary as a function of project complexity is a question for empirical research to examine" (Kirsch, 2000).

The upgrade and remediation of existing enterprise-wide information systems can be an expensive, time-consuming, and risky proposition for the IT organization. An enterprise-wide system upgrade can affect information technology assets distributed throughout the organization. Al-Mashari and Zairi (2000) identify three layers of the SAP R/3 architecture (SAP graphical user interface, SAP application layer, and SAP database layer) which "can be distributed according to specified structures and connected through a network to make them operate as a whole". When conducting system upgrade projects non-compliant systems needed to be identified and corrected on server resources (mainframes, minicomputers, LAN servers), client resources (workstations, personal computers, laptops, personal digital assistants), and the organization's communications infrastructure. Research related to the total cost of ownership (TCO) of end-user workstations must factor operations costs related to installation and upgrades. David *et al.* (2002) indicate that hardware and software upgrades are often related specifying that new software generally requires more powerful hardware forcing hardware upgrades. In this research we use a sample of 449 enterprise-level system upgrade projects in order to investigate the relationship between two IS project characteristics (technical complexity and project size), two

formal project management practices (project methodology and outsourcing) and the target date for project completion. The unique characteristics of enterprise system upgrade projects (the distributed nature of the computer assets and the demand for consistent, reliable processes) made this a good laboratory to re-examine and broaden our understanding of the factors related to IS project performance. Specifically our research empirically tests a portion of the software project management framework proposed by Kirsch (2000) in the more general context of large-scale IS project management.

In the following section, "Theoretical development", we first describe our two major objectives, followed by a review of the literature for each of the following:

- target date for project completion;
- IS project management practices; and
- IS project characteristics.

Based on past research and the framework proposed by Kirsch (2000), as well as an introduction to our variables and constructs of interest, hypotheses are developed in each section. The development of the variables and constructs of interest are more specifically explained in the "Research methodology" that follows. The analysis of an initial model, then revised model, are described in the next section titled "Data analysis". In the next section titled "Discussion", the findings are then discussed in light of past research, which is then summarized in the final section, "Conclusions".

Theoretical development

In this research we have two major objectives. First we seek to answer the question: what project characteristics influence the formal project management practices exhibited by well performing large-scale IS projects? More specifically we examine the three-way relationship between project characteristics (technical complexity and project size), formal project management practices (project methodology and outsourcing) and meeting the target date for project completion. Our research model takes into account the important dimension of project size in addition to technical complexity when assessing the impact of formal project management practices on project performance. Traditional thinking suggests that projects that are high in complexity and large in size require formal methods for planning and control in order to track and integrate the separate components of the project. However, there is anecdotal evidence to suggest a contradictory relationship of project size with project success. For example, it has been the *Fortune* 500 companies, not the small to medium-sized firms that have been the first to successfully adopt ERP systems (Kumar and Van Hillegersberg, 2000). Thus we desire to understand the role that project management practices play in projects with varying organizational scale and technical complexity as it relates to successful large-scale, enterprise-wide IS projects.

Second, our research examines the relationship between project management practices by answering the question: what are the interactions between different project management practices as influenced by the project characteristics of successful enterprise-wide IS projects? In particular we examine the interactions between two project management practices (project methodology and outsourcing) within the context of project characteristics (technical complexity and project size) as they relate to meeting the project's target date. Based on observations made by Lee and Kim (1999)

which stated that the quality of outsourcing partnership is significantly related to the degree of information sharing, communication quality and coordination – all qualities provided by the use of a project methodology, we examined the relationship between outsourcing and project methodology.

Our conceptual research, building on the results of Banker *et al.* (1998) and the software project management framework proposed by Kirsch (2000), examines the role of different management interventions (in the form of project management practices) on projects with different technical and organizational characteristics with varying levels of project performance. Figure 1 illustrates our guiding research model, presenting major constructs and relationships. The following section describes each component of this model, including the development of the related hypotheses, followed then by the research methodology which includes a more detailed explanation of the development of the constructs and variables.

Target date for project completion

Project performance can be broken into five categories:

(1) schedule;

(2) budget;

(3) quality of the system;

(4) satisfaction with the project team; and

(5) business value (Kirsch, 2000).

Various empirical studies of IS projects have examined subsets of these performance categories. For example, Kirsch and Beath (1996) examined schedule and budget outcomes (termed "efficiencies") in relationship to different project coordination mechanisms. Nidumolu (1995) used both objective measures of project performance (schedule overruns, cost overruns and effort overruns) and subjective measures of

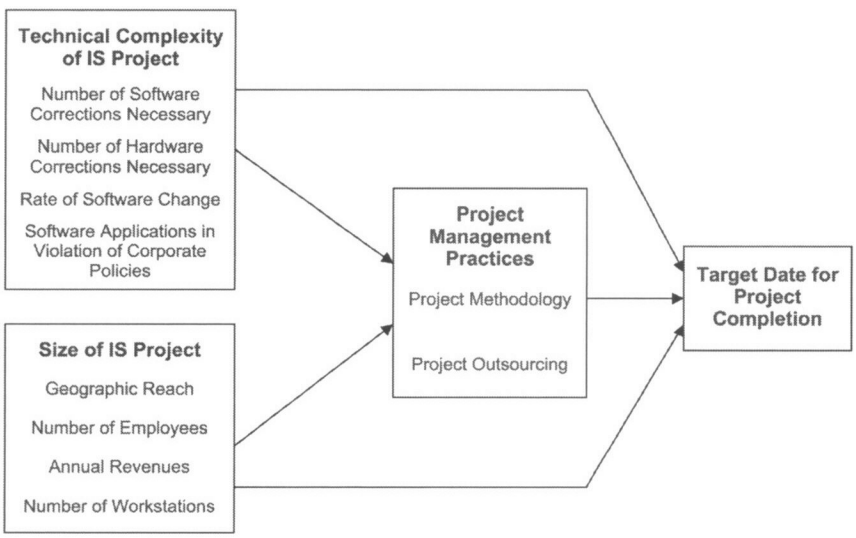

Figure 1.
Conceptual model for large-scale IS project management

project performance (product performance and process performance) in assessing the effects of coordination and uncertainty in software projects. The review of the academic literature on IS project success indicates that measures of performance should be both specific to the problem at hand and should be a detailed measure. While there is a large body of research on IS performance, there is no single measure that covers all aspects.

In this research IS project performance was evaluated using the target date by which the enterprise-wide system upgrade project would be completed. This measure of success was chosen because it is highly measurable and highly specific to this project. Schedule overruns have been used as a dependent variable in prior IT project management research (Kirsch and Beath, 1996; Nidumolu, 1995) and are an important project outcome measurement in the tracking of IT project management success (Standish Group International, Inc., 2001).

IS project management practices

Project management practices have been examined extensively in the software project management literature and, to a lesser degree, in the broader information systems literature. There is empirical research that shows a positive relationship between formal project management practices and the success of a software project. Deephouse *et al.* (1995-1996) show a positive relationship between two project management practices (project planning and cross-functional teams) and project success. However, it is important to note that they found no positive relationship between other practices (design reviews, prototyping, frequent user contact, and maintaining a stable environment) and project success. Guinan *et al.* (1998) found that the type of formal "technology enabler" (CASE, structured methods, etc.) played a small role in determining project team performance. However, the role of formal tools in software project management is not always straightforward. For example, Banker *et al.* (1998) looked at two software design and development practices (code generators and packaged software) and found that the use of code generators actually increased the project hours devoted to software enhancement.

Recently there has been an increased interest in examining the success and failure of enterprise information systems. As a result, the software project management literature has been broadened in both context and scope. First, project management has been placed in the broader context of an enterprise system experience life cycle (Markus and Tanis, 2000). The traditional activities associated with project management (planning, performance monitoring, configuration, integration, testing, and deployment) are viewed within the context of four different phases. Second, the scope of project management research is expanding from a focus exclusively on software development to a broader look at large-scale, enterprise information systems (Kuruppuarachchi *et al.*, 2002). The software project management literature was largely built by researching software development in traditional centralized mainframe-oriented environments, and that changes in the business environment coupled with technological trends such as ERP systems, web-based applications, and distributed systems, have combined to challenge the relevance of existing findings in software project management. Yet, up to this point there are few empirical studies that have tested software project management theories in the context of enterprise-wide information systems projects.

IS project methodology. A project methodology is deemed to be very important in the software engineering discipline. Research by Necco *et al.* (1987) have viewed systems development methodologies as a mechanism of behavior control by articulating precise steps in successfully developing a system. Kirsch (1997) concludes that practitioners often view a methodology as rough guidelines and that these procedures are not always intended to be judiciously followed. A project methodology can be viewed as a set of precisely described procedures or processes for achieving a standard task (Hackathorn and Karimi, 1988). In this context, Guinan *et al.* (1998) found that group production processes (in this case, effective plans and procedures) are positively related to software development success.

An information systems methodology should be tailored to the specific project. In this research all participants were engaged in system upgrade projects. For all organizations these were large-scale, enterprise-wide projects. We inquired about five project methodology components that pertain to this type of project:

(1) problem identification;

(2) risk assessment;

(3) cost calculations;

(4) compliance planning; and

(5) testing and verification.

These five specific methodology components were derived from the literature on IT project management (Barki *et al.*, 1993; Cockburn, 2000; Jones, 1996; Schach, 1992) and large-scale system implementation (Charette, 1996):

H1. Project methodology is positively related to project target date.

Outsourcing. There is a rich body of literature on information technology outsourcing. Lacity and Willcocks (2000) state the primary contribution of the literature on IT outsourcing is to relate actual outsourcing outcomes to various managerial practices, and they conclude that the empirical research "agrees that a detailed formal evaluation process is required and that shorter-term contracts, outsourcing commodity IT on a selective basis, and the retention of requisite management capabilities contribute to success". Grover *et al.* (1996) report that the outsourcing of systems operations and telecommunications was perceived to be successful, but the outsourcing of applications development, end-user support and IS management was not.

The relationship between IS outsourcing and IS project management has not been explicitly studied in the research. However, Lacity and Willcocks (2000) describe six IT outsourcing phases:

(1) scoping;

(2) evaluation;

(3) negotiation;

(4) transition;

(5) middle; and

(6) mature.

Activities associated with the evaluation and negotiation phases most closely correspond to project planning activities, while the activities associated with the transition and middle phases most closely correspond to project control activities. Lacity *et al.* (1996) suggest a negative relationship between size and complexity with outsourcing success when then they state "outsourcing technically immature activities engenders significant risk" and "in cases where technical integration with other processes is high, the risks of outsourcing increase".

The literature on IS outsourcing indicates that "selective outsourcing" is one of the primary ingredients to IT outsourcing success. System upgrade projects were ideal for selective outsourcing because the expected results of the project were clear, the scope of the project was easily defined, much of the outsourced effort involved updating older systems, not cutting-edge technologies, and the expertise for the project was typically not found within in-house staff or there was not sufficient manpower with the expertise to respond to the demand. King and Malhotra (2000) note that "maintaining control over an outsourced function is complicated by the power of the vendor". Completely outsourced work, with well-defined requirements and boundaries result in less interaction required between vendors and internal constituents. Lee (2001) labeled the result of such interaction as "knowledge sharing". Most of the upgrade projects, because of the integrated nature of many systems, were not turn-key in nature, required much more interaction and knowledge sharing between vendors and internal IS departments, and was a necessity due to insufficient internal expertise and manpower. Thus:

H2. Outsourcing interaction is positively related to project target date.

IS project characteristics: antecedents to project management practices

Prior research suggests that project characteristics directly affect project management practices. Zmud (1980) states that technological complexity, the degree of novelty of the application, technological change and project size influence the outcome of large software projects. Kirsch (2000) states the importance of understanding the role of complexity in software project management and concludes that "exactly how project management practices will vary as a function of project complexity is a question for empirical research to examine". The definition of project size and the complexity of a project has, at times, been blurred in the literature. Kirsch (2000) states that complexity is often thought of in terms of project size, and that large software project consists of many interrelated parts, while others have made a distinction between the complexity of the technology and the size of the project. In this research we make a clear distinction between technical complexity and project size.

Technical complexity. The technical complexity of an IS project has multivariate dimensions that are specific to the particular project under investigation. The literature on system upgrade projects indicates several important technical dimensions that add to the complexity of the projects. Upgrade projects had to include tasks for both hardware and software remediation, the amount of software change can affect upgrade efforts, and the amount of software not supported by the organization's MIS staff increases project complexity (Ben-Menachem and Gelbard, 2002) (David *et al.*, 2002). In addition, the works of Powers and Dickson (1973) and Abdel-Hamid and Madnick (1989) suggest that project characteristics ought to impact the type of management

practice. In this research we test the notion that the greater the individual measures of technical complexity related to the project, the greater the need for utilizing a project methodology and the greater the need for complex outsourcing, resulting in more outsourcing interaction:

H3a. Non-compliant software is positively related to project methodology

H3b. Non-compliant software is positively related to outsourcing interaction

H4a. Non-compliant hardware is positively related to project methodology

H4b. Non-compliant hardware is positively related to outsourcing interaction

H5a. Rate of software change is positively related to project methodology

H5b. Rate of software change is positively related to outsourcing interaction

H6a. Non-supported software is positively related to project methodology

H6b. Non-supported software is positively related to outsourcing interaction

Project size. The size of an IS project can be assessed as either a latent variable (Jiang and Klein, 1999) or as an independent manifest variables (Banker and Slaughter, 1997). Size is often considered in studies of enterprise systems. Markus *et al.* (2000) deals directly with size related to ERP project success while Holland and Light (1999) use a case study approach to ERP implementation at different sized firms. In this research we test the notion that the larger the size of the project, the greater the need for utilizing a project methodology and the greater the need for more complex outsourcing requiring more interaction:

H7a. Project size is positively related to project methodology

H7b. Project size is positively related to outsourcing interaction

Direct impacts of technical complexity and project size on target date

One of the central points of our research is to investigate the notion that project management practices act as an intervening mechanism that mediates the relationship between the characteristics of a project and project target date. However, there is previous research to suggest that perhaps the characteristics of a project directly affect project performance. In our study we asked about the amount non-compliant software and hardware, as well as the amount of software change can affect upgrade efforts, and the amount of software not supported by the organization's MIS staff, all of which could conceptually increases project complexity Therefore we propose to test the following:

H8a. Non-compliant software is inversely related to project target date

H8b. Non-compliant hardware is inversely related to project target date

H8c. Rate of software change is inversely related to project target date

H8d. Non-supported software is inversely related to project target date

H9. Project size is inversely related to project target date.

Given these hypothesized relationships, this raises an important issue for investigation. Do any project characteristics directly influence project performance or is it intervention of specific project management practices on different types of projects that ultimately lead to meeting project target dates?

Interactions between different project management practices

Interactions between outsourcing and project methodologies have not been explicitly studied in the prior literature. However, Lee and Kim (1999) found that participation, communication and information sharing are all positively related to partnership quality in IS outsourcing. This suggests that project methodologies may be a means of increasing communication and information sharing and typically allow for increased participation. Thus we hypothesized that there would be a positive relationship between projects that are outsourced requiring more interaction between the internal constituents and external vendors, and the use of specific project methodologies. In general, as the level of outsourcing interaction between an organization's personnel and external constituents increases, it is expected that there would be an increased use of project methodologies to ensure successful coordination, communication, and documentation of the compliance work performed:

H10. Outsourcing interaction is positively related to project methodology.

Research methodology

In order to study the model described in the previous section, a survey was designed to measure the characteristics of the project (project size and technical complexity), the specific project management practices used (project methodology and outsourcing), and the performance of the project (target date for project completion). The characteristics of enterprise-wide system upgrade projects (the distributed nature of the computer assets for testing, the time criticality of the project, and the large demand for administrative resources) make it good laboratory to reexamine and broaden our understanding the factors related to IS project performance. Face validation was achieved through review of the instrument by peer information system instructors. The survey was sent to 2,773 persons responsible for system upgrade projects within their firm. A total of 449 usable surveys were returned. The survey respondents had a broad range of upper management positions and represented a wide range of organizations in terms of corporate size and industry (see Table I).

Respondent characteristics	Percent response	Respondent characteristics	Percent response
Titles		*Industry*	
Manager of IS	29.9	Manufacturing	20.4
Executive VP/general manager	29.8	Government	14.5
CIO/CTO	24.0	Wholesale/retail	14.3
VP of IS	14.7	Health/medical	10.5
Chairman/CEO/COO	0.8	Education/research	9.5
Controller/CFO/treasurer	0.8	Finance/banking/insurance	8.1
		Transportation	3.8
		Other	18.9

Table I. Characterisics of respondents

Measures, procedures and preliminary analysis

Most of the indicators used in this study were objective in nature, with the intent for the survey respondent to self-report project characteristics, practices and performance. Measures were developed for analysis using structural equation modeling procedures, requiring the specification of exogenous and endogenous variables. The following provides a description of each indicator.

Exogenous variables. Project size was developed as a latent variable based on a number of items identified as:

- annual revenue;
- number of employees;
- number of workstations; and
- geographic reach.

These are not meant to be an exhaustive list of all the dimensions of project size, but are similar to other measures previously used in this field of study based on the review of the literature. It is important to note that our model explicitly assumes that, in the case of an enterprise-wide system upgrade project, organization size is a measure of project size. As the organizational reach involves international locations, more users, more workstations, the system upgrade project grows in breadth. These factors were also correlated with annual revenues. This relationship is unique to enterprise-wide systems. Theoretical and practical considerations influenced the items developed. In order to address the dimensions of technical complexity, four independent, manifest (observed) variables were defined:

(1) non-compliant software: percentage of software applications not system compliant;

(2) software change: rate of software change;

(3) non-supported software: percentage of software in violation of corporate policy; and

(4) non-compliant hardware: percentage of BIOS not system compliant.

The first three items relate to software and the last to hardware. Each was analyzed separately as manifest variables. According to Chin (1998):

> An underlying assumption for SEM (Structural Equation Modeling) analysis is that the items or indicators used to measure an LV (latent variable) are reflective in nature. Thus while it may occur, formative indicators need not be correlated nor have high internal consistency such as Chronbach's alpha.

Models that contain only manifest variables are often referred to as path analysis, while structural equation modeling allows for a mixture of manifest and latent variables. Single survey items treated as manifest variables are considered and specified to be free of error measurement (MacCallum, 1995; Schumacker and Lomax, 1996). While the three items did require some judgment to be made by the respondent regarding how often software changes or the percent of non-compliant applications or BIOS on a typical workstation, the response options were deemed to be wide enough to allow for the respondent to accurately select the appropriate option. All three items relate to the state of physical complexity issues, not perceptions or attitudinal conditions. The three formative

indicators are specifically related to the degree of complexity of the system upgrade project, but not necessarily correlated given the varying nature of the systems used in different organizations, therefore a latent variable was not constructed. For example, a large manufacturer may have a large percent of older, non-compliant software on systems that are often relatively stable, resulting in a low degree of occurrence of software changes or non-supported software. A newer service-based company may have an overall low level of non-compliant software, but tracking those applications may be more difficult due to a higher frequency of software changes or non-supported software. Additionally, there is no reason for hardware compliance and different software issues to be correlated. Therefore, they were treated as three independent manifest variables measuring different dimensions of technical complexity. A response of "Information not available" was treated as missing for purposes of analysis.

Endogenous variables. Outsourcing interaction was measured using a single survey item, a manifest variable. A response of "internal resources" indicates no outsourcing, therefore no interaction with a vendor A response of "external resources" indicates a complete outsourcing of the project, which requires analysis, needs assessment, and design work that requires communication and interaction between organizational personnel and external constituents, but development is more commonly turn-key in nature, with an overall moderate degree of interaction with external constituents. A response of "both", which is more common, requires even more interaction between organizational personnel and the external constituents and more complex integration issues are typically addressed. Project methodology was developed as a latent variable based on a survey item with five sub-items, each reporting the status of each stage of a typical system upgrade methodology. Target date was used as the measure of project success. The respondents were asked to report which half of which year was the projected target date for completion of the system upgrade project, as of the time of the survey. This measure of success was chosen because it is highly measurable and is highly specific to this project. A response of "Information not available" was treated as missing for purposes of analysis.

Confirmatory analysis

The two latent variables developed as project size and project methodology constructs, were assessed for reliability by calculating Chronbach's alpha. Chronbach's alpha for the project size construct was 0.75 and 0.86 for the project methodology construct, which fall within an acceptable range (Nunnally, 1967). Convergent and discriminant validity of the purported constructs were assessed by performing principal component factor analysis using varimax rotation. The results are shown in Table II. "Annual revenue", "Number of employees", "Number of workstations" and "Geographic reach" comprise the project size construct while the rest comprise the project methodology construct. All indicators loaded onto their proposed factor, falling within an acceptable range, indicating both convergent and discriminant validity.

Data analysis

In order to test the proposed model, structural equation modeling (SEM) was used. This form of analysis has been used with greater frequency in the IS field in the past few years and is an example of "a second generation of multivariate analysis" (Fornell and Bookstein, 1982). The analysis was performed using AMOS, Analysis of Moment

Structures. AMOS is a general maximum likelihood structural equation estimation procedure similar to LISREL which provides a test of parameter estimates as well as several measures of overall fit of a model.

Initial model – structural equation modeling results

The initial model tested was a recursive model and saturated, resulting in all possible paths tested in an exploratory mode. The hypothesized model is shown in Figure 2. Latent variables are modeled as ovals while manifest variables are modeled as rectangles based on current graphical conventions (Arbuckle and Wothke, 1999; Hatcher, 1994). Neither manifest variables that comprise the two latent variables, nor error terms are shown in order to simplify the graphical representation.

Table II.
Confirmatory factor analysis of principal components

	Component	
	Project size	Methodology
Annual revenue	0.832	−0.080
Number of employees	0.848	−0.060
Number of workstations	0.806	0.148
Geographic reach	0.502	−0.146
Problem identification	−0.180	0.706
Risk assessment	−0.143	0.807
Risk correction	−0.123	0.840
Compliance planning	0.053	0.831
Risk management	−0.018	0.768

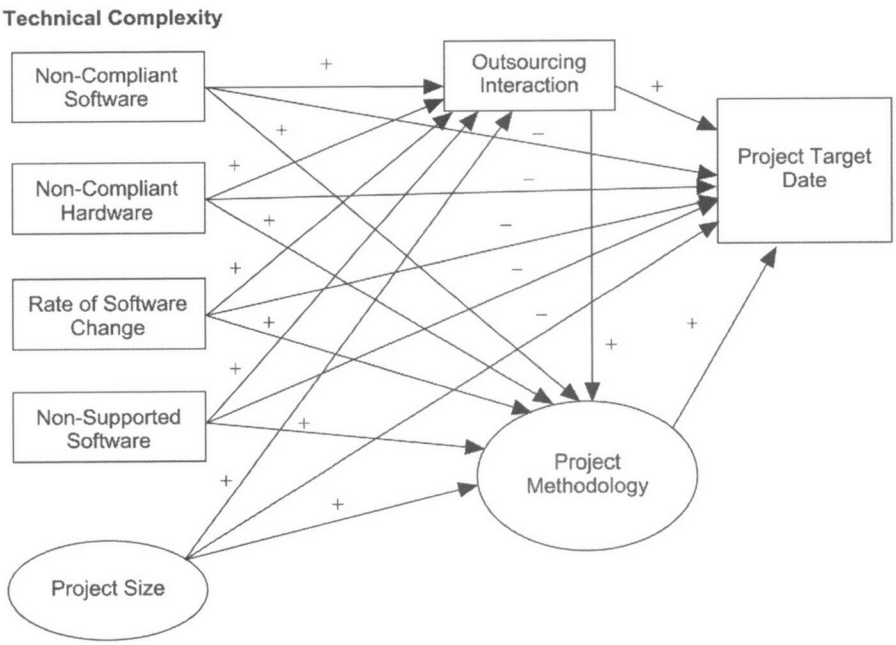

Figure 2.
Initial model

Results based on maximum likelihood path analysis indicate a poor fit based on a chi-square of 354.80 (df = 78, p-value = 0.000). The chi-square test requires the data demonstrate multivariate normality and can be affected by sample size, thus other fit indexes are typically considered. Others include comparative fit index (CFI), normed fit index (NFI), relative fit index (RFI), and root mean square error of approximation (RMSEA). Hu and Bentler (1999) recommend the use of multiple indexes and report criteria "rules of thumb", such as cutoff values of at least 0.90, but preferably 0.95 or greater, for CFI, NFI and RFI and less than 0.06 for RMSEA.

For this model, CFI = 0.982, NFI = 0.977, RFI = 0.965 and RMSEA = 0.079, indicate a marginal fit with some conflicting results, especially the RMSEA. A number of path coefficients were found to be insignificant. In addition, the Technical Complexity measure of "Non-compliant hardware" had no statistically significant relationship with outsourcing interaction, methodology or target date. Table III provides the hypotheses, standardized path coefficients, hypothesized relationship, conclusion and critical ratio for each path of the saturated model.

All hypothesized relationships of statistically significant paths were supported. Two insignificant paths had relationships opposite that expected, *H8b* and *H9*. The size of the path for hypothesis *H8b* is too small to consider, but the path coefficient of 0.07 is of such magnitude to be given some consideration. It indicates that larger projects might have better performance.

Revised model – structural equation modeling results

A revised model was analyzed with non-compliant hardware and all insignificant paths eliminated as shown in Figure 3.

Assessment of the revised model resulted in a chi-square = 210.36 (df = 75, p = 0.00), CFI = 0.991, NFI = 0.986, RFI = 0.980, and RMSEA = 0.056. All remaining path coefficients were found to be statistically significant. Table IV shows the results.

Examination of the revised model reveals that 7 of the 18 hypothesized paths in Figure 2 were supported. As predicted, all technical complexity manifest variables, except for non-compliant hardware, were significantly related to the intervening outsourcing interaction indicator, which was in turn positively related to the project methodology intervening variable. This indicates that as the technical complexity of an IS project grows, complex outsourcing relationships manifest. Project methodology was found to be a significant intervening variable between both outsourcing interaction and project size, and the project target date. This supports the importance of the use of project methodologies as projects increase in size and/or involve outsourcing in order to improve project performance. In addition, there is a positive relationship between project size and outsourcing interaction indicating that larger projects will often involve more complex outsourcing relationships.

Discussion

The goal of this study was to examine the role of formal project management interventions on information system (IS) projects. We were interested in answering the following two questions:

(1) What project characteristics influence the formal project management practices exhibited by high performing enterprise-wide IS projects?

Table III.
SEM results of initial model

Hypothesis	Path	Hypothesized relationship	Path coefficient	Hypothesis supported – critical ratio?	
1	Project methodology → Project target date	+	0.21	Yes	(4.17)*
2	Outsourcing interaction → Project target date	+	0.05	No	(1.02)
3a	Non-compliant software → Project methodology	+	0.04	No	(0.82)
3b	Non-compliant software → Outsourcing interaction	+	0.10	Yes	(2.26)**
4a	Non-compliant hardware → Project methodology	+	0.08	No	(1.70)
4b	Non-compliant hardware → Outsourcing interaction	+	0.01	No	(0.21)
5a	Rate of software change → Project methodology	+	0.00	No	(0.02)
5b	Rate of software change → Outsourcing interaction	+	0.09	Yes	(1.89)***
6a	Non-supported software → Project methodology	+	0.06	No	(1.33)
6b	Non-supported software → Outsourcing interaction	+	0.14	Yes	(3.12)*
7a	Project size → Project methodology	+	0.18	Yes	(3.35)*
7b	Project size → Outsourcing interaction	+	0.18	Yes	(3.64)*
8a	Non-supported software → Project target date	–	−0.05	No	(−1.46)
8b	Non-compliant hardware → Project target date	–	0.01	No	(0.18)
8c	Rate of software change → Project target date	–	−0.02	No	(−0.41)
8d	Non-supported software → Project target date	–	−0.05	No	(−1.04)
9	Project size → Project target date	–	0.07	No	(1.28)
10	Outsourcing interaction → Project methodology	+	0.11	Yes	(2.30)**

Notes: * significant at $p = 0.01$; ** significant at $p = 0.05$; *** significant at $p = 0.06$

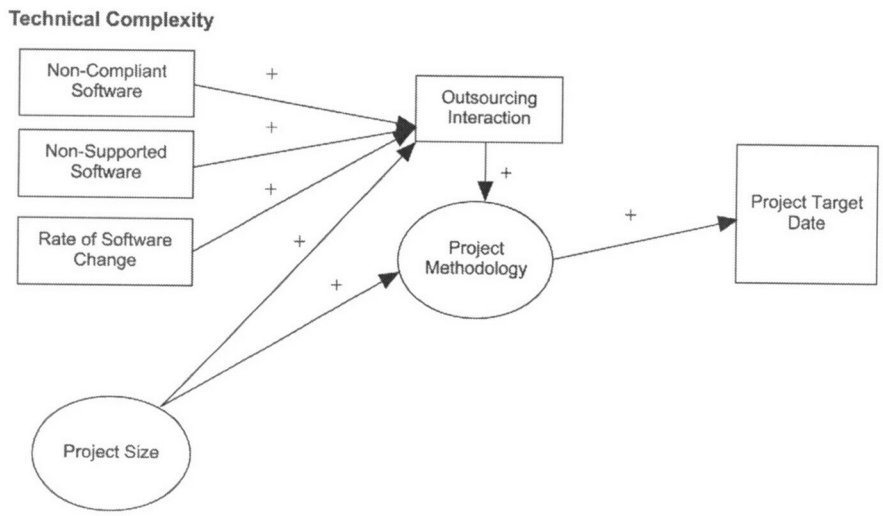

Figure 3.
Revised model

(2) What are the interactions between different project management practices as influenced by the project characteristics of well performing enterprise-wide IS projects?

We implemented the research using a dependent measure of IS project performance based upon a self-reported measure of target date (the expected date by which the system upgrade project would be completed). In the following section we discuss the answers to these questions along with the implications for theory and practice.

Project management practices that affect performance

Our results indicate that the use of a formal, problem-specific methodology affects performance. The positive relationship between project methodology and project performance supports previous findings that indicate the importance of the use of structured approaches that help to control and coordinate project activities in order to successfully complete a project in a timely manner. Especially where a delivery date is of the essence, a well-defined sequential series of steps, that is monitored and managed, is correlated with success. It is important to note that there is prior research that suggests a lack of correlation between some methodological steps (design reviews, prototyping and user contact) and software project success (Deephouse *et al.*, 1995-1996). Unlike prior studies, our research analyzed precise methodological steps that were specific to the problem at hand.

In addition, our results indicate that level of outsourcing interaction does not directly predict project performance. Instead we found that complex IS projects correlate positively with the increased outsourcing interaction. In turn, more complex outsourcing relationships are positively correlated with the use of formal project methodologies in high-performing projects. This confirms earlier research by Lee and Kim (1999) that suggests participation, communication and information sharing, Lee's (2001) knowledge sharing, are all positively related to partnership quality. It should be noted that while only 1.4 percent of the IS projects surveyed relied exclusively on

Table IV.
SEM Results for revised model

Hypothesis	Path	Hypothesized relationship	Path coefficient	Hypothesis supported – critical ratio?
1	Project methodology → Project target date	+	0.21	Yes (4.31)*
3b	Non-compliant software → Outsourcing interaction	+	0.10	Yes (2.34)**
5b	Rate of software change → Outsourcing interaction	+	0.09	Yes (1.90)***
6b	Non-supported software → Outsourcing interaction	+	0.14	Yes (3.12)*
7a	Project size → Project methodology	+	0.18	Yes (3.34)*
7b	Project size → Outsourcing interaction	+	0.18	Yes (3.60)*
10	Outsourcing interaction → Project methodology	+	0.13	Yes (2.72)*

Notes: * significant at $p = 0.01$; ** significant at $p = 0.05$; * significant at $p = 0.06$

externally outsourced resources, a large majority (75.6 percent) of all projects outsourced at least part of their system upgrade project. Our results show that using a project specific methodology with the outsourced projects was highly correlated with project success. The practical implication of this is that the level of outsourcing interaction alone does not necessarily impact IS project performance. Increased outsourcing interaction must be combined with a project methodology to achieve project success.

Influence of project characteristics on project management practices and performance

Our research shows that neither project size nor the technical complexity of an IS project are indicators of project performance. It is the management intervention, i.e. the utilization of a formal project methodology, in response to the IS project's size and complexity, that is critical.

Technical complexity. The initial model that we studied included three software complexity measures and one hardware complexity measure. The hardware measure, specifically percentage of BIOS not system compliant, was not found to be significantly related with outsourcing interaction, project methodology, or project performance. At the onset of this research hardware compliance was thought to be one of the most important concerns with respect to system upgrade projects. Given our results, this suggests that while hardware was an issue, it was dwarfed by the magnitude of the software issues. The other technical complexity measures (non-compliant hardware, non-compliant software and the rate of software change) were positively related to outsourcing interaction, indicating that as technical complexity increases, more complex interaction with vendors often occurs. Outsourcing has become an increasingly popular management option over the past decade in light of the continued streamlining by staff reduction and flattening of organizational structures by shifting managerial responsibilities to lower levels. This places even more demand on project managers to successfully manage the interface between internal staff and external partners in complex IS projects.

Project size. In our initial model there was no significant relationship found between project size and project performance. However, our results did indicate a weak correlation in the relationship between project performance and project size. However, our study concentrated primarily on larger sized projects with more than 75 percent of the respondents responsible for enterprise projects in organizations exceeding annual revenues of one-half billion dollars. We found that project size was positively correlated with the level of outsourcing interaction. This indicates that, like technical complexity, as project size increases, there is an increased tendency to have more complex outsourcing relationships. But unlike technical complexity, project size was also positively related to project methodology. This suggests that a higher level of outsourcing interaction is perhaps not necessary to achieve IS project success in large IS projects that are not as technically complex.

Interactions between project methodology and outsourcing interaction and its effect on performance

As interactions between internal and external constituents increases, coordination and communication issues become critical. This was supported through the finding that project methodology was found to be a significant intervening variable between

outsourcing interaction and project target date. The very nature of a project methodology is to provide mechanisms to support management in the communication of project issues, monitor the status of different activities, and improve coordination. Given the increasing complexity of outsourcing, there should be a parallel increase in future IS research involving outsourcing. One potential line of research may be to analyze different methodological techniques for their ability to support the communication and coordination processes between two or more organizations when outsourcing is required.

Conclusions

Our results show that technical complexity and project size do *not* directly affect meeting the project's target date. Neither large nor technically complex IT projects are predictors of poor project performance. Rather, our results show that it is the intervention of a formal project methodology that predicts the successful completion of a project by its projected target date. This is an important conclusion. Much had been written in the literature about how large, complex IT projects have high failure rates (Brown *et al.*, 1998; Standish Group International, Inc., 2001). Our study provides conclusive evidence that the greater the degree of methodology implementation the greater the chance for meeting the project's target date. Prior to this research, this had not been explicitly shown in the research literature.

The results of this paper suggest that the larger and more complex the IS project, the greater the need for management interventions that include the utilization of project specific methodologies. In addition, technically complex IS projects tend to require more complex outsourcing relationships in combination with a project specific methodology in order to achieve success. This suggests that a project methodology, that is common to both the organization's internal personnel and to the external partners, will more than likely be required in well-performing IS projects. In addition, our results suggest that many of the project management principles learned from years of studying software development projects may also have application when applied to enterprise-wide IS projects. Viewed in context of results from prior research in software project management, our results establish the importance of methodology in project success, particularly as it applies to large, enterprise-wide system upgrade projects.

Clearly, the message to managers of IS projects is to establish a project methodology to be used throughout the life of a project, especially in large, enterprise-wide projects, and more importantly, when some degree of outsourcing is required. The methodology must be clearly documented and understood by all project team members, including external constituents involved in the outsourced efforts. A good methodology can provide a standardized set of procedures and terminology that can be referenced by the project manager and team members in communications and provide a framework for the documentation of the project.

Limitations and future research

Our study has limitations that should be noted. The project performance measure used in this study, target date, was self-reported and takes into account a single dimension of project performance. Future research could consider additional measures of performance such as cost, end-user satisfaction and business value. In our study only one indicator of hardware technical complexity was considered, and this variable was

ultimately dropped and not included in the final model. Therefore, no specific conclusions could be drawn regarding hardware-related complexity in IS project management. As noted earlier, Kirsch's (2000) revised contingency model for software project management was a primary reference model for this study. Our study provides overall support for the portion of that model which views project management practices as interventions between project characteristics and project performance. In addition, our study also provides evidence that there are potential interaction effects between such management practices, and should be considered and analyzed in future research. Testing the differences in the effectiveness of different types of project methodologies, in a variety of different project settings may also result in findings of interest. In conclusion, we believe this study has proven valuable in furthering this field of study and hope that our recommendations for future study might inspire others to continue to build this knowledge base.

References

Abdel-Hamid, T.K. and Madnick, S. (1989), "Lessons learned from modeling the dynamics of software development", *Communications of the ACM*, Vol. 32 No. 12, pp. 1426-38.

Al-Mashari, M. and Zairi, M. (2000), "The effective application of SAP R/3: a proposed model of best practice", *Logistics Information Management*, Vol. 13 No. 3, pp. 156-66.

Arbuckle, J.L. and Wothke, W. (1999), *AMOS 4.0 User's Guide*, SPSS Inc. and SmallWaters Corporation, Chicago, IL.

Banker, R.D. and Slaughter, S.A. (1997), "A field study of scale economies in software maintenance", *Management Science*, Vol. 43 No. 12, pp. 1709-25.

Banker, R.D., Davis, G.B. and Slaughter, S.A. (1998), "Software development practices, software complexity, and software maintenance performance: a field study", *Management Science*, Vol. 44 No. 4, pp. 433-50.

Barki, H., Rivard, S. and Talbot, J. (1993), "Toward an assessment of software development risk", *Journal of Management Information Systems*, Vol. 10 No. 2, pp. 203-25.

Ben-Menachem, M. and Gelbard, R. (2002), "Integrated IT management tool kit", *Communications of the ACM*, Vol. 45 No. 4, pp. 96-102.

Brown, W.J., Malveau, R., Brown, W.H., McCormick, H.W. and Mowbray, T.J. (1998), *AntiPatterns: Refactoring Software, Architectures, and Projects in Crisis*, Wiley & Sons, New York, NY.

Charette, R.N. (1996), "Large-scale project management is risk management", *IEEE Software*, Vol. 13 No. 4, p. 110.

Chin, W. (1998), "Issues and opinions on structural equation modeling", *MIS Quarterly*, Vol. 22 No. 1, pp. vii-xvi.

Cockburn, A. (2000), "Selecting a project methodology", *IEEE Software*, Vol. 17 No. 4, pp. 64-71.

David, J.S., Schuff, D. and St Louis, R. (2002), "Managing your IT total cost of ownership", *Communications of the ACM*, Vol. 45 No. 1, pp. 101-6.

Deephouse, C., Mukhopadhyay, T., Goldenson, D.R. and Keller, M.I. (1995-1996), "Software processes and project performance", *Journal of Management Information Systems*, Vol. 12 No. 3, pp. 187-205.

Fornell, C. and Bookstein, F.L. (1982), "Two structural equation models: LISREL and PLS applied to consumer exit-voice theory", *Journal of Marketing Research*, Vol. 19 No. 4, pp. 440-52.

Grover, V., Cheon, M.J. and Teng, J.T.C. (1996), "The effect of service quality and partnership on the outsourcing of information systems functions", *Journal of Management Information Systems*, Vol. 12 No. 4, pp. 89-117.

Guinan, P.J., Cooprider, J.G. and Faraj, S. (1998), "Enabling software development team performance during requirements definition: a behavioral versus technical approach", *Information Systems Research*, Vol. 9 No. 2, pp. 101-25.

Hackathorn, R.D. and Karimi, J. (1988), "A framework for comparing information engineering methods", *MIS Quarterly*, Vol. 12 No. 2, pp. 203-21.

Hatcher, L. (1994), *A Step-by-Step Approach to using the SAS System for Factor Analysis and Structural Equation Modeling*, SAS Institute, Inc., Cary, NC.

Holland, C.P. and Light, B. (1999), "A critical success factors model for ERP implementation", *IEEE Software*, Vol. 16 No. 3, pp. 30-6.

Hu, L. and Bentler, P.M. (1999), "Cutoff criteria for fit indices in covariance structure analysis: conventional criteria versus new alternatives", *Structural Equation Modeling*, Vol. 6 No. 1, pp. 1-55.

Jiang, J.J. and Klein, G. (1999), "Risks to different aspects of system success", *Information & Management*, Vol. 36 No. 5, pp. 263-72.

Jones, C. (1996), *Patterns of Software Systems Failure and Success*, International Thomson Computer Press, London.

King, W.R. and Malhotra, Y. (2000), "Developing a framework for analyzing IS sourcing", *Information & Management*, Vol. 37 No. 6, pp. 323-34.

Kirsch, L.J. (1996), "The management of complex tasks in organizations: controlling the systems development process", *Organization Science*, Vol. 7 No. 1, pp. 1-21.

Kirsch, L.J. (1997), "Portfolios of control modes and IS project management", *Information Systems Research*, Vol. 8 No. 3, pp. 215-39.

Kirsch, L.J. (2000), "Software project management: an integrated perspective for an emerging paradigm", in Zmud, R.W. and Price, M.F. (Eds), *Framing the Domains of IT Management: Projecting the Future through the Past*, Pinnaflex Educational Resources, Cincinnati, OH, pp. 285-304.

Kirsch, L.J. and Beath, C. (1996), "The enactments and consequences of token, shared, and compliant participation in information systems development", *Accounting, Management and Information Technologies*, Vol. 6 No. 4, pp. 221-54.

Kumar, K. and Van Hillegersberg, J. (2000), "ERP experiences and evolution", *Communications of the ACM*, Vol. 43 No. 4, pp. 23-6.

Kuruppuarachchi, P.R., Mandal, P. and Smith, R. (2002), "IT project implementation strategies for effective changes: a critical review", *Logistics Information Management*, Vol. 15 No. 2, pp. 126-37.

Lacity, M.S. and Willcocks, L.P. (2000), "Relationships in IT outsourcing: a stakeholder perspective", in Zmud, R.W. and Price, M.F. (Eds), *Framing the Domains of IT Management: Projecting the Future through the Past*, Pinnaflex Educational Resources, Cincinnati, OH, pp. 355-84.

Lacity, M.C., Willcocks, L.P. and Feeny, D. (1996), "The value of selective IT outsourcing", *Sloan Management Review*, Vol. 37 No. 3, pp. 13-25.

Lee, J.N. (2001), "The impact of knowledge sharing capability and partnership quality on IS outsourcing success", *Information & Management*, Vol. 38 No. 5, pp. 323-35.

Lee, J.N. and Kim, Y.G. (1999), "Effect of partnership quality on IS outsourcing success: conceptual framework and empirical validation", *Journal of Management Information Systems*, Vol. 15 No. 4, pp. 29-61.

MacCallum, R.C. (1995), "Model specification: procedures, strategies, and related issues", in Hoyle, R.H. (Ed.), *Structural Equation Modeling*, Sage Publications, Thousand Oaks, CA.

Markus, M.L. and Tanis, C. (2000), "The enterprise system experience – from adoption to success", in Zmud, R.W. and Price, M.F. (Eds), *Framing the Domains of IT Management: Projecting the Future through the Past*, Pinnaflex Educational Resources, Cincinnati, OH, pp. 173-207.

Markus, M.L., Tanis, C. and Van Fenema, P.C. (2000), "Multisite ERP implementations", *Communications of the ACM*, Vol. 43 No. 4, pp. 42-6.

Necco, C.R., Gordon, C.L. and Tsai, N.W. (1987), "Systems analysis and design: current practices", *MIS Quarterly*, Vol. 11 No. 4, pp. 461-75.

Nidumolu, S. (1995), "The effect of coordination and uncertainty on software project performance: residual performance risk as an intervening variable", *Information Systems Research*, Vol. 6 No. 3, pp. 191-219.

Nunnally, J.C. (1967), *Psychometric Theory*, McGraw-Hill Book Company, New York, NY.

Powers, R.F. and Dickson, G.W. (1973), "MIS project management: myths, opinions and reality", *California Management Review*, Vol. 15 No. 3, pp. 127-56.

Rockart, J.F., Earl, M.J. and Ross, J.W. (1996), "Eight imperatives for the new IT organization", *Sloan Management Review*, Vol. 38 No. 1, pp. 43-55.

Schach, S.R. (1992), *Practical Software Engineering*, Irwin, Homewood, IL.

Schumacker, R.E. and Lomax, R.G. (1996), *A Beginner's Guide to Structural Equation Modeling*, Lawrence Erlbaum Associates, Mahwah, NJ.

Standish Group International, Inc. (2001), *CHAOS 2001: A Recipe for Success*, Standish Group International, Inc, West Yarmouth, MA.

Zmud, R.W. (1980), "Management of large software development efforts", *MIS Quarterly*, Vol. 4 No. 2, pp. 45-55.